"Impact of Couple-Based Interventions on Knowledge Uptake, Implementation, and Communication of Strategies to Prevent HIV, Non-Communicable and Neglected Tropical Diseases in Zambian HIV Seroconcordant Negative Couples"

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DECLARATION BY CANDIDATE

I have read and understood the School's definitions of plagiarism and cheating given the Research Degree Handbook and I am aware that more extensive explanations about these and related matters are given in the assessment irregularity procedures and my course handbook.

I, Tyronza Daniell Sharkey, confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

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Abstract

Background: Most HIV transmission in generalized epidemics in SSA and Zambia occurs in cohabiting heterosexual couples. Couples' Voluntary counseling and Testing reduces HIV transmission by 47% in concordant negative couples (CNC). However, half of residual infections post-CVCT occur in CNC due to unprotected extramarital sex. Neglected tropical diseases (NTD) and non-communicable diseases (NCD) continue to pose significant public health threats in terms of morbidity and mortality in SSA and Zambia. This thesis will address these public health issues through the use of HIV and non-HIV-related video-based group sessions with couples.

Methods: The thesis' data is from a cluster-randomized trial. "Strengthening Our Vows" intervention or SOV encouraged communication and negotiation of explicit sexual agreements (SA) to prevent HIV through unprotected extramarital sex. The comparator, "Good Health Package" or GHP, focused on health education, health screenings, provision of commodities, and interactive training to prepare couples to implement strategies to prevent NTD and NCD for their family's health.

Questionnaire data from baseline, two-week post-intervention in SOV/GHP, and six months post-intervention in GHP were analyzed. Outcomes measured were baseline sociodemographic and sexual and reproductive behavioral characteristics between arms; communication and negotiating explicit SA in SOV; knowledge and skills uptake, recommendations; household roles; and adoption and maintenance of strategies in GHP.

Results: Approximately 24% of CNC at baseline had at least one HIV risk factor. Most SOV spouses chose monogamy as their primary SA. Negotiations at home were friendly, supportive, and lasted 15-60 minutes. Approximately two-thirds of spouses noted at least one threat to remaining HIV-free. The most commonly cited threats were alcohol use, financial pressures, travel, and discord at home.

The GHP arm observed increased short-term and sustained long-term (6-month) knowledge and skills uptake for treating water with chlorine and handwashing techniques. Increases were also noted for reducing salt/sugar intake, taking medication, and getting levels checked. Sharing responsibilities increased for collecting and chlorinating water, sharing food purchasing, and caring for sick persons.

Conclusion: This thesis highlights that video-based interventions for couples can facilitate communication and negotiation of explicit sexual agreements for HIV prevention. In addition, video-based sessions for couples can increase knowledge and skills uptake, adoption and maintenance of healthy lifestyles, and sharing household roles for NCD and NTD prevention. Findings highlight a critical knowledge gap on NTD and NCD in Zambian CNC. Findings show opportunities for integrating health topics within couples-based research to address a myriad of health issues.

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Dedication

To my dearest dad and sister, Perry, Sr. and Yvonne as well as family members who have gone Home to be with God, I miss you and will love you always. I will continue to carry all our memories, love, and laughter with me wherever I go. I vow to continue to live my life to the fullest with as little regret as possible.

I love you for all eternity. Until we meet again.

Ty

List of Acronyms

AIDS	Acquired Immunodeficiency Syndrome
ANC	Antenatal clinic
ART/ARV	Antiretroviral therapy
BMI	Body Mass Index
CAS	Condomless anal sex
CDC	Centers for Disease Control and Prevention
CFHRZ	Center for Family Health Research in Zambia
CNC	HIV seroconcordant negative couples
CNM	Consensually nonmonogamous
CSO	Civil Society Organizations
CTLS	Community-led total sanitation
CVCT	Couples’ HIV Voluntary Counseling and Testing
CVD	Cardiovascular disease
DC	HIV serodiscordant couple
DHS	Demographic Health Survey
DM	Diabetes mellitus
FP	Family planning
GBV	Gender Based Violence
GEE	Generalized estimating equations
GHP	Good Health Package
GRZ	Government of Zambia
HIV	Human immunodeficiency virus
HR	Harm reduction
HTS	HIV Testing Services
IPV	Intimate Partner Violence
LMIC	Lower middle income countries
LSHTM	London School of Hygiene and Tropical Medicine
MCH	Maternal and child health
MDA	Mass Drug Administration
MSM	Men who have sex with men

NCD	Noncommunicable disease(s)
NIMH	National Institutes of Mental Health (US)
NTD	Neglected Tropical disease(s)
OPA	Organizational Policy Analysis
PEP	Post-exposure prophylaxis
PMTCT	Prevention of mother-to-child transmission
PrEP	Pre-exposure prophylaxis
RZHRG	Rwanda Zambia Health Research Group
SA	Sexual agreement
SAC	School aged children
SDG	Sustainable Development Goals (United Nations)
SOV	Strengthening Our Vows
SRH	Sexual Reproductive Health
SSA	Sub-Saharan Africa
STH	Soil-transmitted helminths
STI	Sexually transmitted infections
TasP	Treatment as Prevention
TB	Tuberculosis
UNFPA	United Nations Populations Fund
UNICEF	United Nations Children's Fund
VMMC	Voluntary medical male circumcision
WASH	Water, sanitation, and hygiene
WHO	World Health Organization
ZASF	Zambia HIV/AIDS Strategic Framework
ZDHS	Zambia Demographic Health Survey
ZHSP	Zambia Health Strategic Plan
ZMOH	Zambia Ministry of Health
ZNCDHSP	Zambia Noncommunicable Health Strategic Plan

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1. Chapter 1. Introduction

1.1 Country profile

Zambia is a land-locked country located in Southern Africa with a population of about 18.38 million, much of which is urban (1). Lusaka and Copperbelt are the two largest provinces in Zambia, where Lusaka and Ndola serve as their provincial capitals. Lusaka is also the capital of Zambia. Nyanja and Bemba are the most commonly spoken local languages in Zambia. Christianity is the most common religion. Most couples report practicing monogamy, while 11% of marital unions are polygynous, mostly occurring in Southern Province (2). The practice of polygyny in Lusaka and Copperbelt provinces is low, ranging from 1-4% (2). The non-government organization Center for Family Health Research in Zambia (CFHRZ) main research centers are located in the urban cities of Lusaka and Ndola, where this research was conducted.

1.2 Overview of HIV epidemic in sub-Saharan Africa and Zambia

Approximately 37.7 million people live with HIV worldwide, two-thirds in Africa (3, 4). In addition, of the 1.5 million new HIV infections, an estimated 58.6% occurred in Africa (3, 4). In sub-Saharan Africa, which carries the heaviest burden of the HIV epidemic, most HIV transmissions occur in heterosexual couples, particularly in areas where the epidemic is generalized (5). Stable, cohabitating heterosexual couples in sub-Saharan Africa comprise 60% of new infections, with ~50 % in HIV seroconcordant negative couples (CNC) (6). The majority of new infections in CNC are from external partners with the remaining occurring within the couple due to unknown HIV infected partner transmitting to their main partner (6).

Concurrent partnerships are one of the key drivers of HIV transmission (6, 7) in SSA. Multiple partners increase opportunities for HIV transmission, especially in the context of moderate-high HIV prevalence settings (8, 9).

1.2.1 HIV epidemic in Zambia

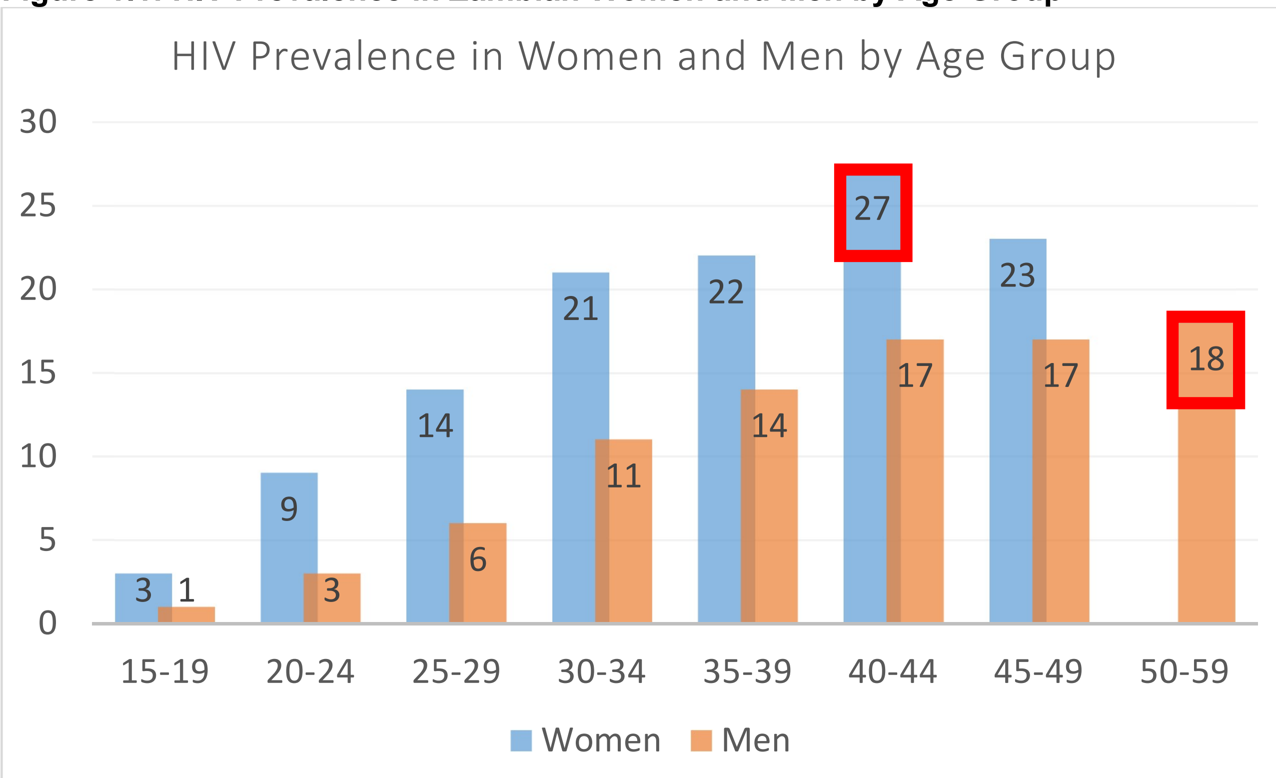
Zambia has one of the highest HIV prevalence in the world. The HIV prevalence in Zambia is 11.1% (1.2 million), with couples and those living in urban areas having a higher HIV prevalence than the national average at 15.4% and 15.9% respectively (2). Though HIV prevalence in Zambia has declined, new infections have not, partly because of having unprotected sex with concurrent partners (2).

1.2.2 Age-sex distribution and HIV

Zambia has more younger than older age groups (10). Age distributions by sex are similar, though slightly higher in females versus males in most age groups (10). Based on Zambia's 2015 census, approximately 22% of females were 15-45 years of age, and 25% of males were 15-65 (10). This age group is highlighted as couples recruited for this study were 18-45 years and 18-65 years for women and men, respectively.

In Zambia, 62% of adolescents 18-19 years of age are sexually active (11). Women and men in ZDHS reported first sexual intercourse at 16.6 and 18.5 years, respectively, with a median age at marriage at 19.1 and 24.4 years (2). Females account for most new HIV infections, particularly in the 15-24 age group, where females are three times more likely to have HIV than their male counterparts (2). HIV prevalence in women steadily increases until 40-44 years of age, while men's peak at 50-59 (2). In addition to adolescents and young adults, men 50+ years of age have also been identified as a risk group (12). The graph below shows HIV prevalence in women and men by age group.

Figure 1.1: HIV Prevalence in Zambian Women and Men by Age Group



Graph of HIV prevalence data presented in the Zambia DHS 2018 Report (2). The red boxes denote peak HIV prevalence.

1.2.3 National response to the HIV epidemic

Zambia's HIV prevalence has decreased over time (2, 11). Zambia's National Health Strategic Plan outlined strategies such as voluntary medical male circumcision (VMMC), HIV testing, ART, and pre-exposure prophylaxis (PrEP) to priority populations to be expanded further to curb the HIV epidemic (11). Several HIV testing strategies have been highlighted in Zambia's HIV testing services guidelines, such as community-based, provider-initiated, self and home testing, voluntary counseling and testing,

testing of mothers at antenatal clinics, and couples' testing (12). Zambia stated it has reached the first targets set by the UN Sustainable Development Goals (SDG) for 90-90-90; however, the country continues to face challenges as the rate of new infections has not declined (13). Without addressing gender inequalities in women and having more men access HIV testing and treatment services, the current targets reached will not be sustained (13).

1.2.4 Impact of CVCT

Most new HIV infections in SSA occur in cohabiting heterosexual couples (14, 15). In addition, most couples in SSA do not know their spouse's HIV serostatus. An effective HIV prevention strategy to address this gap, Couples' Voluntary HIV Counseling and Testing (CVCT), allows couples to undergo counseling, testing, and disclosing results together. CVCT was created by the Center for Disease Control and Prevention in collaboration with Rwanda Zambia Health Research Group and endorsed by the World Health Organization (16, 17). The impact of CVCT has been assessed by the Center for Family Health Research in Zambia (CFHRZ) through implementation projects where more than 200,000 couples were counseled and tested (18). These projects found that 79% of couples were CNC, 13% concordant positive, and 8% serodiscordant (DC) (18). The percentage of couples that were CNC and discordant in Zambia fell within the range of prevalences noted in a study by *Wall et al.* in six countries in SSA (19). Authors noted that the prevalence of CNC ranged from 70-97% while DC ranged from 3-16% (19). Regarding impact in Zambia, CVCT was shown to reduce HIV transmission between 63-79% in DC and 47% in CNC (18). Similar to modeling predictions by

Chemaitelly et al. (6), approximately half of new HIV infections in Zambian couples post-CVCT occurred in CNC (18) largely due to the large number of CNC.

In addition to reductions in HIV incidence, studies have shown improved protective behaviors, such as reduced unprotected sex (20) and increased condom use (20-23) were found, in couples who counseled and tested together (20-22, 24, 25). A clinical trial comparing CVCT to individual VCT among HIV-positive women found that women who underwent CVCT had increased uptake of nevirapine for mothers and infants and were more likely to report abstaining or using condoms with their partners (26). Couples have cited several reasons for seeking VCT services together, such as knowledge of their joint HIV serostatus, treatment support, and reducing mistrust concerns within the relationship (27). Social support was sustained among HIV-positive individuals and their partners when they received couples counseling (28). In another study, sustained reductions in self-reported unprotected sex acts were noted in DC after CVCT (29).

Some studies show CVCT to be more protective than individual VCT (20, 22, 23). *Jiwatram-Negrón and El-Bassel* summarized study findings comparing CVCT to VCT or general health promotion activities (30). Authors noted that CVCT resulted in better study outcomes related to reducing risky behaviors, improving sexual safety, HIV knowledge, willingness to be tested, and seeking testing services (30). In addition, the authors noted increased condom use and disclosure, reductions in infections and unprotected sex acts, and fewer coercive sex occurrences in couples who received couples-based VCT (30).

1.3 Epidemiology of noncommunicable diseases (hypertension and diabetes)

Diabetes and hypertension are leading causes of morbidity worldwide, with 422 million and 1.13 billion cases, respectively, with low middle income countries (LMIC) being disproportionately affected (31, 32). If continued on the same trajectory, diabetes (type 2) will become the 7th leading cause of death by 2030 (31). Recent surveys suggested 15% of Africans have diabetes type 2 (33), which is projected to increase to 23.9 million by 2030 (33). Diabetes has been referred to as a “silent disease” as many are undiagnosed (31). Africa accounts for 27% of hypertension cases worldwide (33). In SSA, including Zambia, these two NCD have become increasingly more common due to increased urbanization and industrialization; dietary and lifestyle changes, such as increased tobacco use, salt, sugar, and high fat intake; stress, increased life expectancies; and being more sedentary (34-41). Both NCD increase the risk for cardiovascular diseases (CVD), a leading cause of death worldwide, with ~75% of cases in LMIC (42, 43). The increased prevalence of CVD in SSA has been attributed to hypertension and diabetes (40). Risk factors in Zambia associated with mortality from CVD include high blood pressure, high body mass index, and dietary risks, which have been ranked from 6th to 8th, respectively (44).

1.3.1 Hypertension

In Zambia, stroke and heart diseases are among the top 10 causes of death, ranked at 3rd, 7th, and 10th positions, respectively (44). In 2013, the United Nations predicted that Zambia may have a five times increase in cardiometabolic disorders (hypertension, stroke, diabetes, and heart disease) by 2100 if no prevention efforts are taken (45).

Several studies in Zambia have examined hypertension prevalence and risk factors. Hypertension (>=140/90mmHg) is the most common non-communicable disease and the main cause of death due to CVD in Zambia (46). Hypertension prevalence ranged in Zambian studies from 25.9% to 32.8% (11, 34, 37, 38, 46-48). In a cross-sectional study by Goma *et al.,* of the 30.7% of participants diagnosed with hypertension, only 42.6% already knew of their diagnosis (46). Two studies in urban areas of Western Province in Zambia estimated pre-hypertension (130-139/80-89) prevalence was 24.6-45% (37, 38). Due to increased changes to dietary and inactive lifestyles, obesity has become a major concern in Zambia and a risk factor for hypertension (35, 38, 49). Risk factors associated with NCD in Zambian adults included insufficient dietary intake in terms of fruit and vegetables (90.4%); being overweight/obese (24.4%); inadequate physical activity and sedentary lifestyles (19.5%, 8.9%); hypertension (18.9%); tobacco use (10.7%); and diabetes 6.2% (35). Similar findings were found by *Nnyepi and colleagues, who* reported that NCD risk factors in Zambia were insufficient dietary intake (~95%), physical inactivity (~76%), and being overweight (~40%) or obese (~12%) (34). In the same study, 49% of Zambia women were overweight (34). A study in Lusaka found obesity prevalence at 14.3%, with women being three times more obese, putting them at elevated risk of NCD (49). High salt intake is a known risk factor for hypertension. A study in Western Province urban areas found women’s daily salt intake to be twice that of the WHO allowance of five grams (37). Another study found that being a woman, living in urban areas, and having less than primary education were more likely to have more NCD risk factors (35). The same study also showed more than

25% of participants had 3-10 NCD risk factors (35). *Nnyepi and authors* previously reported a similar finding from WHO STEP survey data (34).

In a study examining neurologic admissions in Lusaka, Zambia, 43% were due to strokes with a mean age of 60 (42-78) years, of which 62% were women (50). Medical histories of these stroke cases included HIV (18%), hypertension (80%), diabetes (16%), heart disease (34%), atrial fibrillation (9%), and previous stroke (22%), which were significantly associated with ischemic strokes (50). Hypertension can have severe or fatal consequences if left untreated. In ZDHS 2018, the majority of women diagnosed with hypertension reported not being on treatment (2).

1.3.2 Diabetes

Similar to hypertension, diabetes is becoming a public health burden in SSA. An estimated 14.2 (9.5-29.4) million persons in SSA aged 20-79 years have diabetes (51). In SSA, prevalence is estimated to be 2.1-6.7% (51). Another study by *Werfalli et al.* looking at diabetes prevalence in older adults in SSA found it to be at 13.7% (52). Compared to other areas in the world, SSA has the highest percentage of undiagnosed diabetes, with 66.7% (51). Urban areas bear the brunt of diabetes despite accounting for only 38.7% of the SSA population (51). With the current trend, the number of adults with diabetes will double in SSA by 2040 (51). The burden of diabetes is further exacerbated by self-management of diabetes being suboptimal (53, 54).

Compared to hypertension, fewer studies have examined diabetes in Zambia. A study by *Bailey and colleagues* found the prevalence of diabetes in 57,809 participants (31,000 households) across Zambia to be 2.9% (55). Among participants with diabetes, 34.5% did not know their diagnosis previously, with this proportion being higher when household socioeconomic position and education level decreased (55). Their study also found distal risk factors associated with diabetes, such as age, sex, and household socioeconomic position (55). Their study found that the odds of diabetes increased with age, higher BMI, and higher household socioeconomic position (55). Of participants who knew their diagnosis, 66% were not on any treatment, and 34.4% had random blood glucose concentrations above the recommended level, which suggested their condition was not well-controlled (55). In ZDHS, a subset of women similar to those with hypertension reported being diagnosed but not on treatment (2). A study looking at 121 bankers in Ndola, Zambia, found the prevalence of diabetes to be 15% (56). Like *Bailey et al.*, Msopa *and colleagues* showed that higher BMI, age, and sex (unadjusted) were associated with diabetes in addition to lack of physical activity and blood pressure (56). The highest risk is seen in those with obesity and not being physically active (56).

1.4 Epidemiology of neglected tropical diseases (diarrheal diseases, schistosomiasis, and soil-transmitted helminths)

Neglected tropical diseases (NTD), such as schistosomiasis, soil-transmitted helminths (STH), and diarrheal and respiratory diseases due to poor water, sanitation, and hygiene (WASH) present a threat to health in Zambia and SSA. Schistosomiasis and soil-transmitted helminthiasis are endemic and considered one of the main causes of health and economic burden in Zambia (11).

Worldwide, diarrhea disproportionately affects 1.7 billion children under five years of age each year (57). Diarrheal diseases are the leading cause of malnutrition and the 2nd leading cause of death in children < 5 years worldwide (57) (35). Diarrheal diseases result in 2.5 million deaths a year, of which 60-70% occur in children <5 years old, and of which, half are in Africa (58). Diarrheal diseases are preventable through access to safe water and proper handwashing (57). Risk factors for diarrheal disease include unsafe water, lack of or inadequate handwashing practices, poor sanitation, improper handling, and food preparation practices (57, 59, 60). Access to safe water reduces diarrheal diseases and the risk of stunting and deaths in children (60-62). Long-term consequences of stunting have been cited to potentially increase the risk of certain non-communicable diseases later in life (34).

1.4.1 Diarrheal and respiratory diseases

In Zambia, poor WASH practices were the fourth leading cause of death (44). The prevalence of diarrhea among children < 5 years of age in ZDHS was 15% (4-30%) (2). Diarrheal diseases also cause acute respiratory syndrome, whose prevalence was estimated at 2% prevalence two weeks before ZDHS (2). With handwashing, diarrhea and respiratory diseases like pneumonia can be reduced by 50% or more (59, 63-67). A study found that diarrhea prevalence in children was lower in households with improved drinking (14%) compared to households without (17%) households without (2). Cholera outbreaks during Zambia's rainy season have been attributed to fecal-contaminated water sources and inadequate drainage (68-72). Risk factors associated with cholera in Zambia were drinking from a borehole, close contact with the primary case, proximity to water bodies, flooding, and water shortage (73-75). With inadequate drainage, peoples' exposure to temporary bodies of water increases. A recent study in Lusaka highlighted how the recent growth of peri-urban areas has contributed to inadequate sanitation and the inability to provide adequate treated water to meet the demand (76). Such conditions increase the likelihood of water-borne infections like cholera (76).

1.4.2 Schistosomiasis

Schistosomiasis affects over 236 million people worldwide, disproportionately affecting Africa (77). The most common species of schistosomiasis in Africa are *Schistoma mansoni* (intestinal) and *Schistoma hematobium* (urogenital). At-risk groups include women doing chores in infested waters and poor and rural communities. Increased cases of schistosomiasis have been observed in urban/peri-urban areas due to migration from rural areas (78). Current targets for intervention include preschool-aged children (Pre-SAC), school-aged children (SAC), adults and communities in endemic areas, and adults with occupations involving water (78). Periodic prophylaxis has been recommended for SAC and at-risk populations, though issues with limited availability of praziquantel prevent this (78). In addition, a growing literature suggests a link between urogenital schistosomiasis and HIV transmission in women as well as cervical cancer (79-81).

Schistosomiasis is endemic in all of Zambia’s 10 provinces, with Lusaka and Copperbelt Provinces categorized as high risk (>=50%) and low risk (>=1-10%) respectively (82). Schistosomiasis prevalence was also noted to be potentially higher than previously thought (82). MDA targeting at-risk populations has been implemented (83), and scaling up disease control efforts has been planned (11). From 1976-2019, the pooled prevalence in Zambia for *S. hematobium* and *S. mansoni* was 35.5% and 34.9% respectively (79). Trends in Zambia have shown a decline in schistosomiasis between

1990-2010; however, post-2010, this has not been sustained (79). Approximately four million school-age Zambian children (SAC) were affected by schistosomiasis between 1976-2019, with *S. hematobium* being more common than *S. mansoni* (79). A similar trend was seen in another study in SAC where the prevalence of *S. hematobium* (17.4%) was higher than *S. mansoni* (8%) (84). A study looking at schistosomiasis among pre-SAC and children less than six years of age noted a pooled prevalence of 19% with more infections caused by *S. Mansoni* (22%) than *S. hematobium* (15%) (85). Among general and adult populations in cross-sectional studies in Zambia, schistosomiasis prevalence ranged from 3-88%, with the prevalence of female genital schistosomiasis (FGS) as high as 84.2% in a national sampling (82). Co-infections with hookworms have also been observed in SAC and adults (82).

1.4.3 Soil-transmitted helminths (STH)

STH affects 1.5 billion people yearly (86) and is caused by contaminated soil and poor hygiene. Roundworm (*Ascaris lumbricoides*), whipworm (*Trichuris trichiura*), and hookworm (*Ancylostoma duodenale*) are the most widespread STH worldwide and in SSA (87, 88), with reductions of STH in SSA between 52-74% when compared to pre-2000 (87). Authors estimated that since 2000, roundworm, whipworm, and hookworm prevalence was 16.5%, 6.6%, and 4.4%, respectively (87). At-risk populations include pre-SAC and SAC, women of reproductive age, including women and adults with high-risk occupations that put them in contact with soil (86).

STH affects more than four million SAC in Zambia (88). The prevalence of ascaris/hookworm and trichuria in the southern province of Zambia was 7.4-12.1% and 0%, respectively (89). A study in Ndola found the prevalence of intestinal parasites to be

19.6%, with ascaris being the most common (90). Risk factors associated with STH in this study were the father's unemployment and the child having a previous worm infection (90). In Pre-SAC in Kafue, Zambia, the prevalence of helminth infections was 17.9%, mostly due to ascaris and hookworm (91). Untreated helminthiasis can result in iron deficiency anemia (2) and nutritional and growth issues in children.

2. Chapter 2 literature reviews

2.1 Couples-based HIV interventions

Earlier studies highlighted the importance of approaching couples as a unit for HIV prevention (5). Couples-base HIV prevention strategies have been shown to reduce risky sexual behaviors by decreasing alcohol intake (30, 92), reducing unprotected sex (93), increasing condom use (92, 94), and increasing access to HIV testing, care, and adherence to ART (30). Additionally, reductions were seen in HIV incidence (30, 92) and viral loads in HIV-positive individuals (30). Couples-based HIV prevention strategies involving adherence to pre-exposure prophylaxis (PrEP) in DC and treatment as prevention (TasP) with ART in HIV-positive partners of DC have reduced HIV transmission and viral load (95). *Muessig and Cohen* pointed out that these PrEP and TaSP trials were essentially combinative trials in that all couples had received intensive couples' counseling (95). Thus further supporting that CVCT is an ideal platform to expand couples-based interventions.

Couples reaching a consensus within the relationship has been cited as one of the greatest influences on condom use (96). *Muldoon and colleagues* showed how disagreement in decision-making in DC in Uganda resulted in lower reported condom use than DC where both partners agreed (97). Further highlighting that joint sexual decision-making can improve protective behaviors, such as condom use (97).

Integrating partner testing for men in antenatal services increased women's attendance in PTMCT and adherence to ART and improved infant outcomes (5). Men who knew their HIV status supported their partners in getting HIV care (5). A review of CVCT showed how the integration of CVCT into routine clinic services increased PMTCT uptake, improved infant outcomes, and increased partner's uptake and adherence to ART services (5). These findings subsequently translated to increased support to include CVCT in antenatal services (5).

2.2 Sexual agreements

Why sexual agreements as an added component to CVCT in CNC?

2.2.1 HIV risk in CNC post CVCT

CVCT reduces HIV infection in CNC, though residual infections remain. CNC, being 79% of all couple HIV serostatus type and consisting of half of the new infections, represent a large number of couples still at risk. In ZDHS, ~20% and 1% of married/cohabiting men and women reported having two or more partners in the past 12 months (98). Other studies have reported similar behavioral patterns in men reporting more multiple and concurrent partners (99, 100). Biomedical interventions to prevent HIV in CNC are limited compared to DC. PrEP, though efficacious, is not a feasible option for CNC in Zambia currently as CNC incidence is 0.57%, and PrEP is prioritized for risk groups with an annual incidence of >=2% (101). As HIV infections in CNC are due to concurrent partners with more partners increasing HIV risk (8, 9), additional prevention strategies are needed beyond risk reduction counseling post-CVCT to enhance CVCT's impact. Though couple-based strategies have been shown to be more impactful than individually focused, there continues to be fewer HIV interventions focused on heterosexual couples (20, 22, 102).

2.2.2 Sexual agreements in MSM

Sexual agreements (SA) in western men who have sex with men (MSM) couples have been extensively investigated as it relates to the establishment and communication of SA and HIV risks associated with SA and unprotected anal sex or condomless anal sex and HIV (103-139). *Crawford et al.* noted that successfully negotiated SA required reliable info on the partner's HIV serostatus and an open, honest commitment to the SA (140). Other studies have examined SA by couples' HIV serostatus (141, 142) . This is important as prevention strategies can be better optimized depending on couples' HIV serostatus. *Mitchell and authors* noted that knowledge of HIV status might not translate to having an SA, as couples had established SA until after an unprotected, sexual exposure (117, 143). One study stated that SA negotiation in MSM couples involved determining the level of acceptable risk, condom use, and use of alternative preventative measures (103). *Bavinton and colleagues* found that committed, romantic MSM couples with an SA and openly discussed risks had reduced HIV risk factors from outside partners (109). Recent studies in South Africa and Namibia have begun characterizing SA in MSM couples (144, 145). An earlier study by *Kippax et al* showed general compliance among CNC MSM who had SA prohibiting unprotected sex with casual partners; they also had lower HIV risk (146).

In terms of components of negotiated safety and how they are used in HIV prevention, *LeBlanc and colleagues* described negotiated safety as agreements that included either mutual monogamy not requiring condoms, condom use with all outside partners and no condom use within the couple, or condom use both within and outside the couple (147). A study comparing consensually nonmonogamous (CNM) to monogamous MSM couples showed that though CNM had more lifetime sex partners, they were more likely to report using condoms with primary and outside partners and STI testing (148). However, most monogamous couples who reported outside partners did not notify their partners (148). These study findings suggest that MSM couples who practice monogamy may require additional HIV preventative strategies in case of an outside sexual act (148). *Rios-Spicer et al.* reported various agreements, ways of characterizing them, and their relationships to health outcomes in MSM couples. The authors concluded that more research is needed to understand better agreement breaches, communication of breaches, and expansion of research beyond MSM (134). *LeBlanc and colleagues* noted the inclusion of breach clauses as a component of negotiated safety (147). *Mitchell et al.* study highlighted the need for skill-building exercises to improve communication, particularly in the formative stages of the relationship (123, 137). *Mitchell et al.* also highlighted in an eHealth intervention that when SA was discussed in a more structured way as opposed to typical educational content, couples were more likely to establish an SA (123). *Prestage and authors* found that approximately 50% of MSM reported some discomfort discussing sexuality and HIV serostatus with their partner, which may affect their ability to adhere to the agreement or put them at increased risk of HIV (149).

2.2.3 Sexual agreements in heterosexual couples

Most SA research to date has been in MSM couples. The use of SA to prevent HIV in heterosexual couples has not been extensively studied. Though *Miller and authors* noted that most studies in heterosexual couples have focused on safer-sex communication in casual relationships, they discussed that communication in committed couples on health matters was important and needed to prevent HIV (150). Studies in heterosexual couples assessed the presence of monogamy agreements in relationships (151), interest or willingness to use SA (152-154), and type of SA (151). A study with 25 high-risk couples showed couples assessed risk though negotiated safety was not being heavily promoted at the time in the United States (155). The authors also noted that some couples had established implicit monogamy agreements, which were poorly adhered to (155). *Corbett and authors* commented that perhaps in a committed relationship, negotiated safety might be acceptable (155). *Hotton and colleagues* found that young African-American adults in heterosexual relationships had difficulties in communicating and issues surrounding trust, which might have led to monogamy agreements that were often implicit (156). The authors also noted that although participants knew sexual concurrency was an issue, it was rarely discussed in the relationship (156). *Hutton and colleagues'* results highlighted that couples were generally aware of risk and reduction strategies but acknowledged having faulty assumptions and poor adherence, which put them at an increased risk of HIV/STI (156). Authors noted that future studies should focus on dyadic communication and negotiated safety (156). An unintended pregnancy intervention study by *Warren et al.* showed that about half (n=227) of young adult heterosexual couples had an explicit monogamy agreement, of which 71% (n=162) sustained the agreement (157). Though couples reported having monogamy agreements, there was generally a lot of discordance within the relationship on the SA and the type (157). *Hotton et al.* similarly showed that approximately 50% of individuals in heterosexual relationships had explicit monogamy agreements, with more than 80% being sustained (156). A cross-sectional study by *Momplaisir et al.* in 41 US couples assessed the concordance of SA regarding mutual agreement on what behaviors are allowable both in and outside their relationship (151). They found that most partners (68%, n=56 individuals) either did not have an SA or had different expectations about them (151). However, couples (n=26) with concordant SAs were more confident working with their partner on condom use if having sex outside of the relationship and were more likely to agree to routine HIV/STI testing with their partners (151). SA in heterosexual couples could help lessen barriers faced when discussing safer sex openly in marriage, as a study in Tanzania has highlighted open sex dialogue in marriage to be limited (158). In Australian couples, an overwhelming majority (96%) expected sexual exclusivity of themselves and their partners, though only about half of men and two-thirds of women had discussed sexual exclusivity and explicitly agreed (159). At the one-year follow-up, approximately 4% of men and 2% of women had reported sex outside their primary relationship (159); of these, a majority were in relationships that were explicitly or implicitly sexually exclusive (159). This study highlighted the need to establish agreements explicitly before foregoing condoms in the relationship (159). A study in Zimbabwe by *Hageman et al.* explored HIV risk factors at the individual, partner, and couple-level in women who were monogamous (160). The authors noted that some women who were unaware of their HIV status tried to communicate their concerns about outside partners (160). *Hageman and authors* also highlighted that the partner's monogamy was insufficient to prevent HIV if the other partner was engaging in risky behavior (160). Studies in MSM show that similar to heterosexual couples there may be difficulties in communicating outside relationship with partners.

A few trials have included monogamy as part of the intervention content. *El-Bassel and colleagues* discussed monogamy in the context of a potential barrier to HIV/STI protection (161). In another study by *El-Bassel and others*, couple sessions covered factors within the couples associated with sexual risk reduction, which included monogamy, communication, problem-solving, and negotiation (162). *Wechsberg and authors* incorporated a commitment pledge for monogamy in their intervention (92).

2.2.4 Gaps identified

2.2.4.1 HIV prevention in CNC

Most dyadic research for HIV prevention has occurred in heterosexual couples where at least one partner is HIV-positive. There are limited studies on HIV prevention in CNC in SSA who may also be at risk due to concurrent partners and residing in high HIV prevalent areas.

2.2.4.2 Sexual agreements or communication in heterosexual couples

There are few studies on SA in heterosexual couples, particularly on SA and reducing HIV risk factors. Most studies have focused on safer sex communication in the context of casual relationships. Studies mostly looked at the feasibility and presence of monogamy agreements or the use of self-reported agreements in relationships, which were often implicit. These agreements were not spoken but assumed as understood, which could result in different expectations putting couples at risk. In addition, communicating agreements was noted to be difficult in MSM and heterosexual couples. Based on these studies, more structured guidance for effectively communicating and negotiating explicit sexual agreements in heterosexual couples is needed. Tools are also required to help couples discuss difficulties in communicating these agreements. Most studies were on a smaller scale where couples' HIV serostatus may not have been known. A few interventions have included monogamy in their content; however, whether they used monogamy agreements was not measured.

This thesis aims to add to body knowledge about sexual agreements and heterosexual couples by encouraging CNC to discuss and develop explicit sexual agreements that include a variety of options such as monogamy, condom use with outside partners, CVCT with an outside partner, and in the event of HIV exposure, abstaining from sex with spouse and retesting for HIV.

2.3 WASH and NTD interventions

2.3.1 WASH

A key component of the WASH strategy, handwashing, is an effective strategy to prevent diarrhea and is part of the 7-point plan by UNICEF and WHO on diarrheal control (163, 164). Various water and sanitation hygiene (WASH) intervention studies have focused on strategies such as health education, hand washing, and chlorination of water to prevent mortality and morbidity associated with diarrheal diseases and other diseases related to poor WASH conditions such as soil-transmitted helminths and schistosomiasis. Various systematic reviews have examined the effectiveness of hand washing and water treatment in reducing diarrhea risk or incidence (163). In an examination of community-based trials by *Curtis and colleagues*, hand washing was estimated to prevent diarrhea risk by up to 47% (59, 163). Another review examining a wide range of WASH interventions in LMIC noted a previous review by *Fewtrell et al.* which found these interventions resulted in ~ 44% reduction in diarrhea incidence (163, 165). Handwashing strategies pointed out in the literature included training and education in individuals/groups on hygiene practices, handwashing and soap, transmission, and how these germs affect health using various mediums, such as leaflets, posters, drama, and songs (163, 166, 167). Handwashing with soap and flowing water was shown to be more effective than communal handwashing, where multiple family members share the same bowl of water to wash their hands in many instances without using soap (163, 168). This communal handwashing practice likely contributes to diarrheal diseases rather than preventing them, as contaminated hands may contaminate food (163, 169). Similarly, a review examining handwashing interventions with training components in SAC in developing countries found that handwashing was associated with significant reductions in diarrheal and respiratory infections (170).

A review of handwashing promotion studies for diarrhea prevention found that handwashing reduced one-third of diarrheal cases in LMIC, though there were only two studies in Africa (163). In eight LMIC communities, of which one was in SSA, handwashing promotion resulted in a one-fourth reduction of diarrheal episodes (163). Overall, the review showed that handwashing plus soap intervention had reduced diarrhea; improved prompts for handwashing, i.e., before eating/cooking, after going to the toilet, after changing baby's nappy/diaper; and improved handwashing technique (163).

In Lusaka Province, Zambia, a non-randomized control trial for handwashing with soap intervention conducted by the Programme for Awareness and Elimination of Diarrhea showed a decrease in diarrheal infections and a 34% reduction in the probability of death in children under the age of five (171).

Poor knowledge and practical skills have also been associated with improper or suboptimal WASH practices (172-176).

2.3.2 Schistosomiasis

Since the World Health Assembly resolutions 54.19 in 2001 (177) and 65.21 in 2012 (178) set goals for the elimination of schistosomiasis, most prevention focus has been on mass drug administration (MDA) of praziquantel (179). Though MDA significantly reduces schistosomiasis' prevalence, this has not led to its elimination (179-181). Thus, there is a renewed interest in examining other interventions, including those with behavior change components (179-181). This is important as MDA campaigns, many ongoing for 10 years or more, have not fully translated to knowledge uptake, leading to misconceptions and negative attitudes towards MDA, thus preventing the complete elimination of schistosomiasis (182-184). In addition, a study in South Africa have shown knowledge of transmission, prevention, signs, and symptoms to be inadequate (185). Some community-based approaches using community dialogue (186) in Mozambique and a participatory hygiene and sanitation transformation intervention (PHAST) in Tanzania (187, 188) have shown that increased knowledge translated to actions to either control or prevent schistosomiasis and may change misconceptions (187, 188) (186). In Zambia, a systematic review by *Kalinda and colleagues* noted a study by *Silwambe and Baboo,* which showed that 30% of respondents in the town of Kaoma knew about schistosomiasis (82, 189). A systematic review by *Price and authors* noted that health education had a beneficial impact by improving knowledge and understanding of schistosomiasis (190). To progress toward the elimination of schistosomiasis, providing health education to and involving caregivers in the planning process will be critical (183, 191, 192).

2.3.3 Soil-transmitted helminths

Deworming is a known, short-term MDA used to prevent STH (193). A review on WASH access and practices and STH infections found that handwashing before eating and after defecating resulted in decreased odds of ascaris (193). In addition, significant associations were found between the use of soap or its availability, handwashing after defecation, and reduced STH infection of any kind (193). Similar to WASH and schistosomiasis, a knowledge gap was observed in a study of caregivers in South Africa by *Sacolo-Gwebu et al.* where <50% knew about transmission, prevention, signs, and symptoms of STH (185).

2.4. NCD interventions

As with NTD, knowledge uptake should be an important aspect of any NCD intervention. A study on health literacy intervention for diabetes was shown to be effective in promoting knowledge of disease, attitude, and behavior (194). In diabetes and hypertension, lack of knowledge about a condition, its symptoms, risk factors, disease complications, misconception, and misperception has contributed to their disease burden and likely contributed to undiagnosed diabetes in Africa, which has a prevalence of 1-14% (55, 195-197). Similar to diabetes and hypertension, studies looking at CVD have highlighted patients' low perception of risk, poor knowledge about CVD and its related conditions/risk factors may result in seeking medical late, having inadequate self-care, and ensuring effective prevention and treatment (40, 198). Zambia and other studies in SSA have highlighted that a lack of general knowledge of NCD, understanding of healthy lifestyles, screenings, and suboptimal management contribute to the development or worsening of these conditions (37, 39, 195). In some instances, participants may be aware of CVD risk though ingrained food preferences, for example, adding salt, remained the same (39, 199).

2.5 Gaps identified in WASH, NTD, and NCD interventions

Many studies have identified gaps related to a lack of awareness or poor knowledge about health conditions and how to prevent them. Awareness of potential knowledge gaps on NTD and NCD among Zambian couples was based on anecdotal information from CVCT counselors providing basic health education on these topics to increase HIV retesting rates after CVCT. Their feedback led to the creating of a more intensive and interactive program covering NTD and NCD of public health importance in Zambia. Their observations align with needs assessment findings from the 2009 Zambia's NCD Programme where inadequacies in community awareness of hypertension and diabetes were reported at 74.6% and 76.1%, respectively (200).

3. Chapter 3 Study aim and research questions

3.1 Research project aims

Couple-based interventions covering HIV, NTD, and NCD have the potential to improve communication, knowledge uptake, adoption, and maintenance of strategies with the goal of integration into CVCT. There is limited literature on sexual agreements and HIV risk in CNC heterosexual couples, particularly in SSA. In addition, various studies cite a lack of or limited knowledge of WASH, NCD, and NTD. Addressing this knowledge gap is critical given the impact of HIV, NTD, and NCD on morbidity and mortality in SSA and Zambia. In addition, there are inter and intra- co-morbidities or infections associated with HIV, NTD, and NCD, which may worsen a disease prognosis or increase disease or infection risks.

In this chapter, I will present the following: 1) the study aim and 2) the research questions.

3.1.1 Aims

This thesis aims to assess post-intervention communication and adoption of sexual agreements for HIV prevention as well as assess knowledge uptake of HIV, NCD, and NTD in Zambian CNC.

3.1.2 Research questions

1. Are there differences in baseline characteristics in the intervention and comparison arms? (Research Paper 1)
2. Will CNC who receive a video-based group session in the intervention “Strengthening Our Vows” (SOV) be able to communicate and negotiate sexual

agreements to keep their marriage HIV-free from extramarital partners? (Research Paper 2)

3. Will CNC who receive a comparator video-based group session, “Good Health Practices” (GHP), to prevent NCD and NTD, show improved knowledge and application of prevention and treatment of diarrheal and respiratory diseases, intestinal helminths, hypertension, diabetes, and schistosomiasis? (Research Paper 3)

Figure 3.1 shows how the three research papers will be used to highlight various health topics (HIV, NTD, and NCD) covered in the video-based group sessions with couples and assess their effect on communication, knowledge, skills, and sharing of responsibilities in the dyad.

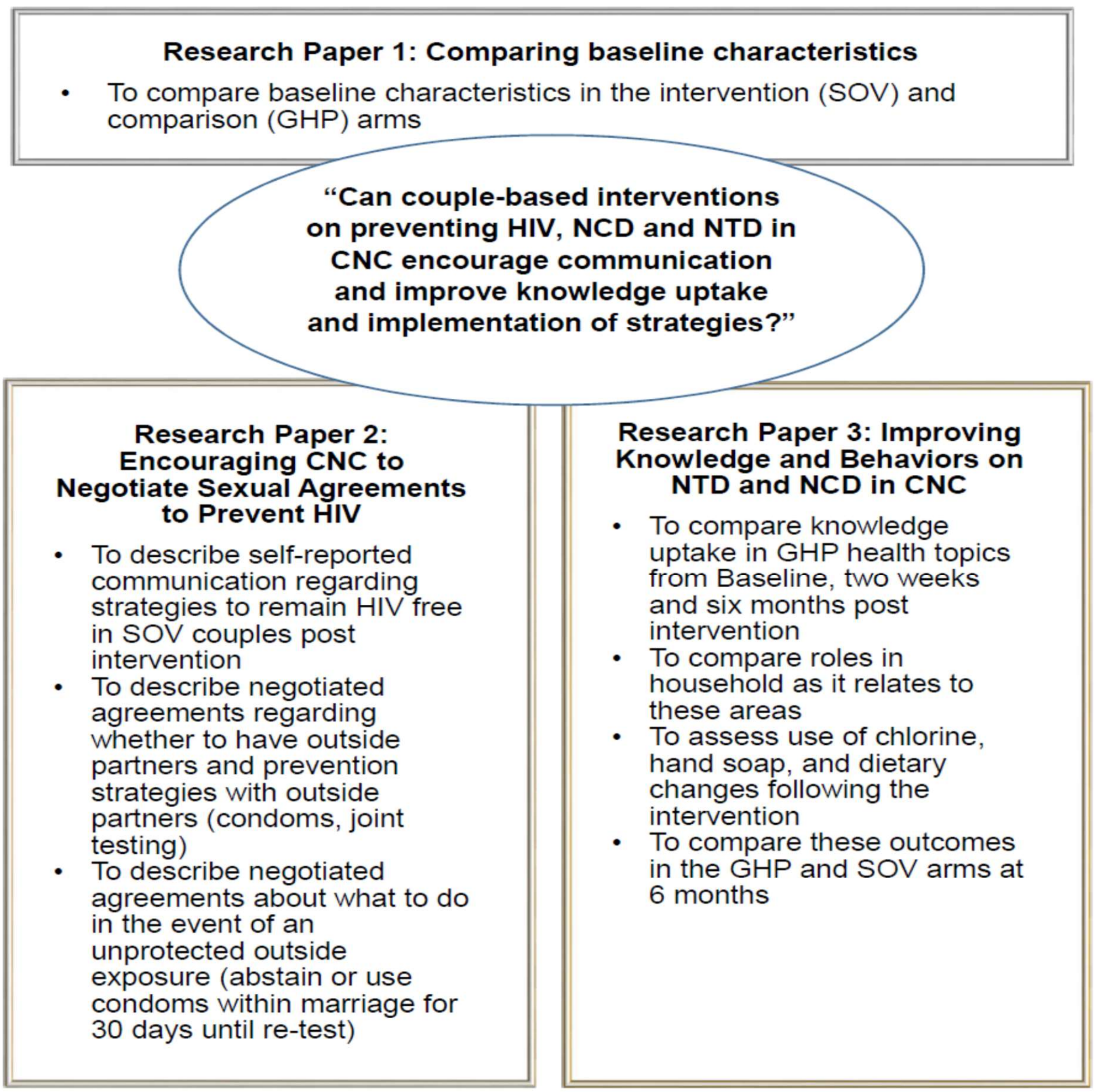


Figure 3.1: Framework of Thesis and Linkage between Chapters

4. Chapter 4 Methods

4.1 Description of intervention and comparator

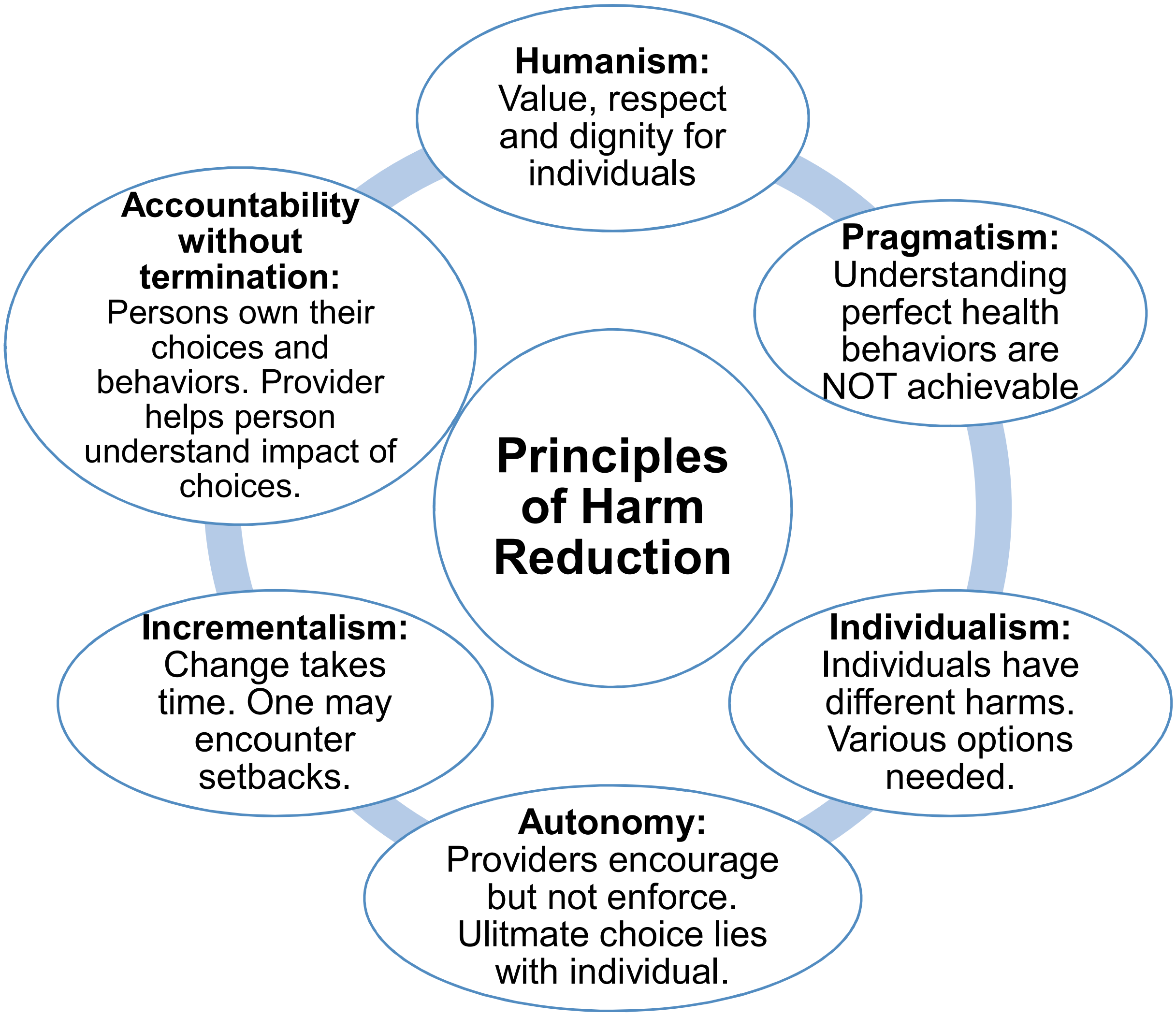
This thesis consists of two video-based group sessions, one for each study arm. One video session covered encouraging communication and negotiating sexual agreements in the “Strengthening Our Vows” intervention arm or SOV. The comparison arm, “Good Health Practices” (GHP), consisted of a video group session on knowledge, practical training, and implementing strategies related to the prevention and treatment of diarrheal and respiratory diseases, STH, hypertension, diabetes, and schistosomiasis. The formative work for SOV and rationale for GHP have been described in more detail in Research Paper 1.

4.2 Framework and relevance to hypothesis

4.2.1 Harm reduction and HIV prevention

Harm reduction approaches (HR) recognize that promoting and adopting abstinence and avoidance-only approaches to address risky behaviors may not be realistic. Thus, HR provides a more pragmatic approach. HR has six principles illustrated in Figure 4.1 (201). Historically, injection drug use and safe needle programs extensively used HR approaches to prevent HIV. HR has since been incorporated into other HIV prevention strategies, which include condom use; HIV sero-testing and negotiated safety in MSM; skills building on condom use, condom negotiation and sexual communication with partners in women; health education, use of barrier methods, provision of condoms, and peer support systems in sex workers; and expansion of sex education in adolescence to include non-abstinence approaches (201).

Figure 4.1: Six Principles of Harm Reduction



4.2.1.1 Harm reduction framework for SOV

In the video, SOV incorporated HR into scripted scenarios to show how threats, unprotected sex, and not knowing the outside partner's HIV status could put their marriage at increased risk for HIV. The threats used in scripts were based on common threats cited by CNC in the formative phase. The video highlighted how couples can use their sexual agreements, "Together HIV Free" and "Protecting My Spouse," to prevent HIV from entering the union and protect their spouse. For detailed information on sexual agreement content, refer to Research Paper 1.

To illustrate SOV within HR, I used a modified harm reduction approach for HIV and safer sex, as suggested by Mattson (202). This modified approach is described in Table 4.1.

Table 4.1: SOV within HR

Harm Reduction (HR) Approaches	**SOV within HR**
Treating individuals with dignity, respect, and compassion	The study team were lay counselors who were trained in CVCT and human subjects protection
Acknowledging that risky behaviors will always exist and thus it is better to minimize harmful effects	The possibility of a sexual encounter outside the marriage is real. In some situations, it may be difficult to stick to remain HIV-free. It is important to recognize potential challenges. Encouraging spouses to identify their threats and discuss sexual agreements with them to prevent HIV from entering the relationship was a realistic way to address this issue.
Offering a range of choices and not just avoidance of harms	Couples may choose monogamy as sexual agreement or abstain from having sex with an outside partner until tested together. Spouses may choose to use condoms with outside partners. Spouses may also use condoms or abstain from sex with their spouse in case of potential HIV exposure until retested in 30 days. SOV recognizes that one approach may not fit all thus, options are given.
Understanding threats that may lead to a harm. Not minimizing or ignoring the realities and dangers of risky behaviors.	Threats (e.g., alcohol, financial pressures, traveling, and tensions at home) may lead spouses to have unprotected sex with an outside partner. Unprotected sex can bring HIV into the marriage.
Engaging in unhealthy/unsafe practices can harm the individuals practicing them, their loved ones, and communities	Engaging in condomless, outside sex and not knowing the outside partner's HIV status can put the couple at risk of STI and HIV. Both spouses communicating and negotiating sexual agreements may protect them as well as their children and family.
Recognizing the realities of economic, social, and personal issues may affect one's risk and how one deals with risky-behavior	Realities (threats) such as traveling, desire for extra money and goods, financial pressures, disagreement between spouses and inattentive spouses, alcohol, post-partum, and menstruation can affect risk or how risks are dealt with.

Encouraging individuals to make reasonable, informed choices to mitigate harms to themselves and others	Participants in group sessions were asked to personally reflect on the sexual agreements discussed, go home and discuss with their spouse and choose the best strategy for them and their marriage.
Understanding personal biases and judgments affect counseling and interactions with participants	Counselors and the study team were trained on the study protocol. This training included an emphasis on not being judgmental and avoiding personal biases.
Ensuring strategies are relevant and practical for individuals	Various options were presented to keep marriage HIV free, including protecting the spouse in case of potential outside HIV exposure. Strategies include practical, well-known, evidence-based strategies, like condom use, HIV retesting, and couples' counseling testing with outside partners.
Ensuring strategies can be used, short-term and can be tailored	Sexual agreements have various options, which participants can change depending on the situation.
Empowering individuals to take ownership of practicing safer/healthy choices. Health professional encourages and facilitates dialogue instead of making choices for individual	Couples have the ultimate responsibility to keep HIV out of the union. Emphasis is on a commitment to each other. The counselor also commits to helping the couple reach their goal. Couples were encouraged on the importance of communication in establishing sexual agreements.

4.2.1.2 Reframing monogamy and faithfulness within the context of SOV

In SOV, monogamy (faithful) was framed in the context of an HIV prevention strategy. This was important as the concepts of “faithful” and fidelity may be subjective (203). In a qualitative study in Zambia, participants described faithful as being supportive, respectful, and maintaining harmony within the house (203). Thus, a person may interpret being faithful as behaving in a faithful manner but still have multiple partners (203).

4.2.2 Harm reduction and NTD/NCD prevention

GHP was not developed based on a specific theoretical framework but expanded on a previously used simplified flip chart with basic health education and provision of commodities for follow-up HIV testing after CVCT. The expanded version included more health education content, hands-on practical skills activities, screenings, provisions of commodities, and implementation of strategies at home for healthy households. Information on GHP's rationale is found in Research Paper 1.

4.3 Development of questionnaires

4.3.1 Sociodemographic, reproductive, and sexual behavioral questions

Sexual behavioral questions used in SOV and GHP were based on similar questions used in past studies with heterosexual couples in Rwanda Zambia Health Research Group (RZHRG). The development of sociodemographic, reproductive, and sexual behavioral questions was noted in Research Paper 1.

4.3.2 SOV-specific questions

Based on focus groups and interviews, SOV-specific questions were created during the formative phase and were pilot-tested. Questions were not based on a theoretical construct but on RZHRG's 30-plus years of experience conducting HIV and sexual behavior research in heterosexual couples. The development of SOV-specific questions was noted in Research Paper 1.

4.3.3 GHP-specific questions

GHP questionnaire topics have been broadly described in Research Paper 1. Questions in the GHP questionnaire related to drinking water sources, time to collect drinking water, and water treatment before drinking are similar to those captured in Demographic Health Surveys (2). The demonstration of the handwashing technique was based on steps from WHO guidelines on handwashing. The remaining questions did not follow a specific standardized tool.

4.4 Study procedures at baseline and visit 2 in SOV and GHP and visit 4 in GHP only

Study procedures at specific analysis time points are indicated in Figure 5.1 in Research Paper 1 and described in Research Papers 1-3. Research Paper 3 included visit 4 procedures for GHP only as SOV was a contemporaneous comparison to determine whether other external NTD or NCD programs and interventions impacted outcomes.

4.5 Data management and analysis

Data management and analysis for this thesis were explained in Research Papers 1-3.

4.6 Ethical considerations

Information related to written joint consent has been described in Research Papers 1-3.

5. Chapter 5 Research Paper 1: A Cluster Randomized Trial to Reduce HIV Risk from Outside Partnerships in Zambian HIV-Negative Couples using a Novel Behavioral Intervention, “Strengthening Our Vows”: Study Protocol and Baseline Data (Research Paper 1)

Overview of Research Paper 1

The study protocol was described for this cluster randomized trial on which this thesis is based. Paper 1 provides information about formative work for this CRT in addition to study procedures, analysis plans, and baseline characteristics of two arms being compared “Strengthening Our Vows” (SOV), the HIV intervention, and “Good Health Package” (GHP), the non-HIV comparator.

The chapter highlights objectives related to this thesis, which include describing the communication and negotiating of sexual agreements after intervention and measuring improvement in the GHP arm as it relates to knowledge of prevention and recommendations for diarrheal and respiratory diseases, STH, schistosomiasis hypertension, and diabetes.

This chapter shows imbalances with regard to some sociodemographic characteristics between SOV and GHP. However, no imbalances were noted for outcomes of interest. In addition, approximately one-quarter of couples in SOV and GHP have had at least one HIV risk factor since married.

Imbalances related to sociodemographic characteristics will be dealt with in the analysis.

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RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

SECTION A – Student Details

Student ID Number	1406846	**Title**	Ms
First Name(s)	Tyronza Daniell		
Surname/Family Name	Sharkey		
Thesis Title	Impact of Couple-Based Interventions on Knowledge Uptake, Implementation, and Communication of Strategies to Prevent HIV, Non-Communicable and Neglected Tropical Diseases in Zambian HIV Seroconcordant Negative Couples		
Primary Supervisor	Dr. Rosanna Peeling		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	Contemporary Clinical Trials Communications		
When was the work published?	23 September 2021		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	Yes	Was the work subject to academic peer review?	**Yes**

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Where is the work intended to be published?	

Please list the paper's authors in the intended authorship order:	
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Creation of intervention and comparison arm flip chart guides, videos, questionnaires, other data collection tools and databases; training of study and clinic teams; implementation of the work and data collection; project administration; data analysis; manuscript preparation, review and editing.

SECTION E

Student Signature	Tyronza Sharkey
Date	15-Mar-2023

Supervisor Signature	Rosanna Peeling
Date	15 March 2023

Title: A Cluster Randomized Trial to Reduce HIV Risk from Outside Partnerships in Zambian HIV-Negative Couples using a Novel Behavioral Intervention, “Strengthening Our Vows”: Study Protocol and Baseline Data

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Highlights

- Novel HIV behavioral intervention adapted from sexual agreements in couples of men who have sex with men (MSM).
- Use of sexual agreements to reduce HIV and sexually transmitted infections (STI) risk factors in heterosexual Zambian couples.
- Jointly and individually, spouses decide how to remain HIV free and protect spouse.
- The comparator promotes healthy households to prevent various non-HIV/STI diseases.

Keywords: HIV Cluster randomized trial Zambia Heterosexual couples Extramarital partners Sexual agreements

Abbreviations

ART Anti-Retroviral Treatment

CAB Community Advisory Board

CAS Condomless Anal Sex

CDC Centers for Disease Control and Prevention

CFHRZ Center for Family Health Research in Zambia

CVCT Couples' HIV Voluntary Counseling and Testing

CNC Concordant HIV-negative couples

DHS Demographic Health Survey

GHP Good Health Package

MSM men who have sex with men

PrEP Pre-Exposure Prophylaxis

RPR Rapid Plasma Reagin

STI Sexually Transmitted Infections

SOV Strengthening Our Vows

SSA sub-Saharan Africa

V0–V5 Visit 1-Visit 5

WHO World Health Organization

Abstract

Background: Heterosexual couples contribute to most new HIV infections in areas of generalized HIV epidemics in sub-Saharan Africa. After Couples' Voluntary HIV Counseling and Testing (CVCT), heterosexual concordant HIV negative couples (CNC) in cohabiting unions contribute to approximately 47% of residual new infections in couples. These infections are attributed to concurrent sexual partners, a key driver of the HIV epidemic in Zambia.

Methods/design: Ten Zambian government clinics in two of the largest cities were randomized in matched pairs to a Strengthening Our Vows (SOV) intervention or a Good Health Package (GHP) comparison arm. SOV addressed preventing HIV infection from concurrent partners and protecting spouses after exposures outside the relationship. GHP focused on handwashing; water chlorination; household deworming; and screening for hypertension, diabetes and schistosomiasis. CNC were referred from CVCT services in government clinics. Follow-up includes post-intervention questionnaires and outcome assessments through 60 months. Longitudinal outcomes of interest include self-report and laboratory markers of condomless sex with outside partners and reported sexual agreements. We present baseline characteristics and factors associated with study arm and reported risk using descriptive statistics.

Results: The mean age of men was 32 and 26 for women. On average, couples cohabited for 6 years and had 2 children. Baseline analyses demonstrated some failures of randomization by study arm which will be considered in future primary analyses of longitudinal data. An HIV/STI risk factor composite was not different in the two study arms. Almost one-quarter of couples had an HIV risk factor at baseline.

Discussion: In preparation for future biomedical and behavioral interventions in sub-Saharan Africa, it is critical to understand and decrease HIV risk within CNC.

Introduction

Most incident HIV infections in sub-Saharan Africa (SSA) occur in cohabiting heterosexual couples, including discordant and concordant HIV negative (HIV-) couples (14, 204). Couples' Voluntary Counseling and Testing (CVCT) was developed by CDC (205) in collaboration with the Rwanda Zambia HIV Research Group and endorsed by WHO for HIV prevention in 2012 (17). In Zambia, a demonstration project in 73 government health centers provided CVCT to 207,428 couples of whom 13% were concordant HIV+, 8% were discordant (DC), and 79% were concordant negative couples (CNC). CVCT reduced transmission in both DC and CNC. Though the DC remained at comparatively higher risk (1.78/100 Couple-Years HIV incidence after CVCT+condoms+ART) than the CNC (0.53/100 CY), the CNC were a much larger percentage of all couples. As a result, 47% of the new infections that occurred after CVCT were in CNC and 53% were in DC (18).

Having multiple and concurrent partners results in extended sexual networks which increases opportunities for HIV transmission (8, 9), and multiple, concurrent partnerships are one of the key drivers of the Zambian HIV epidemic (206). In Zambia's 2013-2014 Demographic Health Survey (DHS), approximately 20% of men and 1% of women who are married/cohabiting report having two or more partners in the past 12 months (207). This is similar to literature from other countries that show men report more multiple and concurrent partners than women (99, 100). Couples-based HIV interventions tailored for CNCs could enhance the impact of CVCT to further reduce HIV risk in this group.

Other prevention modalities, like pre-exposure prophylaxis (PrEP), have been shown to reduce HIV transmission. However, PrEP implementation has been slow due to costs, clinic capacity, communication and awareness, supplies, and access (18, 208). Additionally, from the end-user perspective, drug adherence, access, side effects, stigma, and perceptions of safety and effectiveness pose challenges to uptake (209, 210). In Zambia, given the low incidence of HIV following CVCT (18), CNC do not qualify for PrEP based on WHO Guidelines.

Previous work with negotiated agreements in western couples provided the template for our work. Much of this work was done with men who have sex with men (MSM) couples, in whom the majority of new infections are also acquired from a main partner (136, 211, 212). Gass et al found that MSM were more likely to have condomless anal sex (CAS) with the main partner (105). In 1999, Crawford et al reported that when sexual partners engage in negotiated safety agreements, they usually did not practice unsafe sex (140). In 2001, the same group interviewed MSM with regular partners and found a variety of agreements including negotiated safety (29%); no CAS (34%); and unsafe sex (11%) (213). Kippax et al published similar findings from the pre-HAART era, with 91% of concordant HIV- men reporting no outside CAS with use of a negotiated agreement in 82% (146, 214). A 2014 longitudinal study by Darbes et al found that higher investment in sexual agreement and communication were among the factors that significantly predicted less CAS with outside partners for seroconcordant MSM couples (104). Hoff et al and Gomez et al have assessed predictors of broken agreements (130) and the effects of relationship characteristics and serostatus differences on sexual agreements in MSM couples (129, 130, 142) . Mitchell et al explored the influence of substance use on adherence to sexual agreements among MSM (116). Stephenson et al found that partnered HIV- MSM were less likely to seek regular HIV testing compared with MSM in an open relationship (141). In a 2015 qualitative study of heterosexual clients attending Sexually Transmitted Infections (STI) services in the US, Stephenson et al showed high levels of willingness to be jointly tested and counseled for HIV and to discuss sexual agreements (153).

We developed the Strengthening Our Vows (SOV) intervention to reduce HIV risk among Zambian CNC through modeling and supporting negotiation for sexual agreements between husband and wife. This intervention is relevant and timely as couple-based strategies may be more impactful than individually focused approaches in reducing sexual risk behaviors but no study has yet evaluated sexual agreements in heterosexual African couples (20, 22, 102). In this randomized trial, we include a comparator arm with an intervention focused on neglected tropical and non-communicable diseases, in keeping with UN Development goals (215).

Methods

Pre-Trial Planning

Focus groups and interviews

The pre-pilot and pilot phases for developing SOV were conducted from 2011-2014. We present the summary of the phases in Table 5.1. Focus groups and individual interviews were conducted with convenience samples of heterosexual CNC, CNC in which one or both partners had become HIV infected due to exposure outside the relationship, and CVCT counselors. All participants provided written informed consent. Focus groups with couples were sex-separated with facilitators and note takers of the same gender as participants to encourage candid discussions on concurrent partners and relationship agreement in the context of HIV prevention. These trained facilitators and note takers were senior counselors, who spoke the local languages Nyanja and Bemba, and had extensive training and experience in CVCT and conducting focus groups and interviews. Focus groups with couples were done in a local language while focus groups with CVCT counselors included both men and women and were conducted in English. Focus group sessions were audio recorded but not transcribed verbatim. Rather, recordings were reviewed later and compared against notes to ensure accuracy of thematic identification. Interviews were conducted with each spouse separately in the local language and were not recorded.

Focus groups and interviews typically lasted from 30 to 60 min. At end of each session, study staff met, reviewed the participants' responses, and noted repeating themes. Recruitment for focus groups concluded when saturation of themes was reached. The purpose of the formative work was to discuss counselor's experiences managing concurrent partners during CVCT; highlight couples and counselors' perceptions of negotiated sexual agreements as an HIV prevention strategy; determine feasibility and acceptability of sexual agreements for CNC; identify threats in a union that might lead to a potential HIV exposure from concurrent partners; explore issues that may impact facilitating sexual agreements with CNC; and develop a pragmatic behavioral intervention to guide couples on taking preventative actions to protect their marriage from HIV exposure from outside partners.

From the pre-pilot phase, we identified key considerations and themes such as discussing hypothetical concurrent partners in the abstract during counseling; not disclosing outside partners without spouse's permission; providing discrete referrals for CVCT with outside partners; ensuring gender balance when discussing threats that lead to HIV exposure; and ensuring neutrality and confidentiality throughout counseling. Important messages highlighted by participants included an emphasis on the window period between exposure and seroconversion during which individuals are very contagious, and alternatives to monogamy including testing with outside partners prior to sex and using condoms during all outside sexual contacts. Interviews with men and women of seroconverted CNC highlighted threats that might lead to potential HIV exposure outside the relationship such as traveling, the desire for extra money and goods, post-partum abstinence, discord within the marriage, and inattentive spouses. Some participants mentioned that, as long as their spouse protected them from HIV, they did not need to know the details of their outside sexual contacts. These findings were incorporated into the intervention and open-ended, post-intervention questionnaire that would be used during the pilot phase with CNC. During the pilot phase, staff were trained on the draft tools. We performed mock intervention and post intervention visits with CNC to assess visit flow, length of visit, and further refined the questionnaire based on responses from couples and feedback from counselors. During this period, identifying potential threats to remaining HIV free and using a non-verbal communication cue were further explored and incorporated into the intervention and post-intervention questionnaire. The construct of the questionnaires used to assess the impact on SOV was based on our 27 years of experience on sexual behavior in cohabiting Zambian heterosexual couples. These questionnaires were consistent with our previous work with regard to measurement of standard behavioral outcomes, such as outside partners, condom use, alcohol use, joint testing and self-reported STI treatment.

Intervention and comparator content

The intervention and comparator arm materials included client videos and complementary counselor flip charts. The structure of the video and flip chart aligned in terms of headings, pause points, and content covered; the flip chart provided counselor structure to highlight key important points during pauses. This was done through group brainstorming as well as questions and answers. All materials were translated into local languages, Bemba and Nyanja and content was equivalent to or below 8th grade level. Video run-time for each arm was approximately 1 h. We present the intervention content in Table 5.2.

The SOV video was structured in two segments and included the HIV prevention agreements within the plans: “Together HIV Free” and “Protecting My Spouse” with guidance to finalize the plan in “Making Your Plan.” The first segment included the same content presented separately to men only and women only groups. “Together HIV Free” focused on keeping HIV from entering the marriage by 1) not having sexual partners outside of the relationship, 2) testing jointly with outside partners and only having sex with those who are also HIV-, and/or 3) using condoms every time with an outside partner (29, 155). “Protecting My Spouse” discussed ways to avoid passing the virus on in the event of an unprotected sexual exposure to an outside partner with HIV + or unknown HIV status and included 1) abstaining from sex with the spouse or 2) using condoms consistently with the spouse until HIV retest after the “window period” of 30 days. The “window period” was emphasized in the video as a particularly infectious period prior to development of anti-HIV antibodies.

For the second segment, husbands and wives were brought together into one group to view and discuss six scripted video scenarios depicting hypothetical couples with various risk factors identified from the formative research. Each video scenario highlighted different potential threats to remaining HIV free including longstanding outside partners (“old boyfriends/girlfriends”); traveling and working away from home; alcohol use (216-218); receipt of attention, money and gifts; and sexual inactivity due to wife’s postpartum abstinence and menstruation. The creation of the scenarios was guided by the harm reduction approach where potential real-life threats to remaining HIV free are acted out and couples discussed and used various strategies from “Together HIV Free” and “Protecting My Spouse” to prevent HIV from entering the union. There were pauses in the video after each scenario for counselors to use the flip chart for further discussion of the HIV risk the couples in each scenario faced; what actions could reduce risk of HIV; and what couples could agree to do to prevent HIV in the future. The video also featured communicating the need for using “Protecting My Spouse” and included tips on how to deal with difficult communication and disclosure. An alternative and unique concept for communicating the need to use the “Protecting My Spouse” plan was the “yellow card”, a visual cue derived from soccer, to signify a non-verbal signal to the spouse about a potential HIV exposure and need for caution. The familiarity and understanding of the use of the yellow card in soccer made it a neutral tool for men and women to use given the sport’s popularity in Zambia. The yellow card, which all intervention couples received, was used in scenarios to illustrate how the card can be used to indicate the need to have a conversation about a potential HIV exposure and need for an alternative/interim plan to ensure protection from HIV within the relationship. The final part of the video, “Making Your Plan”, asked couples to discuss risk reduction plans together and return in one to two weeks for a counseling session to finalize their agreement and ‘take their vows’. Vows were an opportunity for the couple to discuss and identify their mutual agreement and commitment to keeping each other HIV free and to provide both partners with an opportunity to verbally communicate directly to their partner regarding their agreement and commitment.

Flip chart-based GHP had been previously developed for use at government clinics to improve follow-up testing rates after CVCT (219) and covered education, prevention and screening of diarrheal diseases, intestinal helminths, hypertension, diabetes, and schistosomiasis. The diseases were chosen as they are common health issues in Zambia in addition to being a simple, low cost service that could be easily integrated into CVCT. For this study, we further expanded GHP to include more health education content on each of the diseases; practicum for handwashing and water treatment with chlorine; and barriers to applying GHP at home. Pauses were incorporated throughout the video in key areas to cover flip chart talking points and allow for questions. Similar to SOV, GHP had two segments, with couples being separated into groups of men only and women only in the first segment and being brought back together in the second segment. The first segment opened with the theme “Everyone has an equal responsibility in keeping our family healthy” and covered each health topic; risk groups; information on transmission and mechanism of action; signs and symptoms; key facts and statistics; and prevention strategies. Modifiable lifestyle choices related to diet, salt intake and physical activity were emphasized for prevention of hypertension and diabetes. Schistosomiasis education highlighted how freshwater areas within a city could be potentially infected as a recent study had shown active infection in 10% of Lusaka adults (80). Pauses in the video also allowed counselors to demonstrate and for participants to practice proper handwashing techniques, preparation of potable water by measuring chlorine for 5L and 20L containers, and portion size of salt and sugar. The second segment consisted of mini quiz game where couples were asked about content covered and practiced preparing chlorinated water and handwashing. This segment closed with couples talking about what the theme “Everyone has an equal responsibility in keeping our family healthy” meant to them. Participants were provided with a bottle of chlorine, hand soap and deworming pills for the family to take home.

Rationale for the comparator

The comparator GHP was designed to be unrelated to HIV but to include a similar format (videos and group discussions) and to require a similar amount of time with beneficial health messaging unrelated to HIV, STI or sexual behavior. All couples received CVCT prior to joining the study. Post-test counseling in CVCT covered HIV risk reduction strategies with basic messaging on monogamy, alcohol awareness, condom use with outside partners, and repeat HIV testing if exposed. The GHP arm was family focused while SOV was couple focused.

Study Objectives

This trial has primary and secondary objectives related to both the intervention, Strengthening Our Vows, and the comparator, Good Health Package.

Primary objectives

1. Compare the impact of ‘Strengthening our Vows’ (SOV) negotiated sexual agreement intervention versus a comparison arm on reduction in a composite of HIV risk factors from concurrent partners. The HIV risk factors include incident HIV and sexually transmitted infections (STIs) diagnosed and by self-report of outside treatment as well as self-report of outside partners, condom and alcohol use during sex with outside partners, knowledge of outside partner HIV status, and joint HIV testing with outside partners
2. Describe the types of risk couples report for acquisition of HIV in the marriage and the HIV prevention agreements SOV couples develop to reduce those risks
3. In the comparison arm that receives a “Good Health Practices” (GHP) intervention focusing on prevention of neglected tropical and non-communicable diseases, measure improvement in knowledge of prevention and treatment of diarrheal and respiratory diseases, intestinal helminths, hypertension, diabetes, and schistosomiasis

Secondary objectives

1. Assess the ability of an e-fingerprinting system to enhance follow-up and detection of study outcomes, multiple enrollments and potential spillover effect
2. Disseminate and incorporate successful strategies learned from the SOV and GHP into current CVCT and Couples' Family Planning Counseling guidelines

Ethics

Approval for this trial has been granted by the OHRP-registered University of Zambia Biomedical Regulatory Ethics Committee and Emory University Institutional Review Board. This trial is registered at the US National Institutes of Health (ClinicalTrials.gov) as NCT02744586. Couples viewed a verbatim reading of the informed consent on a video, met with a counselor to discuss any questions or clarifications, and jointly signed consent. A unique alphanumeric ID was implemented for all data gathering tools. Locator information was stored separately from data to maintain privacy and confidentiality. As stated in the informed consent, couples may withdraw from the study at any time without losing their entitled benefits. The study involves some risks and discomforts, such as blood draws, answering personal questions, and discussions at home related to study topics. Participants may opt out of questions or discussions if they are not comfortable and can seek additional counseling at the clinic, individually or with their spouse. Information a spouse provides individually is confidential and is only disclosed to the spouse with explicit permission. Initial and ongoing training and supervision of the study team is conducted to mitigate risk.

Community Advisory Board (CAB)

Before the beginning of the trial, the study team engaged the CABs in Lusaka and Ndola to review protocol, informed consents and discuss recruitment. The CAB has representation from media; education; health; faith-based institutions; law enforcement, young adults; community leaders; people living with HIV; as well as at-risk HIV populations. The CAB continues to be updated throughout the trial on study progress. At each meeting, a light lunch and an honorarium are given.

Trial Design Overview

We illustrate the trial design and procedures in Fig. 5.1. This is a clinic-randomized trial among CNC. We selected government health clinics as the unit of randomization since the intervention is provided in a group setting. Clinics in matched dyads were randomly assigned to either intervention or comparison arm via a coin toss. Eligible couples attending their neighborhood clinics automatically received the arm assignment for the clinic. At the final visit, the alternative intervention is offered so that participants can benefit from both interventions.

Clinic Selection and Randomization

The cluster randomized trial comprises urban, government health clinics in Ndola and Lusaka Zambia which provided Couples' HIV Voluntary Counseling Testing (CVCT) services in collaboration with the Center for Family Health Research in Zambia (CFHRZ). Of 55 clinics offering CVCT, 10 clinics were selected based on urban location (catchment population of 10,000–145,000 people) from "The 2012 List of Health Facilities in Zambia" preliminary report (Republic of Zambia Ministry of Health, 2012).

The first selection criteria were that the clinics be far enough apart to have low risk of spillover and that in the aggregate they have the volume of CVCT that would ensure recruitment of a sufficient number of couples for the trial.

To detect possible patient spillover due to bus routes and walking trails not reflected on maps, the study team and drivers mapped transport routes to high-volume clinics and checked with clinic staff about their clientele to ensure that chances of spillover would be low. Clinics were then matched by clinic volume (number of couples tested), distribution of couple HIV serostatus, and follow-up testing rates in the year following CVCT (219). The five dyads were randomized via coin toss by an unbiased staff member not directly involved with the clinics. Coin toss was done for the first clinic in each dyad. The second clinic in the dyad received the opposite arm by default.

Study Population

Couples who received CVCT services at the clinics in Ndola (n = 8) and Lusaka (n = 2) were pre-screened. Those meeting initial eligibility at pre-screen were invited for screening, enrollment, receipt of SOV intervention/GHP comparator, and follow-up.

Trial Procedures

Trial procedures are outlined in Fig. 5.1: Trial Design and Procedures. Trial procedures for couples include a baseline visit (V0), intervention visit (V1) and four post-intervention visits (V2–V5).

***Staff training and quality assurance*:**

As in our past training programs, we administered pre and post-didactic training tests to select government clinic nurses and counselors who worked with us on CVCT. The purpose of the pre and post tests were to identify knowledge gaps and assess knowledge uptake after training. The trainees for this study were selected by our team based on their experience and performance with the CVCT program. Trainees who passed the didactic test proceeded to practicums observed by trainers and including obtaining informed consent, leading the video group discussion, and administering questionnaires. The flip chart provided to the counselor for use during video sessions included explicit instructions to ensure that important topics were emphasized during Q and A and were consistently delivered over time. It is traditional in Zambia for counselors and nurses to use “call and response” (220) when doing health talks in the clinics, which is an excellent way to ensure audience participation and comprehension. Each clinic was staffed by a senior research nurse who provided ongoing monitoring and mentorship to ensure fidelity to the study procedures. In addition, “mystery couples” (221) were selected from among community health workers who had collaborated with the research team for many years. They were trained on checklists of procedures to pay attention to and interviewed by study trainers after each visit. Their feedback was relayed to the research nurse for inclusion in oversight duties.

Study reimbursement

At each visit, couples receive study reimbursement to cover time at clinic and transport, as described in the informed consent. Reimbursement is 30 kwacha (approximately 3

USD) per person. An additional 20 kwacha (approximately 2 USD) per person is given as a lunch allowance for longer study visits.

Pre-screening at CVCT

At CVCT services in government health centers, couples underwent pre-test counseling, HIV rapid testing per national guidelines adapted for couples (screening with HIV with Alere Determine HIV1/2 and confirmation with either Trinity Biotech Uni-Gold HIV or Standard Diagnostics (SD) Bioline HIV-1/2 3.0), and post-test counseling provided by government counselors. Couples received HIV results together and were counseled per their couple HIV status according to CDC and WHO guidelines (17, 205). Each couple was given a unique couple ID during CVCT, which they maintained throughout the trial. Eligible and interested couples were referred for additional screening procedures.

Visit 0 (V0): Screening and enrollment

Screening

Screening. Screening and enrollment procedures based on Inclusion and Exclusion Criteria, Table 5.3 occurred on Saturday or Sunday when the clinics were less busy and group activities could be conducted without disruption to regular clinic flow. This visit lasted 2–3 h. Participants were given a membership card recording their study ID, appointment dates, and fingerprints.

Enrollment

A baseline questionnaire was administered to each spouse separately by a gender-matched counselor and included socio-demographic characteristics (income, number of persons/children in the household and literacy) and past and recent sexual history questions were asked related to HIV risk behaviors, such as age at sexual debut, number of lifetime sexual partners, frequency of sex with spouse, outside partners since married, condom use with outside partners, alcohol use during sex with outside partners and ever being treated for an STI. In addition, to measure unrelated outcomes addressed in the comparator arm, participants were asked about roles in the household for daily activities (collecting and treating water, preparing and purchasing food, taking care of sick persons, changing baby's nappy, washing dishes and handling animals). Spouses were also asked about knowledge and behavior related to communicable and non-communicable diseases addressed in the GHP comparison program. Couples consented to storage of blood, urine and vaginal swab samples.

Visit 1 (V1): Intervention visit

Participants were scheduled for the intervention one or two weekends after enrollment. Testing for HIV was repeated as described above in CVCT in addition to syphilis testing with SD Syphilis 3.0 Bioline and microscopic exam of wet mount for detection of vaginal trichomoniasis. Quality control testing was performed at our research laboratories with wet mount microscopy for vaginal trichomoniasis and IMMUNOTREP RPR® by Omega Diagnostics for syphilis. While laboratory tests were underway, couples in both intervention and comparison arms attended their arm specific video group sessions. The content and format of the videos and discussions is presented above. Participants with positive syphilis tests were provided with treatment at no cost. This visit lasted 3–4 h.

Intervention Arm: Strengthening Our Vows (SOV)

At the end of the visit, each spouse was offered a yellow card to use in the event of an outside sexual exposure and provided with condoms. They were invited to revisit the issues raised in the video and group discussion at home and to develop an agreement to remain HIV-free as a couple. They were scheduled for a counseling session one to two weekends later to finalize their agreement and take their vows.

Comparison Arm: Good Health Package (GHP)

Following the video and group discussion, couples were screened for hypertension via blood pressure cuff and diabetes (glucose) and schistosomiasis (blood) via urine dipstick. Individuals were provided with immediate treatment with praziquantel if blood was detected in the urine. Any participant with abnormal screening results, i.e., blood pressure greater than/equal to 140/90 mmHg and/or glucose on urine dipstick greater than/equal to 500 mg/dl was provided with additional lifestyle and dietary counseling, low sodium salt, and referral for further clinical assessments as indicated. Each couple received deworming tablets for the family, chlorine for water treatment, and hand soap. They were scheduled for a follow-up visit one to two weekends later to assess changes in knowledge and behavior.

Visit 2 (V2): Follow-up visit

In the SOV arm at V2, each spouse was interviewed separately by a gender-matched counselor. The questionnaire covered knowledge of strategies which included recall of topics covered during intervention and questions related to the 30-day “window period” for HIV and the importance of abstaining or using condoms for this 30-day period if HIV exposed. Spouses responded to a series questions related to discussion of plans "Together HIV Free" and "Protecting My Spouse" with their spouses and whether they made their plan. These questions ranged from discussions at home in terms of the environment, length of discussion, agreement on the plan, discussion initiator, and comfort discussing these plans. The counselors read strategies for the "Together HIV Free" plan (monogamy, always using condoms with outside partners, testing with outside partners and/or knowing their HIV status) and "Protect My Spouse" plan (following an unprotected outside exposure, abstain from sex with spouse or use condoms for 1 month until HIV retest) and participants reported which components were a part of their agreement. Respondents reported whether they had challenges communicating their plans effectively and if there were any threats to their ability to remain HIV free in the union. After the interview, each partner was asked whether there was any information they had shared with the interviewer that they would NOT want discussed when the couple was brought together. Counselors for the two partners met separately to compare notes, brought the couple together, and reinforced and congratulated couples on successful negotiations while avoiding disclosure of confidential information. Spouses then recited the standardized SOV vows to each other, which include not exposing themselves to HIV outside the marriage and if potentially becoming exposed to HIV, keeping the spouse safe during the window period until repeat test was done. The citing the vows together gave the couple an opportunity to practice direct communication of their plans in a supportive environment with the counselor. This process further emphasized positive communication about keeping HIV out of the marriage from outside partnership through using the plans. In the

GHP arm, men and women were interviewed separately to assess change in knowledge and behavior related to components of the GHP intervention.

In the GHP arm, men and women were interviewed separately to assess change in knowledge and behavior related to components of the GHP intervention.

Visit 3-Visit 5 (V3-V5): Follow-up visits

Follow-up visits are scheduled 3 months (V3); 6 months (V4); and 60 months (V5) after intervention (V1). Each spouse is administered a questionnaire that includes sexual behavior questions that make up the HIV risk factor composite; these include reported sex with outside partners since participating in the intervention (for V2) or since the last visit (for V3, V4 and 5), HIV status (if known) of those outside partners, HIV testing with outside partners, condom use and alcohol use during outside exposures; and STIs including syphilis, genital ulcers, gonorrhea and genital discharge, which were diagnosed at or treated between study visits. Laboratory testing is done for HIV and STI using same tests outlined in enrollment procedures. Follow-up visits last between 1 and 4 h.

V5

At V5 after data collection regarding HIV risk behaviors and laboratory testing for HIV and STI, participants in each arm will receive the video-intervention from the other arm (i.e., SOV participants receive the GHP video intervention and GHP participants receive the SOV video intervention). The construct of the questionnaires used to assess the impact on SOV was based on our 30 years of experience on sexual behavior in cohabiting Zambian heterosexual couples. These questionnaires were consistent with our previous work with regard to standard behavioral outcomes, such as outside partners, condom use, alcohol use, and self-reported STI treatment.

Retention

Locator cards, appointment books, and late lists

Couple's locator information and phone numbers are updated throughout the trial. Phone numbers are verified by counselors during the visit. Appointments are recorded on couple's membership card and an internal appointment book. Couples with phones receive reminder texts prior to study visits and are called on the day of the visit if late for appointment. Appointments are rescheduled as needed. Late lists are generated to follow-up couples who miss appointments. Couples are contacted via SMS, phone call and/or home visit.

Couple identification

At enrollment and at each follow-up visit, right and left index and thumbprints of each spouse are taken manually using paper and fingerprint ink. Manual records are used real-time at the clinic for participant identification by comparing the ink fingerprints on the membership card issued at enrollment with the fingerprint obtained on the day of the follow-up visit.

We also captured electronic fingerprints (222) using tablet-based biometric software and a Lumidgm scanner. Tablets from participating clinics are brought to the research sites in Lusaka and Ndola for data upload as neither wifi nor adequate cellular reception are available at the clinics. Unique and anonymous numbers (not fingerprint images) are stored on a password secured website. This ensures that couples have not been enrolled in more than one clinic, and that the participants who return for follow-up are those who were enrolled with that identifier. Confirmation that the correct couple was interviewed at each follow-up visits is done post-hoc using this electronic database.

Sample Size and Power Calculation

Power calculations were based on Hussey and Hughes (223) assuming enrollment of 1800 couples and a conservative 58% retention. Conservative retention estimates are based on our many years of experience with cohort studies in Zambia. Loss to follow-up is expected to be high due to high rates of relocation (224). Expected outcomes are based on the literature. The calculations in Table 5.4 show risk in the intervention group and detectable risk ratio for 80% and 90% power with intraclass correlation value of 0.10.

Data Management

Questionnaire data is managed using Microsoft Access and Research Electronic Data Capture (REDCap) electronic data capture tools hosted at Emory University (225) with IT support from Research and Woodruff Health IT Division grant support (UL1 TR000424). All laboratory data is managed in Microsoft Access. Data cleaning is conducted in REDCap as well as queries generated in Microsoft Excel and Microsoft Access. Data analysis is conducted using SAS 9.4 (SAS Institute, Cary, N.C.).

Baseline Data Analyses

Baseline sociodemographic, reproductive health characteristics, sexual history and behavioral characteristics by study arm

To assess the success of randomization and the resulting equivalency of participants in the two arms, baseline characteristics are compared between SOV and GHP for socio-demographic, contraceptive, reproductive and sexual behavioral characteristics including baseline HIV risk factors (Tables 5.5 and 5.6). A Couple HIV Risk Factor composite was created to indicate whether either or both partners self-reported any baseline HIV risk factors, defined as previous treatment for STI, outside partners since marriage, and condom and alcohol use with outside partners. Comparison of baseline characteristics by arm are done using *t*-test for continuous variables and Chi-Square for categorical variables. Each covariate in bivariate analysis is compared by study arm using generalized estimating equations (GEE) and presented as crude odds ratios (cOR) with 95% confidence intervals (CI). GEE is used to account for clustering. Any imbalances in baseline characteristics by trial arm will be considered as possible confounders in future analyses of the impact of the intervention on HIV/STI risk. To bolster the assumptions for the power calculations above, the composite Couple HIV Risk Factor is compared in the two arms.

Planned Data Analyses

Communication of plans to remain HIV free between SOV couples post Intervention

We will compare responses between spouses at V2 one to two weeks after the SOV intervention to assess knowledge retention. More importantly, we will compare responses from each spouse regarding their discussion of the two plans “Together HIV Free” and “Protecting My Spouse” at home. The questions will explore actions and communication, individually or jointly, as it relates to plan selection; disclosure of plan to spouse; identification of threats to remaining HIV free; protection of spouse in case of

HIV exposure; barriers to using the plans; and the importance of remaining HIV free. Comparisons in responses between spouses will be assessed using logistic regression.

Knowledge uptake in Good Health Package health topics

We will compare baseline to V2 (one to two weeks post intervention), V3 (three months post intervention), and V4 (six months post intervention) and V5 (60 months post intervention) in the GHP arm to assess knowledge and implementation of strategies for keeping their family healthy. Responses will be compared between men and women as it pertains to knowledge and application of strategies in water chlorination, handwashing, deworming, prevention of schistosomiasis, and prevention and management of diabetes and hypertension. In addition, barriers, roles in household as it relates to these areas, and the perceived importance of these strategies will be assessed. Comparisons in responses between spouses will be assessed using logistic regression.

Retention

We will present retention statistics of couples and indicate reasons for withdrawals and lost to follow-up. In addition, we will assess predictors of follow-up by comparing socio-demographic, reproductive and sexual history, and behavioral characteristics of couples completing baseline only versus couples with follow-up.

Impact of the Intervention during 60 months of follow-up

At two weeks, three months and 6 months post-intervention, HIV/STI incidence and risk behaviors will be compared in the SOV and GHP arms.

Given this short time frame of follow-up (for context, couples had been together for 6 years at the time they entered the study during which 24% had at least one partner reporting a risk factor as shown in Table 5.6) we do not anticipate very high levels of risk behavior. Thus, we will combine any reported risk behavior (outside partners, condom use with outside partners, alcohol use with outside partners, knowledge of outside partner HIV status, joint HIV testing with outside partners) or STI diagnosis (HIV, RPR, trichomonas diagnosed in the study or any STI treatment elsewhere) from either partner at V2, V3, and/or V4 into one composite outcome indicating one or more risk factors identified for the relationship, regardless of if it was from one or both partners..

The ongoing long-term follow-up is 60 months after the intervention and we do anticipate more reported risk behaviors and incident STI in this longer time frame. This will allow more detailed comparisons of individual risk factors between arms.

For outcomes assessed up to 6-months or 60 months, outcomes of interest will be described by study arm and compared using t-tests for continuous variables (e.g., number of outside partners) and Chi-Square tests for categorical variables (e.g., risk factor yes/no, composite outcome). In our primary analysis, the effect of the intervention on outcomes of interest will be evaluated using crude logistic regression models and GEE methods. In sensitivity analyses, a multivariable model will estimate the impact of the intervention on outcomes of interest adjusting for any imbalances by study arm identified at baseline (described in the Results section and presented in Tables 5.5–5.6).

Results

We present trial flow from randomization to intervention participation in Fig. 5.1. We have enrolled 1686 couples (813 in SOV arm and 873 in GHP arm) in 10 clinics in Ndola and Lusaka. The average number of enrolled couples per clinic is 168.6 (range 112–224). We show baseline socio-demographics, reproductive and sexual history and behavioral characteristics by study arm in Tables 5.5 and 5.6 respectively.

Bivariate Analysis

Baseline Sociodemographic and Reproductive Health Characteristics by Study Arm (Table 5.5): Significant differences in bivariate comparisons were found between the SOV and GHP arms in income, literacy, duration of cohabitation, number of people and children in the household, and current pregnancy. In summary, couples in the GHP comparison arm had higher men's and women's literacy in the vernacular and English, higher men's income, higher women's employment, fewer people and children living in the home and higher self-reported pregnancy. The two arms did not differ by residence (Lusaka vs. Ndola) or modern contraceptive use among non-pregnant women.

Baseline Sexual History and Behavioral Characteristics by Study Arm (Table 5.6): There were few differences between SOV and GHP arms in sexual history, risk behaviors and STI histories. Variables not significant in bivariate analysis included number of lifetime sexual partners, man's age of sexual debut, alcohol use during sex with outside partners, and ever being treated for an STI. Women in the SOV arm had a younger age at first sexual intercourse and couples in the SOV arm reported fewer sexual contacts within the marriage in the last month. A composite score including history of STI, outside partners, condom use with outside partners, and alcohol use during sex with outside partners in either spouse showed no difference between the two groups. Twenty-four percent of couples had at least one risk factor including 18% with only the man having a risk factor, 3% with only the woman, and 3% with both partners reporting a risk factor since the union began.

Trial Status

The trial started recruitment and enrollment in January 2016. Follow-up for the trial is ongoing.

Discussion

We describe a protocol for testing the impact of ‘Strengthening Our Vows’, an innovative behavioral intervention to reduce HIV risk among HIV concordant negative couples in Zambia through reduction in exposure from concurrent sexual partners. To our knowledge this is the first couple-based HIV prevention trial to look at the impact of sexual agreements in heterosexual African couples. Our study covers important gaps in the literature as it pertains to a health outcome in a high prevalence, resource limited setting, and addresses challenges associated with uptake and continued use of sexual agreements.

The majority of new HIV infections in sub Saharan Africa occur in cohabiting couples and CVCT has been recommended for HIV prevention by WHO since 2012. To date, only Rwanda has nationalized CVCT in antenatal clinics, where >80% of pregnant women have been tested with partners since 2013 (226) thus resulting in prevention of an estimated 70% of all new infections (14, 204). Research and implementation programs in several countries confirm that CVCT is feasible (18) (227-237), recently summarized in a review of uptake of couples' testing (238). Several clinical trials have provided CVCT in order to recruit discordant couples for biomedical prevention interventions (239, 240) or concordant positive couples into treatment interventions (241) but prevention and treatment efforts to date have focused on HIV-infected couples.

A combination approach to HIV prevention has been adapted for specific risk groups such as female sex workers (FSW) and youth (242-247). These targeted interventions ideally focus limited resources on those at highest risk. Examples in couples include treatment-as-prevention in the HIV+ partner in discordant couples (248), PrEP in the HIV- partner if the HIV+ partner does not have an undetectable viral load (239), and male circumcision in uninfected men married to HIV+ women (249). Given the low incidence of HIV in CNC after CVCT, cost-benefit analyses preclude PrEP in this group. Similarly, given limited access and low uptake in many areas (250-252) men in concordant HIV- unions would be a lower programmatic priority for male circumcision compared with single men or men with HIV+ spouses.

Though unprotected sex with concurrent partners remains the primary mode of HIV acquisition in heterosexual CNC in Africa, couples lack evidence-based pragmatic, communication and action-focused strategies to aid in their decision-making to protect their marriages from HIV. Our 'Strengthening Our Vows' approach aims to incorporate this combinative strategy with CVCT, an already proven, cost-effective strategy and adapts strategies previously used to provide a platform for couples to discuss concurrent partnerships and HIV prevention (134, 147).

In a review of 48 studies of HIV- MSM couples by LeBlanc et al, negotiated safety included the following components: joint HIV testing and counseling; explicit relationship boundaries with either monogamy allowing no condom use within the couple, or consistent condom use with outside partners; and a communication plan in the event the agreement was breached (147). Though this review was published after our trial began, it describes an approach very similar to our intervention.

The literature on negotiated sexual agreements has grown since we began our trial and new findings will inform our analyses. Rogers et al. assessed measures of love, trust, and conflict style as they relate to agreement type, satisfaction with a breaking of agreements (139). Mitchell et al. found that MSM cited rewards of sexual agreements included honesty, communication, clear expectations, intimacy and trust. Challenges included stigma about having an open agreement; awkwardness and jealousy (107). Hoff et al. found positive relationship dynamics are associated with less risk with partners outside the relationship, but were associated with greater odds of condomless anal sex (CAS) with primary partners (132). Feinstein also found that MSM who were seriously dating their partner and those with monogamous agreements were most likely to report condomless anal sex within the union (CAS) (138). Hoff explored relationship quality and sex life enhancement motives and found the former associated with less CAS and the latter with more CAS outside the primary relationship (135). Perry et al. found that decision-making power relative to one's partner was not associated with any agreement outcome, but that younger and lower earning MSM partners more frequently broke their agreements but the latter more often disclosed breaks (108). Gusakova found that while monogamous couples had more positive attitudes toward communication about sexual agreements, the perceived impact of broken safety agreements in this group were less clear (253).

Young partnered US men who have sex with men ± women reported a need for skills training in negotiating sexual agreements (254). To add to this complexity, dynamics change as relationships evolve: Mitchell et al. reported that desire for sexual exploration, events with other men, past relationships, other couples and duration of the union affect the context of agreements, highlighting the importance of maintaining open communication (123). Given that outside exposures do happen even with monogamous agreements, prevention efforts should help couples mutually agree to integrate HIV testing into their sexual agreement (119). A qualitative study of MSM in South Africa found sexual agreements permitting non-monogamy with female partners only, suggesting heteronormative societal pressures (144).

Responses describing the type of agreement a couple has do not always agree when partners are interviewed separately: Gamarel et al. found 45% of transgender women and their cisgender primary male partners had different perceptions of what their agreement was (255). Studies in African heterosexuals have examined concordance in reporting sexual behaviors and risks. In Uganda, questions with high or substantial couple agreement included condom use at last sex and frequency of condom use while low or fair couple agreement was found in decision-making regarding condom use, wanting more biological children and deciding when to have sex (256). This is similar to our own findings with Rwandan couples (257). Other studies have focused on couples with one or both partners HIV+ (96, 258-261) and have examined patterns of communication in couples and enhanced male involvement in HIV prevention with pregnant women (262-265), though without a specific focus on negotiated agreements (229, 266-269).

Studies on sexual agreements with heterosexual couples are more limited and mostly assess feasibility of sexual agreements, self-reported monogamy agreements, or perceptions of western providers about agreements (270, 271). In a comprehensive scoping review of the primary literature on sexual agreements, including negotiated safety, Rios-Spicer and colleagues identified several knowledge gaps including the need to expand sexual agreements research beyond MSM populations and the need to better understand agreement breaks and break disclosure (134).

CVCT reduces incident HIV infections in Zambia CNC and during post-test counseling sexual agreements are often spontaneously developed by the couples that primarily focus on monogamy. Current counseling guidelines do not include structured support for negotiated agreements, how to protect individuals and their spouses from threats to monogamy or how to react to potential outside HIV exposures if they happen.

The addition of cost-effective, sustainable strategies to the existing HIV prevention toolkit are critical as funding for HIV continues to decline. This is especially true in resource limited settings. Though we have not performed cost analysis for this added component, we have shown that CVCT is feasible on a large scale (226), cost-effective (18), and able to be integrated into routine services (272). In addition to feasibility and cost-effectiveness, we have shown that HIV and unplanned pregnancy prevention efforts can be mutually leveraged with integrated couples-focused programs *(273)*. Lastly, we have also shown that the addition of services such as hygiene, sanitation, and prevention of neglected and non-communicable diseases to CVCT is feasible (219).

Such an integrative, preventive public health package that not only encompasses multiple health topics (HIV/STIs, family planning, hygiene and sanitation, and prevention of neglected and non-communicable diseases) but also includes both spouses is ideal and captures the spirit of the UN Sustainable Development Goals (215).

Our intervention is novel, timely and integrative with minimum anticipated costs. An added strength of the study is that baseline couple HIV risk is not statistically significant between the two arms. This demonstrates that as it relates to the primary outcome of interest, the arms appear to be balanced. We acknowledge that the trial sample size being based on individuals and not clusters as well as sample size adjustments in early enrollment to increase couples instead of clinics may impact power. To account for potential loss of power, we have extended the follow-up period to 60 months. The number of clusters are limited due to budgetary constraints.

Table 5.1: Phases of formative work for Strengthening Our Vows

Phase	Time frame	Participants	Facilitated by	Topics	Key Considerations/Themes for Intervention/Activities
Pre-Pilot					
FGD	Dec 2011-May 2013	CVCT Counselors in GRZ clinics, 11 sessions, 29 M, 91 F and 13 sex not indicated	CFHRZ counselors	Frequency of discussions on concurrent partnerships during CVCT, counselling couples on concurrent sexual partners, and developing concurrent partner modules	• Counseling couples on scenarios for risk reduction and concurrent partners using abstract examples • Ensuring the intervention allows for opportunities for spouses who want to disclose outside partnerships with spouse and faciliate testing at CVCT with those outside partners • Ensuring counseling messaging targets HIV prevention and concurrent partnerships equally between men and women as it is sometimes assumed that only men are involved in extramarital affairs • Ensuring counselors do not interject their personal opinions or judgements into the counseling sessions • Training counselors on concurrent partnerships to ensure they are comfortable with the messages • Providing additional training to counselors to ensure confidentiality and disclosure with individuals/couples in context of multiple concurrent partners
IDI	Jan 2012-Feb 2012	HIV Concordant Negative Couples, 4 M and 3 F	CFHRZ nurse counselors/ physicians	Initial feedback on whether couples would want to discuss outside partners	• Initial interviews showed couples seemed to be open to discussing outside partners

Phase	Time frame	Participants	Facilitated by	Topics	Key Considerations/Themes for Intervention/Activities
FGD	Jul 2012-Jun 2013	HIV Concordant Negative Couples, 16 sessions, 31 M and 31 F	gender-matched counselors (CFHRZ and GRZ)	Discussion with spouse about outside partners, relationship contracts, benefits and disadvantages of discussing outside partners with spouse, how they would like to counselor to bring up outside partners during counseling, how concurrent partners impact HIV transmission, how can we better facilitate this, what are the top 3 things you would like included if you created your own contract	• Partners open to having concurrent partners discussed during counseling • Preferences to discussing concurrent partners using abstract examples • Ensuring discreteness when testing with outside partners at the clinics; no special procedures • Counseling should encourage disclosure only if partner wants to • Partners were open to their spouses protecting them and testing with outside partners but may not want to know themselves • Couples generally supporting the concept of relationship contracts as it set limits and helps to maintain relationship • Partners stating that though concurrent partners exist it is not a social norm • Discussing concurrent partnerships could help someone realize their HIV risk • Ensuring confidentiality • Emphasizing counseling should not focus on blame but risk reduction and protecting spouse
IDI	Feb 2014-Apr 2014	7 HIV seroconverters* and 3 spouses, 5 M and 5 F	CFHRZ nurse counselors/ physicians	CVCT knowledge, impact of testing program on the couple, threats to avoiding exposure to HIV, coping with situation, advice/recommendations to friends in simular situation	• Emphasis on window period as participants seemed surprise of themselves or spouse becoming infected in a short period of time 1-2 months • Threats that led to partner seroconversion: traveling spouse; desire for extra money, goods; desire to be paid attention to; taking spouse for granted • Testing with outside partners together is important before engaging in sex; one should not take verbal indication of being test to be truth. • If outside partner refuses to test, use condoms

Phase	Time frame	Participants	Facilitated by	Topics	Key Considerations/Themes for Intervention/Activities
Pilot					
FGD @ V1	Feb 2014-Mar 2014	HIV Concordant Negative Couples, 8 sessions, 30 M and 30 F	gender-matched counselors (CFHRZ and GRZ)	Piloting "Strengthening Our Vows" Intervention	• Developing intervention visit length and logistic planning for the visit • Conducting mock intervention • Identifying potential threats to remaining HIV free: lack of money or goods; traveling for work; dissatisfaction with spouse; peer and family influence; and alcohol use • Receiving feedback from the CFHRZ counselors on intervention guide after pilot focus groups • Incorporating strategies to communicate risk non-verbally; introduction of yellow card as a non-verbal communication cue • Introducing CFHRZ team to draft post intervention questionnaire
FUP IDI @ V2	Mar 2014	HIV Concordant Negative Couples, 18 M and 17 F	CFHRZ and GRZ counselors	Piloting post-intervention questionnaire	• Administering post intervention questionnaires in an open-ended format until saturation of responses reached • Assessing comprehension, comfort, timing of post-intervention questionnaires • Receiving feedback from the CFHRZ counselors on the post intervention visit flow • Refining questionnaire based on counselor feedback and couple responses

Abbreviations: CFHRZ, Center for Family Health Research in Zambia; FGD, focus group discussions; GRZ, Government Republic of Zambia; IDI, in-depth interviews; M, male; F, female

* 1 concordant negative HIV couple where both spouses seroconverted

Table 5.2: Intervention Content

Visit	Video segments	SOV arm	GHP arm
V01	**Part 1**	Watch 1 h SOV intervention video Separate into men and women groups; facilitated by same sex counselor using a complimentary flipchart to the video **"Together HIV Free" plan** ™ Be monogamous and only have sex with your spouse ™ Always use a condom with outside partners and/or ™ Only have sex with outside partners if you have tested with those partners and you know that they are also HIV- **"Protecting My Spouse" plan** ™Abstain/NOT have sex or use condoms with their spouse until HIV retest in 1 month after the potential exposure. *If continuing to have sex with other partner(s)also:* ™ Test for HIV as a couple with that other partner(s). Some couples test for HIV with their spouse and their boy/girlfriend at the same time. ™Abstain from sex or use condoms with the other partner until they know that partner's HIV status ™Consider ending the relationship with the boyfriend or girlfriend.	Watch 1 h GHP comparator video Separate into men and women groups; facilitated by same sex counselor using a complimentary flipchart to the video **"Everyone has an equal responsibility in keeping our family healthy"** Importance of household roles in maintaining good household health ™Health education (risk groups; information on transmission and mechanism of action; signs and symptoms) for Diarrhea and Worms, hypertension, diabetes, and schistomiasis were covered. ™Modifiable lifestyle choices for prevention of hypertension and diabetes were emphasized ™Illustration of portion control with salt and sugar measurements ™Proper Handwashing technique with practical ™Water chlorination 5L and 20 L with practical ™Health screenings hypertension, diabetes and schistosomiasis ™Barriers to implementing GHP
	Part 2	Couples All Together Six scripted scenarios covering potential threats to remaining HIV free: Longstanding outside partners; traveling and working away from home; alcohol use; receipt of attention, money and gifts; and sexual inactivity due to wife's postpartum abstinence and menstruation	Couples All Together ™Game: GHP review (mini-quiz (6 questions) non-graded ™Couples talked about what the phrase "Everyone has an equal responsibility in keeping our family healthy" meant to them ™Receipt of commodities: low sodium salt, deworming pills for family, chlorine and hand soap ™Treatment and referral for abnormal result

“Making Your Plan” 3-way agreement:
™ Each person commits to keeping yourself and your spouse HIV free.
™ Counselors commit to helping you achieve this goal.
™ The ultimate responsibility of this agreement lies with you individually as well as a couple.
™ Not assigning blame if a partner makes a mistake, but trying to focus on the original agreement from today of keeping HIV out of the marriage
™ Couples asked to agree that if someone makes a mistake, they will put the health of one another first. After that, you can also discuss how to minimize future threats. Can you agree to that?

3-way agreement:
™Each of you commits to keeping yourself and your household healthy
™Counselors commit to help you achieve this goal.
™The success of implementing these strategies is ultimately your responsibility as individuals and as a family.

Figure 5.1: Trial Design and Procedures

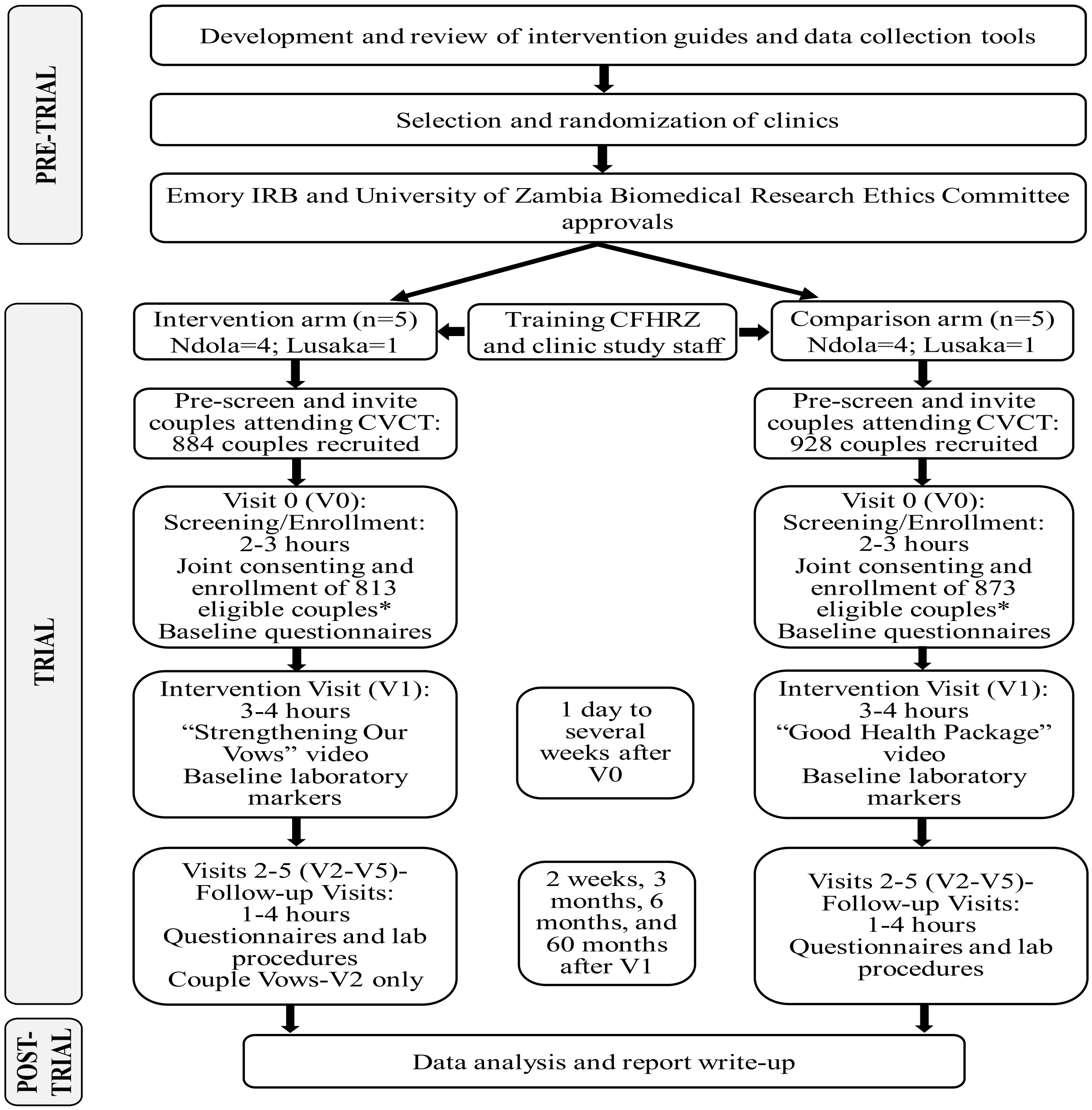

Fig. 1. *Reasons for exclusion (couples may be excluded for multiple reasons): not CNC (8); age (23); not available for follow-up (21); cohabiting <3 months (20); not willing to participate (14); not willing to provide contact information (5); unable to understand study (1); false couple (23); did not return for enrollment (16); outside acceptable window for enroll (6); impairment (2); co-enrolled (3); unknown (3)

Table 5.3. Inclusion/Exclusion Criteria

Inclusion Criteria	Exclusion Criteria
1. Heterosexual, both partners HIV negative	1. Either partner has a condition, in opinion of investigator, that would prevent informed consent or affect reaching study objectives
2. Women aged 18-45 and men aged 18-65 years of age	2. Either partner HIV-positive or with indeterminate HIV rapid test results
3. Cohabiting 3 months or greater	3. May seek health care at a clinic randomized to the opposite arm of the clinic they would enroll in
4. Not taking any anti-retrovirals as Post or Pre-Exposure Prophylaxis	
5. Interested in participating	
6. Able and willing to provide informed consent	
7. Willing to answer questions on risk factors	
8. Available for duration of the study	
9. Willing and able to be reached by phone or home visit	
10. Willing and able to provide locator/contact information for retention and be contacted by study team	

Table 5.4: Power Calculation

Risk Control	Risk Intervention	Risk ratio detected	Power
15%	5%	0.53	80%
	6.5%	0.43	90%
20%	11%	0.55	80%
	12%	0.60	90%
25%	14%	0.56	80%
	15%	0.60	90%

Table 5.5. Baseline Sociodemographic and Reproductive Health Characteristics by Study Arm

	Total (N=1686)		Intervention Arm (N=813)		Comparison Arm (N=873)		p-value[b]	95% CI			
	Mean	SD	Mean	SD	Mean	SD		cOR	LL	UL	p-value
Man age (mean, years) [b]	31.9	7.8	32.1	7.8	31.7	7.8	0.39	1.01	0.99	1.02	0.39
Woman age (mean, years) [b]	26.2	6.7	26.4	6.8	26.0	6.5	0.21	1.01	0.99	1.02	0.21
	N	%	N	%	N	%					
Man's Income											
Yes	1662	99%	793	98%	869	100%	0.001	-			
No	24	1%	20	2%	4	0%		-			
Man's income (IQR, ZMW) [c]	800	800	700	800	900	1000	0.0001	0.99	0.98	0.99	0.002
Woman's Income											
Yes	1132	67%	492	61%	640	73%	<0.0001	Ref			
No	553	33%	320	39%	233	27%		1.79	1.45	2.19	<0.0001
Woman's income (IQR, ZMW) [c]	250	650	200	500	350	900	<0.0001	0.95	0.94	0.97	<0.0001
City of Residence											
Lusaka	334	20%	174	21%	160	18%	0.11	1.21	0.95	1.54	0.11
Ndola	1352	80%	639	79%	713	82%		Ref			
Man vernacular literacy (Bemba or Nyanja)											
Easily	1255	74%	556	68%	699	80%	<0.0001	Ref			
With Difficulty/Not at all	431	26%	257	32%	174	20%		1.86	1.49	2.32	<0.0001
Woman vernacular literacy (Bemba or Nyanja)											
Easily	927	55%	358	44%	569	65%	<0.0001	Ref			
With Difficulty/Not at all	758	45%	454	56%	304	35%		2.37	1.95	2.89	<0.0001
Man reads or understands English											
Easily	1070	63%	470	58%	600	69%	<0.0001	Ref			
With Difficulty/Not at all	616	37%	343	42%	273	31%		1.60	1.31	1.96	<0.0001
Woman reads or understands English											
Easily	716	42%	275	34%	441	51%	<0.0001	Ref			

With Difficulty/Not at all	969	58%	537	66%	432	49%		1.99	1.64	2.43	<0.0001
Couple: Years Cohabiting [b]	5.9	5.8	6.2	5.8	5.5	5.8	0.01	1.02	1.00	1.04	0.01
Couple: Number of people in household [d]	4.6	2.1	4.8	2.1	4.4	2.2	0.001	1.08	1.03	1.13	0.002
Couple: Number of children <16 years old in household [d]	2.1	1.7	2.3	1.6	1.9	1.6	<0.0001	1.15	1.09	1.23	<0.0001
Self-Reported Pregnancy											
Yes	450	27%	143	18%	307	35%	<0.0001	Ref			
No	1236	73%	670	82%	566	65%		2.54	2.02	3.19	<0.0001
If not pregnant, current contraceptive method											
IUD	12	1%	4	1%	8	1%					
Implant	198	16%	97	14%	101	18%					
Injectable	283	23%	159	24%	124	22%	0.062				
Pills	134	11%	64	10%	70	12%					
Tubal Ligation	1	0%	0	0%	1	0%					
None/Condom/Other	608	49%	346	52%	262	46%					

Ref indicates reference group.
[a]Two-tailed t-test for continuous variables, chi-square test for categorical variables with cell counts >=5,
Fisher's exact test for categorical variables with cell counts < 5.
[b] Per one year increase
[c]Per 100 kwacha increase
[d] Per 1 person or 1 child increase

Table 5.6. Baseline sexual history and behavioral characteristics by study arm.

	Total (N=1686)		Intervention Arm (N=813)		Comparison Arm (N=873)			95% CI			
	Mean	SD	Mean	SD	Mean	SD	p-value[a]	cOR	LL	UL	p-value
Man lifetime sex partners (mean) [b]	5.1	8.9	5.5	11.3	4.8	5.8	0.11	-			
Man lifetime sex partners (IQR) [b]	4.0	3.0	4.0	4.0	3.0	3.0	0.11	1.01	1.00	1.03	0.11
Woman lifetime sex partners (mean) [b]	1.9	1.5	2.0	1.4	1.9	1.6	0.18	-			
Woman lifetime sex partners (IQR) [b]	1.0	1.0	2.0	1.0	1.0	1.0	0.18	1.05	0.97	1.12	0.23
Man age at first sexual intercourse (mean, years) [c]	18.7	4.0	18.6	4.0	18.7	4.1	0.62	0.99	0.97	1.02	0.62
Woman age at first sexual intercourse (mean, years) [c]	17.7	2.6	17.3	2.5	18.0	2.6	<0.0001	0.88	0.85	0.92	<0.0001
Couple number of times sex with spouse in last 1 month [d]	12.5	10.1	10.2	7.8	14.5	11.5	<0.0001	0.95	0.94	0.96	<0.0001
	N	%	N	%	N	%					
Man Outside Partners Since Married											
Yes	200	12%	99	12%	101	12%	0.70				
No	1486	88%	714	88%	772	88%					
If yes, man's number of outside partners (mean)	2.0	2.2	2.3	2.8	1.7	1.3	0.07	1.06	0.79	1.42	0.70
Man Condom use with outside partners since married											
Yes without condoms	136	8%	76	9%	60	7%	0.03	1.37	0.96	1.95	0.08
Yes with condoms	64	4%	23	3%	41	5%		0.61	0.36	1.02	0.06
No	1486	94%	714	88%	772	88%		Ref			
Man alcohol use during sex with outside partners											
Yes with alcohol	93	6%	38	5%	55	6%	0.07				
Yes without alcohol	107	6%	61	8%	46	5%					
No	1486	88%	714	88%	772	88%					
Woman outside partners since married											
Yes	19	1%	7	1%	12	1%	0.32				

No	1666	99%	805	99%	861	99%					
If yes, woman's number of outside partners (mean)	1.5	0.8	1.7	1.1	1.3	0.5	0.31	0.62	0.24	1.59	0.32
Woman condom use with outside partners since married											
Yes without condoms	10	1%	4	0%	6	1%					
Yes with condoms	9	1%	3	0%	6	1%	0.63				
No	1666	99%	805	99%	861	99%					
Woman alcohol use during sex with outside partners											
Yes with alcohol	4	0%	1	0%	3	0%					
Yes without alcohol	15	1%	6	1%	9	1%	0.59				
No	1666	99%	805	99%	861	99%					
Man ever treated for STI											
Yes	209	12%	98	12%	111	13%	0.68				
No	1477	88%	715	88%	762	87%					
Woman ever treated for STI											
Yes	74	4%	31	4%	43	5%	0.27				
No	1611	96%	781	96%	830	95%					
HIV Risk Factor by spouse|											
No man and woman HIV risk	1285	76%	622	77%	663	76%					
Yes man only HIV risk	311	18%	154	19%	157	18%	0.40				
Yes woman only HIV risk	44	3%	16	2%	28	3%					
Yes man and woman HIV risk	45	3%	20	2%	25	3%					
Couple HIV Risk Factor |											
Yes	400	24%	190	23%	210	24%	0.75	0.97	0.77	1.21	0.75
No	1285	76%	622	77%	663	76%		Ref			

Ref indicates reference group.

|HIV Risk Factor and Couple HIV Risk Factor includes man and woman's baseline self-reports of previous treatment for STI, outside partners since married, condom use with those outside partners, and alcohol use during sex with those outside partners

[a]Two-tailed t-test for continuous variables, chi-square test for categorical variables with cell counts greater than or equal to 5, Fisher's exact test for categorical variables with cell counts less than 5

[b]Per 1 year increase

[c] Per 1 person increase
[d] Per 1 sex act increase

6. Chapter 6 Research Paper 2: *Use of "Strengthening Our Vows" Video Intervention to Encourage Negotiated Explicit Sexual Agreements in Zambian Heterosexual HIV Seroconcordant Negative Couples*

Overview of Research Paper 2

One of the objectives of Research Paper 1 included describing communication and negotiating sexual agreements. This chapter presents findings from this process two weeks post-intervention.

Couples were able to communicate and negotiate explicit sexual agreements in a friendly and supportive environment. An overwhelming majority of couples chose monogamy as a sexual agreement. In terms of threats to remaining HIV, men and women reported the primary threat for men to be alcohol. While for women, men and women both indicated the primary threat for them was financial pressure.

This study did not include practical skills on couple communication, and couple's self-efficacy was not assessed. In addition, alcohol, GBV, relationship quality, relationship dynamics, gender roles, and gender norms were not part of the sexual agreements or measured. There was no baseline assessment regarding ever using sexual agreements though the rationale for this was explained. These were noted as limitations and areas to explore for future studies.

Manuscript accepted to *Archives of Sexual Behavior* on 14th March 2023. The manuscript was published on 6th April 2023. This paper has an embargo. License to Publish Springer Nature for Research Paper 2 has been attached as Appendix 11.2. Research paper 2 has been "Reproduced with permission from Springer Nature."

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RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

SECTION A – Student Details

Student ID Number	**1406846**	**Title**	**Ms**
First Name(s)	**Tyronza Daniell**		
Surname/Family Name	**Sharkey**		
Thesis Title	**Impact of Couple-Based Interventions on Knowledge Uptake, Implementation, and Communication of Strategies to Prevent HIV, Non-Communicable and Neglected Tropical Diseases in Zambian HIV Seroconcordant Negative Couples**		
Primary Supervisor	**Dr. Rosanna Peeling**		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	Archives of Sexual Behavior		
When was the work published?	06-Apr-2023		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
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SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	

Please list the paper's authors in the intended authorship order:	
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Creation of intervention and comparison arm flip chart guides, videos, questionnaires, other data collection tools and databases; training of study and clinic teams; implementation of the work and data collection; project administration; data analysis; manuscript preparation, review and editing.

SECTION E

Student Signature	Tyronza Sharkey
Date	23-Oct-2023

Supervisor Signature	Rosanna Peeling
Date	23 Oct. 2023

Title: ***Use of "Strengthening Our Vows" Video Intervention to Encourage Negotiated Explicit Sexual Agreements in Zambian Heterosexual HIV Seroconcordant Negative Couples***

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Abstract

Negotiating sexual agreements in combination with couples' voluntary HIV counseling and testing (CVCT) may help further reduce HIV transmission in Zambian Concordant HIV negative couples (CNC). Though CVCT has been shown to reduce HIV transmission in CNC by 47%, approximately half of residual infections occur in this group. We developed a "Strengthening Our Vows" video session to foster communication and negotiation of explicit sexual agreements to reduce concurrent sexual exposures and prevent HIV transmission to the spouse due to unprotected, extramarital sex. CNC were recruited through CVCT services at five clinics in Lusaka and Ndola in 2016. Enrolled CNC attending the facilitated group video sessions were encouraged to discuss sexual agreements at home and return 1-2 weeks later for follow-up assessment. One fourth of the 580 CNC returning reported a history of extra-marital partners and/or a sexually transmitted infection (STI) prior to enrollment. More than 95% reported a friendly, supportive 15-60 min negotiation culminating in an agreement to remain monogamous or disclose sexual contacts and use condoms together until a repeat HIV test 30 days after an outside sexual exposure. Two thirds of participants identified at least one threat to adherence of their agreements including alcohol use, financial pressures, travel, discord in the home, and post-partum or menstrual abstinence. CNC negotiated explicit sexual agreements to avoid exposure to

HIV through concurrent partnerships and protect the spouse in the event of an outside sexual contact. Open communication was a consistent theme to facilitate mutual protective efforts. Long-term follow-up of HIV/STI incidence is ongoing to assess the impact of these agreements.

This sub-study is part of a trial retrospectively registered on ClinicalTrials.gov on April 20, 2016.

Keywords: HIV prevention; dyadic interventions; sexual behavior; concurrent partners; couples HIV testing

Introduction

Most incident HIV infections in sub-Saharan Africa (SSA) occur in steady heterosexual couples (14, 15), of which approximately half are concordant HIV-negative couples (CNC) (6, 18). In addition, a 2017 modeling exercise indicated that “As the HIV/AIDS epidemic has matured in many countries, it is believed that the proportion of new infections occurring within couples has risen.” (274).

Having unprotected sex with multiple partners increases opportunities for HIV transmission (8, 275). Multiple, concurrent partnerships are one of the drivers of the Zambian HIV epidemic (206). In Zambia’s Demographic Health Survey, approximately 20% of men and 1% of women who are married/cohabiting report having two or more partners in the past 12 months (276). This is similar to other countries with men reporting more multiple and concurrent partners than women (100, 203). Baseline data from a cluster-randomized trial (CRT) in Zambia, of which this is a sub-study, further supports CNC being an at-risk population as approximately 24% of CNC have at least one HIV risk factor (277).

One cost-effective HIV prevention strategy with substantial impact for heterosexual couples is Couples' Voluntary HIV Counseling and Testing (CVCT) (Center for Disease Control and Prevention (278) endorsed by WHO (279, 280). In Rwanda, where CVCT has been nationalized in antenatal clinics since 2013, more than 80% of couples have received joint testing (226) and have prevented an estimated 70% of new infections (14, 204). In > 200,000 Zambian couples offered joint testing in > 70 government health centers, CVCT reduced HIV transmission between 47% -79% in CNC and discordant couples (DC) on anti-retroviral therapy (ART) respectively (18). CVCT could avert half of new HIV infection in Zambia for 5% of the annual **President's Emergency Plan for AIDS Relief** budget (18). A modeling study has shown similar results for East-Central, Southern and West Africa (19). Though HIV incidence in CNC is low relative to DC, CNC make up 79% of all couples and thus contribute to approximately half of new infections even after CVCT (18).

Where African couples have been tested jointly, the focus in the literature has been on couples with HIV and on discordant couples in particular with emphasis on disclosure of test results to partners (231, 241, 274, 281-284). More couples-based HIV interventions tailored for CNC are needed to enhance the impact of CVCT and further reduce HIV risk in this large group. One strategy as an added component to CVCT in targeting Western CNC male couples is negotiated sexual agreements within the relationship (Stephenson et al., 2015). These agreements may include either mutual monogamy not requiring condoms, condom use with all outside partners and no condom use within the couple, or condom use both within and outside the couple (147). Though sexual agreements within male couples have been extensively explored (103-108, 141, 142, 144), little is known about the use of negotiated sexual agreements as an HIV prevention strategy in heterosexual African HIV negative couples. In addition, studies on sexual agreements in heterosexual relationships highlight false perceptions about sexual exclusivity (160, 285, 286), lack of explicit monogamy agreements (134, 287), difficulties in communicating sexual concurrency (134), and ambiguity in definitions of ‘monogamy’ amongst clients and researchers (288). All of these issues may increase risk of STIs and HIV within the relationship, especially for countries with high HIV prevalence and a generalized HIV epidemic, such as Zambia. Thus, understanding how couples communicate and negotiate explicit sexual agreements may lead to additional consideration of this couple-based behavioral strategy to prevent HIV.

The aim of this study was to conduct a post-assessment following the “Strengthening Our Vows” video-based intervention targeting heterosexual HIV negative couples in Zambia. The preliminary outcome was communicating and negotiating sexual agreements and identifying threats to maintaining them.

Methods

Study site

This study was conducted at five government health centers in two urban cities Ndola (*n* = 4) and Lusaka (*n* = 1), Zambia, where CVCT services are offered. Coordination for the study was overseen by Center for Family Health Research in Zambia also located in these cities. Both cities were located in provinces where HIV prevalence is highest at ~15% (276).

Study design

This study was designed as a single-arm study. The aim of this study was to test the impact of a video-based intervention “Strengthening Our Vows” (SOV) on negotiated sexual agreements among heterosexual HIV seroconcordant negative couples (CNC) to prevent HIV acquisition through unprotected, extramarital sex and to identify potential threats to keeping their agreements. In addition, participants were asked to recall HIV prevention strategies from the intervention visit. Couples returned one to two weeks after participating in the intervention. Baseline sociodemographic, reproductive, and sexual behavioral characteristics were compared for couples returning for post-assessment (follow-up) versus not to assess predictors of the post-assessment attendance.

This study was part of a cluster-randomized trial (CRT) in Zambia. The CRT design consisted of a similarly structured intervention arm SOV and comparator arm “Good Health Package“(GHP). The overall aim of SOV is to assess the impact of the intervention on reducing HIV risk factors, a composite of incident HIV/STI; self-reported number of outside sexual partners, alcohol and condom use with outside sexual partners, STI treatment, and joint HIV testing with outside partner; and knowledge of outside partner HIV status compared to GHP. GHP’s aim assessed the impact of a video on knowledge uptake, recommendations, and adoption of strategies to prevent diarrheal diseases, including cholera, respiratory diseases, schistosomiasis, soil-transmitted helminthiasis, hypertension, and diabetes in heterosexual CNC.

Participants and Procedures

Prescreening for the study

The pre-screening for this study occurred over a six-month period in 2016 at five governmental health centers offering CVCT services in Ndola and Lusaka. Couples receiving these CVCT services were potential participants for this study. Trained CVCT counselors provided these CVCT services. CVCT included joint pre-test counseling, HIV rapid testing per national guidelines adapted for couples (289), mutual disclosure, and post-test counseling together per their couple HIV status according to Center for Disease Control and Prevention and WHO guidelines (278, 279). Initial eligible and interested HIV negative couples were invited to return for additional screening where eligibility criteria was assessed.

Eligibility criteria

In addition to both spouses being HIV negative, women were age range of 18 to 45 years old, and men were age range 18 to 65 years old. The couple had to be cohabiting for at least three months. Both partners had to be interested, able and willing to provide informed consent, answer questions on risk factors, provide contact information, and be available for follow-up. Eligible couples were invited to return for consenting.

Informed consent

Potential couples were provided with study information by viewing a verbatim reading of the informed consent on a video. The couple met with a counselor to discuss any questions or clarifications on study participation and procedures, and jointly signed consent (18, 290, 291). Couples were also asked if they understood study participation was voluntary.

Baseline questionnaire at enrollment visit

Baseline questionnaires were administered to 813 eligible CNC. CNC were separated by spouse and administered a baseline questionnaire by a gender-matched research counselor. Each spouse was asked questions related to socio-demographic characteristics (income, number of persons and children under 16 in the household, and literacy) and reproductive health (self-reported pregnancy and current family planning). In addition, each spouse was asked about past and recent sexual history related to HIV risk behaviors (lifetime sexual partners, age at first sexual intercourse, and since married frequency of sex with spouse in the last month, outside partners, alcohol and condom use with outside partners and STI treatment).

Invitation to the intervention visit

Couples completed interviewer-administered baseline questionnaire. At the end of the visit, couples were provided study reimbursement. In addition, couples were given an appointment to return to the health center for the intervention visit. The intervention visit was approximately one to two weeks after the enrollment visit.

Incentives

Couples received approximately US $3 per person-visit as study reimbursement to cover time at clinic and transport, as described in the informed consent. An additional US $2 per person was given as a lunch allowance if the visit exceeded 3 hr.

Ethics

University of Zambia Biomedical Regulatory Ethics Committee (Protocol 021-07-15) and Emory University Institutional Review Board (Protocol IRB00083001) in Atlanta, Georgia USA, reviewed and approved the study. Permission to conduct this study in the clinics was granted by the Lusaka and Ndola District Health Offices. The CRT to which this study belongs was retrospectively registered on ClinicalTrials.gov.

The intervention

Development of the SOV intervention video

Similar to heterosexual couples, the majority of HIV transmission in men who have sex with men (MSM) couples have occurred within the primary relationship (211, 212) where sex is more likely to be unprotected (105). With safer sex communication for HIV prevention historically targeting casual partners (150), married heterosexual couples and steady MSM couples may falsely perceive their relationships to be more protected (141, 292).

Our rationale for exploring negotiated sexual agreements in heterosexual couples came from various studies showing that MSM relationships with negotiated sexual agreements usually were less likely to practice unsafe sex (104, 130, 140, 146, 213, 214). In addition, these agreements were noted to be common and mostly kept (213). Other studies showed that a higher level of investment in sexual agreement (104, 130) and communication (104) in addition to other factors significantly predicted less condomless anal sex (CAS) in CNC MSM couples (104) or decreased likelihood of CAS with outside partners (130). One study found that HIV and STI prevention was a main motivator for making sexual agreements in CNC MSM (129). Other studies highlighted important considerations for sexual agreements, such as broken agreements and lack of their disclosure (130) (133), perception of low HIV risk in CNC MSM, and lower HIV testing behaviors (141). Another study explored reported substance or alcohol abuse and recent broken agreements in MSM couples (116). These studies highlight the importance of sexual agreements to keep steady relationships HIV free, to be pragmatic and flexible, to allow a means to disclose broken agreements, to understand threats to sexual agreements, and to encourage re-testing to reconfirm serostatus.

Various literature reviews have also summarized negotiated safety through agreements in CNC MSM couples (147) and reported a wide range of agreements, ways of characterizing them and relationships to health outcomes in MSM couples (134). Authors concluded more research was needed to better understand agreement breaches and communication of them, and the potential expansion of sexual agreements beyond MSM (134).

Our formative work showed Zambian CNC and CVCT counselors being receptive to using relationship agreements as an HIV prevention strategy (277). Our observations were similar to a qualitative study in US heterosexual couples who were willing to undergo couples counseling and testing and discuss sexual agreements (153). These factors led to the creation of a locally adapted video intervention arm "Strengthening Our Vows."

Description of the Intervention

A standardized SOV video intervention was administered to couples over a six-month period in 2016. The SOV video, based on the harm reduction approach, offered a traditional choice of 'monogamy agreement' in addition to other HIV prevention strategies. The video was presented in Bemba and Nyanja and equivalent to or below 8th grade level. The video consisted of two parts, delivered on the same day and within approximately 1 hr run-time. Pauses were incorporated for counselors to facilitate discussion using structured flip chart guides. The SOV video content has been described fully elsewhere (277).

The first part of the video (approximately 20 min) was presented to men and women in participating couples in separate gender-specific groups and included two themes. The first theme focused on keeping HIV from entering the marriage by (a) practicing monogamy, i.e., having sex with your spouse only, (b) testing jointly with outside partners, and only having sex with those who are also HIV-negative and/or (c) using condoms every time with an outside partner. The second theme explored ways to avoid passing the virus on in the event of an unprotected sexual exposure to an outside partner with HIV-positive or unknown HIV status and included an alternative/interim plan of abstaining from sex with the spouse or using condoms consistently with the spouse until HIV retest after the “window period” of 30 days. The “window period” was emphasized in the video as a particularly infectious period prior to development of anti-HIV antibodies. The average group size was five couples (median 11, range 1-16). Subsequently, husbands and wives were brought together into one group to view the second part of the video (approximately 40 min) which presented scenarios highlighting potential threats such as longstanding outside partners; traveling away from home; alcohol use; receipt of attention, money, and gifts; discord in the union; and sexual inactivity due to wife’s postpartum abstinence or menstruation. A guided discussion focused on the HIV risk the couples in each scenario faced; what actions could reduce risk of HIV; and what couples could agree to do to prevent HIV. The video also featured examples of communicating about extramarital partners and included guidance on how to deal with difficult communication and disclosure. A unique concept for communicating an unprotected outside sexual exposure was the yellow card, a visual symbol derived from soccer, to use as a non-verbal notification to the spouse. The final part of the video advised couples to discuss risk reduction plans together and finalize their agreement. The intervention visit lasted approximately 3-4 hr. At the end of the visit, each spouse was given yellow cards to use in the event of outside sexual exposures and provided with condoms. Couples were encouraged to discuss topics from the video at home and return one to two weekends later for post-intervention assessment.

Training of the counselors

Trained research counselors conducted study visits. Selection of counselors was based on their previous experience and performance during the CVCT program. Research counselors received training by the main coordinating research study teams in Lusaka and Ndola on all study procedures including the intervention. Research counselors were not assigned specific couples. Further details regarding counselor training for this study can be found elsewhere (277).

Post-assessment questionnaire at follow-up

Of the 613 CNC, who received the intervention, 580 CNC returned to be administered the post-assessment questionnaire. CNC were separated by spouse and asked questions from a structured questionnaire by gender-matched research counselor. Spouses were asked about knowledge and recall of HIV prevention strategies (window period for retesting for HIV, monogamy/ faithfulness, condom use and HIV testing with outside partners, having sex with only HIV-negative partners, non-verbal communication (yellow card) of potential HIV exposure, and abstaining or using condom with spouse until retested for HIV) covered during the SOV intervention visit and subsequent discussion at home. Each spouse was asked about their discussions at home in regards to timing (length) and context/nature (tone, agreement of a strategy, discussion initiator, and comfort level). In addition, each spouse answered questions about their understanding of the agreements they had negotiated including strategies and potential challenges to using the agreements. Each spouse was also asked to identify any threats that would prevent him/her or their spouse from adhering to their sexual agreement. Each partner was asked if they were willing to discuss agreements, strategies, and challenges with their spouse and the counselor. Finally, each partner was asked whether there was any information they WOULD or WOULD NOT want discussed when brought together as a couple. This visit provided an opportunity for the research counselors for the two partners to meet and compare notes, to bring the couple together, and to reinforce and to congratulate couples on successful negotiations while maintaining confidentiality. Spouses then recited standardized SOV vows to each other, which included not exposing themselves to HIV outside the marriage and, if exposed, keeping the spouse safe during the window period until a repeat negative test.

Data collection/Measures

Predictors of post-assessment

Predictors of post-assessment were measured using baseline questionnaire. Each spouse self-reported information related to socio-demographics, reproductive health, and past and recent sexual history related to HIV risk behaviors. A couple HIV risk composite (Yes or No) was created to assess whether couples had any pre-existing HIV risk behaviors in their marriage. The couple HIV risk composite included self-reported outside partners since married, alcohol use or condomless sex with these outside partners, and being treated for an STI.

Post-assessment at follow-up

Knowledge was measured based on man and woman's responses to open-ended questions on the window period for retesting for HIV and HIV prevention topics covered during SOV intervention visit. Men and women selected best descriptors of discussions at home based on options read by the counselor. All sexual agreements (primary and contingent) were read to spouses prior to choosing. Questions related to barriers, challenges, and concerns using sexual agreements were open-ended. Questions related to individual and perceived spouse's threats to adhering to their sexual agreements were open-ended. Information each spouse WOULD or WOULD NOT want discussed when the couple was brought together was marked. All open-ended questions had pre-coded response options based on SOV content and piloting of the questionnaire during the formative phase of main CRT. Pre-coded options were used due to the number of participants and to facilitate quantification of findings.

Statistical analyses

Statistical analyses were carried out using SAS 9.4 (SAS Institute, Cary, N.C.). Baseline characteristics of couples in SOV clinics who watched the video and returned for follow-up (*n* = 580) were compared to those who did not return (*n* = 233) to assess retention (attrition) bias. Baseline socio-demographics and past and current sexual history, reproductive health and sexual behavioral characteristics were compared by follow-up (post-assessment) attendance using logistic regression and crude prevalence odds ratios (cPORs) and 95% confidence intervals (95% CIs) were calculated. Covariates with statistically significant differences ($p < .05$) were included in the multivariate analysis, and adjusted PORs (aPORs) and 95% CIs were reported.

Responses to the questionnaires administered at follow-up 1-2 weeks after watching the SOV video were presented as frequencies separately for men and women. Statistical differences in responses between men and women were assessed with chi-square tests. Because the number of participants was large, some statistically significant differences were not meaningful, and thus we have highlighted in the results section only significant differences ($p \leq .05$) with a > 5% difference between male and female responses.

Results

Recruitment and follow-up attendance

We compared characteristics of couples with and without a follow-up visit in Table 6.1. Of the 813 enrolled couples in the SOV arm, 580 couples (approximately 71%) completed baseline questionnaire, the intervention visit, and the post-assessment questionnaire 1-2 weeks after receiving intervention. These 580 couples were older, had more children living in the home and had cohabited for longer while couples who did not return had higher incomes and women's comprehension and literacy in English. Sexual histories and risk behaviors showed no significant differences between the two groups with respect to lifetime sexual partners, age at first intercourse, frequency of sex within the union, reporting outside partners since entering the union, ongoing outside partnerships, outside sexual contact under the influence of alcohol, and condom use with outside partners (the latter not shown for women due to small sample sizes). Men's history of treatment for sexually transmitted infection (STI) since the union was also not significantly different between the two groups while women who returned were more likely to report treatment for STI. Because age of man, age of woman, number of children and duration of cohabitation were collinear, only years cohabiting was included in the multivariate model. Of the differences listed above only years cohabiting remained an independent predictor of returning (aPOR 1.05 per year increase, 95% CI [1.02, 1.08], $p = .002$, not shown). Among CNC who returned, a higher percentage had at least one partner reporting an HIV risk factor compared with CNC who did not return, though this was not significant.

Recall of HIV prevention strategies

Table 6.2 presents responses of men and women about their recall of strategies and threats covered during the SOV video. Questions were asked in an open-ended fashion and responses in Table 2 are ordered by frequency of mentions. The most common topic recalled by both men and women was the yellow card, followed by keeping the marriage HIV negative and monogamy/faithfulness. Women were more likely than men (> 5% difference) to mention using condoms with other partners, abstaining or using condoms with spouse for 30 days after an outside sexual exposure, things that might be threats to remaining HIV-free, and what to do in the event of condomless sex with a partner whose HIV serostatus is unknown. Few couples mentioned testing with outside partners and only having sex with HIV-negative people. Most respondents correctly cited the 30-day window between sexual exposure and a positive HIV test.

Discussion and communication at home

Table 6.2 also describes men and women's reported communication at home during follow-up assessment. Only 3% of couples reported not discussing covered topics after the SOV video and half of those cited lack of time or opportunity as the reason. Four in five men and women reported discussing strategies to avoid sexual exposure and a quarter reported discussing threats to remaining HIV-free and what actions to take in the event of an sexual exposure. Both men and women said that the man was more likely to initiate discussion though to different degrees. Almost all couples reported the discussion as friendly and supportive, most said it lasted between 15-60 min and 85% reported agreeing on everything related to their plan with another 15% reporting agreeing on some things (not shown). Men and women were equally likely (98%) to report being very comfortable with the discussion (not shown).

Almost one third of respondents said they would not face any challenges to realistically and effectively using their agreement. Women were more likely to say that they could not tell their spouse if they were exposed while men were more likely to report that they cannot use condoms with their spouse. Twelve percent of respondents said they could not test with other partners and 11% that they could not avoid risks and challenges. Few ($\leq$ 5%) mentioned that they could not trust their spouse to keep the agreements or that they could not use condoms with outside partners.

When asked whether they had any concerns about remaining HIV-free, 13% of men and 9% of women said yes. Reasons differed between men and women with men being more likely to say that they could not test with other partners in their area and women reporting that they suspected or knew that their spouse had another partner.

Negotiated sexual agreements

Negotiated agreements reported at follow-up are summarized in Table 6.3. Most men and women chose to remain monogamous and a majority reported telling their spouse of this plan. Most remaining couples who reported not telling their spouse wished to share their plan though half had not yet done so due to lack of time or opportunity (not shown). Most respondents said their spouse communicated a plan of monogamy with remaining respondents indicating they would like their spouse to share their plan.

Men and women differed on the most common responses about perceived threats to remaining HIV-free both for themselves and for their spouses. Women were more likely than men to report facing no threats. Men felt that the most important threats they would face were alcohol use/abuse, being away from their spouse, and tension or disagreements at home. In contrast, financial pressure related to insufficient income was the most often cited threat reported by women. Less common threats reported with similar frequency by both genders included abstinence due to post-partum, menstruation or illness, lack of sexual satisfaction, and peer pressure to have other partners. Men responded similarly to women that the biggest threat women would face was financial pressure with being away from their spouse and tension or disagreement in the home also common. The most common threats women thought their spouses would face were alcohol use/abuse and being away from each other.

Both men and women were overwhelmingly inclined to share their plan of remaining monogamous. In the event of an outside sexual exposure, 58% of men and women preferred to use the yellow card and another 38% wanted to tell their spouse in another way. Only 4% indicated that they did not want to let their spouse know about the sexual exposure. The most common plan chosen by both genders was to use condoms in the marriage until after a repeat test result in 30 days with 27% preferring to abstain during that time. A majority of men and women wanted their spouse to notify them in the event of an outside sexual exposure.

Discussion

An overwhelming majority of Zambian CNC negotiated explicit sexual agreements of monogamy to prevent HIV from entering the union. Almost all couples described discussions at home as friendly, supportive, and comfortable. Interestingly, though nearly all men and women chose monogamy, two thirds of women and three quarters of men identified at least one threat to their ability to adhere to their agreement. In addition, couples' choice to remain monogamous may not accurately reflect one quarter of couples reporting some baseline HIV risk. We think there could be many reasons for the latter observation including historical risk due to length of cohabitation (6.7 years), recent CVCT and low perceived risk, and societal expectations for married, heterosexual couples. SOV strongly defines monogamy in the context of an HIV prevention strategy while recognizing total monogamy may not be realistic. In addition to monogamy, almost all spouses chose an alternative/interim sexual agreement to use condoms together rather than abstain to protect their spouses from outside-unprotected sexual exposure. These sexual agreements were communicated explicitly during SOV vows, which was often observed as a powerful and emotional moment.

Knowledge of the 30-day window period between sexual exposure and the need to repeat the HIV test was good. Notably, wanting to be honest and wanting the spouse to be honest in the event of an outside sexual exposure was almost universal with the yellow card being the preferred way of communicating this for over half of both men and women.

Threats to Maintaining Monogamy Agreements

Our participants identified familiar threats to monogamy including physical separation due to travel or illness, alcohol use, financial pressure, discord in the home and lack of sexual satisfaction. Physical separation from the spouse was cited as a threat by one third of men and women in our study. This is not uncommon for African couples and has been reported in Malawi (293); in fishing communities in Kenya (294, 295) and Uganda (236), where both men and women are at risk; and among male truck drivers (296, 297) and miners (298), the latter occupations often requiring long stays away from home. Additionally, physical separation for prolonged periods may be challenging for couples who have frequent intra-marital sex (299).

Alcohol use was the most common threat to remaining HIV-free cited by men, and by women about men in our study. This has been a common theme in several studies in couples in South Africa (92, 266, 300-302), Malawi (303), Rwanda and Uganda (216, 304). Our intervention did not include an alcohol reduction component. With only a few HIV-alcohol reductions efficacy interventions being done with mixed findings (305), more research is needed.

Both women and men identified financial pressures ‘financial insecurity’ as the most common threat to monogamy for women. Financial insecurities, including food insecurity, are known drivers of HIV in SSA particularly among women (306-308). Women may engage in extramarital sex for financial reasons and food to support their family. In a study of Kenyan couples in fishing communities, men and women noted that women may engage in extramarital sex to support their children and provide food as husbands may traveling for work without leaving money or spend it on alcohol (299). Women are often vulnerable due to their financial dependence on their spouses putting them at increased risk for HIV. This vulnerability may reduce their ability to negotiate safer sex. This interconnected cycle of financial pressure, alcohol use, and physical separation places both men and women at increased risk for HIV.

Honest disclosure of sex with another partner is a daunting prospect for anyone in a cohabiting partnership and requires trust and open communication (253, 254). Reporting a sexual exposure that will lead to marital condom use or abstinence for a month is especially difficult if pre-existing tensions are present, including relationship dissatisfaction and disagreements which were cited by men and women in our study and have also been reported in South African couple studies (267, 268).

Gender Differences

Differences were noted between men and women as it pertains to recall of HIV prevention topics from the intervention and reported challenges of effectively and realistically using sexual agreements.

Recall of Video Content

Though not significant, men recalled monogamy/faithfulness more than women. However, women had better recall on topics such as, protecting their spouses from HIV, threats to the marriage and dealing with partners with unknown HIV status. In SSA, women's comprehensive knowledge on HIV is generally lower than men (309). A similar trend was also seen in Zambia's Demographic Health Survey as it relates to knowledge of HIV prevention (2). Our observation of women's better recall of HIV prevention content may reflect their interest (310) due to their own or perceived spouses' HIV risk or women's health seeking behaviors.

Challenges to Using Sexual Agreements

Men and women highlighted different potential challenges to using their sexual agreements. More men than women reported not being able to use condoms with their spouse to protect her from unprotected, extramarital sex. Men's concerns regarding condom use with spouse may reflect resistance/reluctance (311, 312); cultural norms (311) and practices (313); reduced sexual pleasure (313-315); loss of intimacy (314, 316); and being suspected of infidelity/unfaithfulness (153, 288, 314). Women, however, reported more than men on potentially having challenges communicating extramarital partners to their spouse. Challenges for women communicating and negotiating sexually protective behaviors like condom use and disclosing HIV status are well studied in SSA. Women's concern to communicate extramarital partners could be due to fear of separation (313), loss of financial security (313), increased tensions in home or partner violence, and labelling and stigmatization (313) which may represent broader issues of power imbalance and gender inequalities found in more patriarchal cultures (313). These challenges further highlight the importance of facilitated discussions with counselors (153) to review and discuss concerns, barriers and solutions, to compare notes with other counselors, and to discuss issues face to face with couples in a neutral environment.

Mitigating Social Desirability Bias

In sexual behavioral studies, such as ours, a common concern is participants reporting behaviors that may be seen as being more socially acceptable. Though no standardized tools or computer/mobile technologies were used, we believe social desirability bias was mitigated by administering the same questionnaires to each spouse separately in private with a gender-matched research counselor. Additionally, couples had time to establish rapport with the research counselors during previous study visits, including consenting, where study procedures were reviewed. A study by Bergen and Labonté highlighted practical strategies similar to ours that can be used to minimize social desirability bias, such as gender matching, privacy, review of study procedures, and rapport (317, 318). In addition, some questions were asked differently but with similar meaning.

Strengths

We note several strengths in our study. A main strength of our study was recruiting CNC who had undergone CVCT, an effective HIV prevention strategy with substantial impact. HIV testing and joint disclosure of HIV results are key components in establishing explicit negotiated sexual agreements (147). Thus, established, standardized indicators that measure HIV testing and joint disclosure of results in couples are needed. Outside of research programs and demonstration projects (319) and in the absence of demand creation efforts (320-326), most adults in SSA continue to be tested as individuals often leading to inaccurate or untruthful disclosures (327, 328). A study in Cape Town showed mutually correct knowledge of partner's HIV status in 38% of women, 28% of men and only 17% of couples (269). To date, studies in SSA with jointly tested couples have focused mostly on discordancy and disclosures. Our study targets heterosexual CNC in SSA where approximately half of new HIV infections in stable unions occur (6, 18). After CVCT, Zambian CNC are at relatively low risk though they contribute to approximately half of residual new infections due to their large numbers (18). Our study highlights the ability of CNC who underwent CVCT to negotiate explicit sexual agreements as an HIV prevention strategy.

In addition, the couple-based nature of this intervention means we have both spouses' responses, which allows for better comparisons and strengthening of our findings. For SOV, we clearly define 'monogamy 'in the context of an HIV prevention strategy as its definition has often been ambiguous (288) with different interpretations (288, 329) historically leading to challenges in its effectiveness as an STI prevention strategy (288, 329). Another strength of this study is showing that CNC can communicate and negotiate explicit sexual agreements to prevent and protect their marriages from HIV from unprotected, extramarital sex. These agreements were discussed and mostly established at home with little to no reported challenges. The findings here support our formative work (277) and others authors (152, 153) that highlight the feasibility, interest and willingness of heterosexual couples to discuss sexual agreements. In addition, SOV targets safer sex communication for HIV prevention in committed couples which historically mostly focused on casual relationships (150). We found almost all couples had explicitly communicated their agreement to be monogamous with their spouses. Our finding is promising as several studies found many monogamy agreements in heterosexual relationships to be understood and expected but often not communicated (155, 159), resulting in them being poorly adhered to (155). SOV equips couples to state explicitly their sexual agreements with their spouses, as false perceptions about sexual exclusivity within heterosexual relationships (153, 159) puts the couple at risk for HIV and other STIs. In addition, the option to initiate a discussion about an HIV sexual exposure, verbally and non-verbally (yellow card) in SOV, may help couples “break the ice” on communicating difficult subject matters like extramarital sex (156). SOV offers a more structured and pragmatic approach to disclose a breach in agreement and take action to protect their spouse through condom use or abstinence until HIV retest within 30 days, which almost all couples adopted.

Limitations

Our study is not without limitations. We acknowledge that baseline knowledge of, presence of and motivations for sexual agreements in CNC was not assessed. Anecdotally, discussions with CNC during the formative phase of the main CRT highlighted they did not discuss extramarital sex and relationship agreements were not common. Additionally, our formative work found though awareness of sexual concurrency exists, it was not a social norm in Zambia (277). This supports that pre-existing communication of an explicit sexual agreement may not be likely. In addition, a study by Stephenson and authors found inclusion of intervention concepts in the pre-intervention phase reduces the ability to quantify its impact (330). Though couples explicitly communicated their sexual agreements, SOV did not include practical skills building on couple communication, which may be beneficial to couples encountering communication that is more difficult. This study did not specifically include or measure gender-based violence (GBV) though this has been explored in other studies (331, 332). However, our study did include handling difficult communication. Leddy and colleagues measured sexual communication self-efficacy (i.e., a couple's confidence in their ability to communicate about HIV prevention) and found an association with better condom use in South African couples (333). While we did not measure sexual communication self-efficacy directly, responses from both men and women in our study indicated a universal desire to disclose and to be disclosed to in the event of outside sexual contacts. Long-term follow-up will tell whether the focus on HIV prevention rather than adultery per se, and the interdependence of the two partners in maintaining the household (334), reduces the barriers to disclosure and adoption of protective behaviors.

Another potential limitation was our study's focus on sexual agreements for HIV prevention. We acknowledge there may be other factors, such as relationship quality, relationship dynamics, gender roles and norms, which affect and influence sexual agreements. In addition, couples may view these factors as more important than HIV prevention and may prefer a more relationship-centered agreement that focuses on non-HIV and non-health topics (153). Recent findings by LeBlanc and colleagues further suggest that heterosexual couples may prefer couple-tailored sexual agreements, re-framed in the context of building relationships and including sexual health (154).

Conclusion

Our study highlights Zambian CNC's ability to negotiate and explicitly communicate their sexual agreement of monogamy. Our study also confirms Zambian CNCs' ability to recall key elements from the "Strengthening Our Vows," video-based intervention using consistent messaging that encourages negotiated sexual agreements with their spouses. Men and women cited similar threats to engaging in unprotected, extramarital sex, such as alcohol use in men, financial pressures in women, physical separation and tension in the home. Our findings are more generalizable to jointly counseled CNC.

These findings are important, as CNC are an understudied and comparatively low-risk group who contribute to a substantial number of new HIV infections in SSA. In addition, our study was conducted in a resource-limited setting, which highlights the potential applicability of video-based interventions. Future studies on negotiating sexual agreements as an HIV prevention strategy in CNC should explore barriers to follow-up attendance in CNC who have not been cohabiting as long and may be younger. Studies on explicit sexual agreements in heterosexual couples remain understudied. Most research to date have been in high income countries. Our study shows the possibility of including a negotiated sexual agreement component with CVCT to reach many CNC in Africa who have not yet been jointly tested and counseled given the high percentage of couples that negotiated sexual agreements in a friendly, supportive and comfortable environment. Additional studies on the feasibility and willingness of heterosexual couples to negotiate and communicate explicit sexual agreements are needed, particularly in SSA, where HIV disease burden is highest.

Table 6.1 Baseline Socio-Demographic, Past and Current Sexual History, Reproductive Health and Sexual Behavioral Characteristics of Couples at SOV Clinics by Follow-Up Attendance

	Watched SOV Video and Attended Follow-up (N = 580)		No Follow-up (*n* = 233)		
	n/mean	%/ SD	n/mean	%/ SD	*p* [a]
Sociodemographics					
Male age (mean, years)	32.5	7.8	30.9	7.7	0.010
Female age (mean, years)	26.8	7.0	25.4	6.4	0.006
If income yes, man's income (mean, ZMW)	998	1242	1204	1364	0.041
Number of people in household	4.9	2.1	4.5	2.1	0.035
Number of children under 16 in household	2.4	1.6	2.0	1.6	0.001
Woman reads or understands English					
Easily	182	32%	93	40%	0.028
With Difficulty/Not at all	395	68%	142	60%	
Couple characteristics					
Years Cohabiting	6.7	6.0	5.2	5.4	0.001
Past sexual history and behavior					
Man lifetime sex partners (mean)	5.1	5.2	5.4	6.7	0.449
Woman lifetime sex partners (mean)	2.0	1.5	1.9	1.3	0.533
Man age at first sexual intercourse (mean, years)	18.5	3.8	18.9	4.3	0.214

Woman age at first sexual intercourse (mean, years)	17.2	2.5	17.5	2.6	0.091
Man: Number of times had sex with spouse in last month (mean)	10.1	8.9	11.3	13.2	0.204
Woman: Number of times had sex with spouse in last month (mean)	10.4	9.8	10.6	8.6	0.787
Man reports ever having outside partners since union					
Yes	68	12%	31	13%	0.530
No	512	88%	202	87%	
If yes, man's number of outside partners (mean)	2.1	2.3	2.6	3.7	0.539
Man: Condom use with outside partners					
Never (0%)	26	38%	10	32%	
Rarely (20%)	11	16%	2	6%	
Sometimes (50%)	13	19%	8	26%	0.590
Often (75%)	4	6%	2	6%	
Always (100%)	14	21%	9	29%	
Man reports sex with outside partners under influence of alcohol					
Yes	28	41%	10	32%	0.400
No	40	59%	21	68%	
Man reports ongoing outside partner(s)					
Yes	11	16%	4	13%	0.768
No	57	84%	27	87%	

Woman reports ever having outside partners since union					
Yes	6	1%	1	0%	0.680
No	573	99%	232	100%	
Man ever treated for STI					
Yes	76	13%	22	9%	0.150
No	504	87%	211	91%	
Woman ever treated for STI					
Yes	27	5%	4	2%	0.048
No	552	95%	229	98%	
Man: At least one risk factor (ever treated for STI or having outside partners)					
Yes	130	22%	44	19%	0.267
No	450	78%	189	81%	
Woman: At least one risk factor (ever treated for STI or having outside partners)					
Yes	31	5%	5	2%	0.045
No	548	95%	228	98%	
Couple: At least one risk factor (either partner treated for STI or having outside partners)					
Yes	145	25%	45	19%	0.081
No	434	75%	188	81%	

[a] Two-tailed t-test for continuous variables, chi-square test for categorical variables with expected cell counts greater than or equal to 5, Fisher's exact test for categorical variables with expected cell counts less than 5

[b] Acronyms: sexually transmitted infection (STI); strengthening our vows (SOV); Zambian kwacha (ZMW)

Table 6.2 Knowledge and Communication After SOV Video Intervention: Questionnaire Responses

	Men (N = 580)		Women (N = 580)	
	N	%	N	%
Knowledge of strategies				
Can you describe for me the topics discussed during the video and group discussions at your last visit? (open-ended)				
The yellow card	412	71%	421	73%
How to keep our marriage HIV negative	376	65%	392	68%
Monogamy/faithfulness	355	61%	324	56%
Using condoms with other partners	199	34%	232	40%
How to protect the spouse in the event of an outside exposure (sexual) to HIV	207	36%	198	34%
Abstaining or using condoms with spouse for 30 days after outside exposure (sexual) and re-testing	121	21%	183	32%
The things that might be threats to remaining HIV free in our marriage	86	15%	122	21%
What to do if you have sex without a condom with someone whose HIV status you do not know	67	12%	111	19%
Testing together with other partners and only having HIV-negative partners	43	7%	57	10%
Other	39	7%	15	3%

When a person is exposed to HIV, it can take some time before it shows up in their blood and they test positive for HIV. How long does it usually take before a person will test positive after an exposure (sexual)?				
30 days/1 month	495	85%	513	88%
Other	69	12%	39	7%
Don't know	16	3%	28	5%
Communicating with the spouse about keeping HIV out of the union				
Since you had your videos and group discussion, did you and your spouse discuss how to keep HIV out of your marriage?				
Yes	569	98%	554	96%
No	11	2%	26	4%
If not, what is the main reason you did not discuss how to keep HIV out of your marriage?				
No time/opportunity	6	1%	10	2%
No need for us to further discuss	1	0%	3	1%
Not comfortable	1	0%	1	0%
My spouse refused to discuss	0	0%	1	0%
Other	3	1%	11	2%
In terms of keeping HIV out of your marriage, what did you discuss?				
Strategies we will use to avoid exposure (sexual)	448	79%	454	82%
Threats we face to remain HIV free	151	27%	151	27%
What we will do if one of us is exposed	130	23%	151	27%
An exposure (sexual) that has occurred	24	4%	21	4%

Other	59	10%	24	4%
Would you describe the discussion as:				
Friendly and supportive	563	99%	549	99%
Tense and uncomfortable	5	1%	2	0%
Hostile/Angry	0	0%	3	1%
Who initiated the discussion?				
You initiated	380	67%	250	45%
Your spouse initiated	147	26%	278	50%
You both initiated	41	7%	26	5%
What do you think are the most difficult challenges for you?				
No challenges	169	29%	191	33%
I cannot tell my spouse if I am exposed	69	12%	104	18%
I cannot test with a partner who is not my spouse	82	14%	59	10%
I cannot use condoms with my spouse	90	16%	47	8%
I cannot avoid the risks/challenges	78	13%	51	9%
I do not trust my spouse to keep the agreements	35	6%	23	4%
I cannot use condoms with a boyfriend/girlfriend	38	7%	12	2%
Other	77	13%	115	20%
Do you have any concerns about your ability to remain HIV- in your marriage?				
Yes	75	13%	50	9%
No	505	87%	530	91%
What are your concerns?				
I can’t test with another partner around here	28	5%	6	1%

We don’t have enough money	18	3%	9	2%
I suspect my spouse has another partner	11	2%	15	3%
My spouse has another partner	12	2%	11	2%
My spouse won’t use condoms	8	1%	6	1%
Other	10	2%	8	1%

Table 6.3 Negotiated Agreements After SOV Video: Questionnaire Responses

	Men (N = 580)		Women (N = 580)	
	N	%	N	%
The plan to keep the union HIV-free				
Which of the following best describes the plan that you have chosen for yourself?				
You will be monogamous and only have sex with your spouse	560	97%	570	98%
You may have other partners but you will always use a condom with them	14	2%	4	1%
You may have other partners but only if you have tested with those partners and you know they are HIV-or you will always use a condom	6	1%	3	1%
Have you told your spouse your plan to avoid HIV exposure (sexual)?				
Yes	555	96%	556	96%
No	25	4%	24	4%
If not, would you like to tell your spouse what your plan is?				
Yes	22	4%	23	4%
No	3	1%	1	0%
Has your spouse told you how they plan to avoid exposure (sexual) to HIV outside marriage?				
Yes	551	95%	560	97%

No	29	5%	20	3%
If not, would you like your spouse to tell you how they plan to avoid exposures (sexual) to HIV?				
Yes	28	5%	19	3%
No	1	0%	1	0%
Which of the following best describes the plan that your spouse has chosen?				
He/she will be monogamous and only have sex with you	549	100%	550	98%
He/she may have other partners but he/she will always use a condom with them	1	0%	8	1%
He/she may have other partners but either he/she has tested with those partners and will know they are HIV-or he/she will always use a condom	1	0%	1	0%
Threats and challenges				
Thinking about the plan you have chosen to stay HIV negative in your marriage, what do you think are the things that make it difficult for you to stick to your plan?				
Alcohol use/abuse	256	44%	102	18%
Financial Pressures	118	20%	202	35%
We are away from each other a lot	204	35%	110	19%
Tension or disagreements at home	189	33%	113	19%
Post-partum abstinence	125	22%	101	17%
Abstinence due to menstruation	89	15%	86	15%
Lack of sexual satisfaction	96	17%	71	12%

Peer pressure to have other partners	60	10%	34	6%
Abstinence due to sickness	29	5%	38	7%
Want nice things like others have	24	4%	46	8%
A girl/boyfriend whose HIV status is unknown	24	4%	29	5%
No risk	142	24%	184	32%
Thinking about the plan your spouse has chosen, what do you think are the things that make it difficult for your spouse to stick to his/her plan?				
Financial Pressures	279	48%	109	19%
We are away from each other a lot	197	34%	158	27%
Tension or disagreements at home	161	28%	126	22%
Alcohol use/abuse	98	17%	156	27%
Lack of sexual satisfaction	86	15%	91	16%
Peer pressure to have other partners	67	12%	44	8%
Want nice things like others have	79	14%	27	5%
Post-partum abstinence	33	6%	64	11%
Abstinence due to menstruation	25	4%	51	9%
No risk	164	28%	144	25%
Topics to discuss when brought back together with spouse				
Discuss plan with spouse:				
I would like to say openly what my plan is	572	99%	577	99%
I would not like to say openly what my plan is	7	1%	3	1%
I want to tell my spouse that my choice is:				

Faithfulness, be monogamous and only have sex with each other	564	97%	570	98%
Using condoms with outside partners	30	5%	11	2%
Testing with outside partners and only having sex with HIV-	4	1%	3	1%
If I have an outside exposure (sexual), I would:				
Like to show the yellow card so we can discuss how to prevent transmission to my spouse	339	58%	333	58%
Like to tell my spouse so we can discuss how to prevent transmission	215	37%	227	39%
Prefer not to share this information with my spouse, but I promise to wait 30 days and get retested before having sex without a condom with my spouse	26	4%	19	3%
In that situation, if I had a possible exposure (sexual) to HIV, I would:				
Use condoms with my spouse for 1 month until the retest	421	73%	399	69%
Abstain from sex with my spouse for 1 month until the retest	151	26%	164	28%
Not do anything different in my marriage, just continue as usual	5	1%	15	3%
Other	3	1%	2	0%
If my spouse had a possible exposure (sexual) to HIV, I would like my spouse to:				

Tell me, so we can abstain or use condoms for 1 month until the retest	555	96%	572	99%
Don't tell me, just abstain or use condoms with me for one month until the retest	11	2%	6	1%
Not do anything different, just continue as usual	11	2%	1	0%
Something else	3	1%	1	0%

7. **Chapter 7 Research Paper 3:** *Impact of a group-based video and discussion group addressing diarrheal disease, helminthic and schistosomiasis infections, hypertension and diabetes on short and long-term improvement in knowledge and healthy behaviors in seroconcordant HIV-negative Zambian couples*

Overview of Research Paper 3

One of the objectives of Research Paper 1 was to measure improvement in the GHP arm as it relates to knowledge of prevention strategies and recommendations for diarrheal and respiratory diseases, STH, schistosomiasis hypertension, and diabetes. In this paper, SOV served as a contemporaneous comparison to rule out other external NTD or NCD programs and interventions that could impact outcomes.

The findings showed substantial increases in the GHP arm as it related to knowledge and skills uptake and recommendations on controlling conditions once diagnosed. Adoption and maintenance of strategies were moderate-high and sustained for some while others had low adoption which further waned with time.

Findings confirm literature regarding a critical gap in knowledge given baseline GHP results. Findings further highlight the importance of health education messaging as part of prevention strategies. Findings also suggest consistent messaging is important.

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RESEARCH PAPER COVER SHEET

Please note that a cover sheet must be completed for each research paper included within a thesis.

SECTION A – Student Details

Student ID Number	1406846	**Title**	Ms
First Name(s)	Tyronza Daniell		
Surname/Family Name	Sharkey		
Thesis Title	Impact of Couple-Based Interventions on Knowledge Uptake, Implementation, and Communication of Strategies to Prevent HIV, Non-Communicable and Neglected Tropical Diseases in Zambian HIV Seroconcordant Negative Couples		
Primary Supervisor	Dr. Rosanna Peeling		

If the Research Paper has previously been published please complete Section B, if not please move to Section C.

SECTION B – Paper already published

Where was the work published?	International Journal of Tropical Diseases		
When was the work published?	27 April 2022		
If the work was published prior to registration for your research degree, give a brief rationale for its inclusion			
Have you retained the copyright for the work?*	Yes	Was the work subject to academic peer review?	**Yes**

*If yes, please attach evidence of retention. If no, or if the work is being included in its published format, please attach evidence of permission from the copyright holder (publisher or other author) to include this work.

SECTION C – Prepared for publication, but not yet published

Where is the work intended to be published?	

Please list the paper's authors in the intended authorship order:	
Stage of publication	Choose an item.

SECTION D – Multi-authored work

For multi-authored work, give full details of your role in the research included in the paper and in the preparation of the paper. (Attach a further sheet if necessary)	Creation of intervention and comparison arm flip chart guides, videos, questionnaires, other data collection tools and databases; training of study and clinic teams; implementation of the work and data collection; project administration; data analysis; manuscript preparation, review and editing.

SECTION E

Student Signature	Tyronza Sharkey
Date	15-Mar-2023

Supervisor Signature	Rosanna Peeling
Date	15 March 2023

Impact of a Group-Based Video and Interactive Group Session Addressing Diarrheal Disease, Helminthic and Schistosomiasis Infections, Hypertension and Diabetes on Short and Long-Term Improvement in Knowledge and Healthy Behaviors in Seroconcordant HIV-Negative Zambian Couples

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Abstract

Background: Non-communicable and neglected tropical diseases (NCD and NTD) contribute to high morbidity and mortality in Zambia. While the public health importance of NTD has long been recognized, prevalence of disease remains high. NCD are emerging as causes of morbidity and mortality. Knowledge of risk factors, diagnosis, management, and prevention of NCDs and NTDs in the general population is poor and as a result, low-cost commodities are insufficiently used.

Methods: Urban couples recruited in five government health centers (HC) participated in a video-based group intervention addressing handwashing, water treatment, routine deworming, and urinary schistosomiasis screening to prevent morbidity and mortality from NTD. Chlorine, soap, and deworming for the family were provided, along with schistosomiasis treatment. The intervention also promoted lifestyle changes to prevent and ameliorate hypertension and diabetes and emphasized the importance of medical management regardless of symptomatology. Blood pressure screening identified hypertensives who were given low-sodium salt and referrals. Those with glucose on urine dipstick were counseled and referred. Knowledge and observed and self-reported behaviors were measured 1-2 weeks and 6 months after the interventions. All activities took place in the HC and conducted by trained HC staff.

A comparison group recruited at five matched HC was assigned to an HIV prevention intervention and completed the same surveys as the intervention group at baseline and 6 months.

Results: One to two weeks after the intervention, reported use of chlorine treatment for drinking water increased from 24% to 96%, with knowledge of correct volume for dilution of 20L and 5L containers improving from 29%-35% to 96%-98%. Knowledge of household deworming increased from 62% to 99%. Observed handwashing technique improved including duration (20 seconds) and scrubbing of back, palms, wrists, between fingers and under fingernails. Knowledge that hypertension and diabetes could be asymptomatic increased from 63% to 82% and recall of potential sequelae also improved including heart disease/attack (14% to 41%), stroke (26% to 61%) and death (65% to 83%). Correct definition of hypertension (BP >=140/90) increased from 6% to 54% and citing salt reduction as part of management increased from 31% to 85%. An increase in those reporting not adding salt (8% to 20%) corresponded with a decrease in those reporting >=1/2 teaspoon (16% to 5%). Knowledge that diabetics should reduce sugar intake increased from 48% to 89% and the proportion reporting adding >=3 tsp to their tea decreased from 42% to 26%. Taking prescribed medication and getting regular medical checks knowledge increased for both hypertension (38% to 73% and 28% to 66%, respectively) and diabetes (32% to 71% and 20% to 60%, respectively). These improvements were retained at 6-month follow-up and sharing-related household duties to prevent NTD and NCD improved. Comparison group surveys confirmed equivalency of NTD and NCD knowledge and behaviors between the two groups at baseline. Surveys at 6 months showed no improvement in the comparison group, confirming that secular trend did not play a role.

Conclusion: Video-based interventions are time and money-saving and ensure consistent messaging. Sustained improvements in knowledge and behavior were reported when low-cost commodities were provided.

Keywords: Non-communicable diseases, Neglected tropical diseases, Hygiene and sanitation, Helminthiasis, Handwashing, Healthy lifestyle, Video, Couples

Abbreviations: BP: Blood Pressure; CLTS: Community-Led Total Sanitation; CNC: Concordant HIV-negative Couples; CRT: Cluster Randomized Trial; CVCT: Couples' HIV Voluntary Counseling and Testing; ELISA: Enzyme-Linked Immunosorbent Assay; GHP: Good Health Package; HC:
Health Center; NCD: Non Communicable Diseases; NTD: Neglected Tropical Diseases; SSA: Sub-Saharan Africa; WHO: World Health Organization

Introduction

Neglected tropical diseases (NTD) and non-communicable diseases (NCD) pose an important threat to health in Africa. In Zambia and many sub-Saharan Africa (SSA) countries, the most prevalent NTDs are cholera, soil transmitted helminths and schistosomiasis. Among the leading causes of death in Zambia are lower respiratory infections (pneumonia) and diarrheal diseases at 4^{th} and 5^{th} respectively, with children most affected (2, 335). Various studies in SSA including Zambia have shown that handwashing can reduce prevalence of diarrheal diseases by 25% or more (63-67, 336). Cholera is also a frequent problem in two of the largest cities in Zambia, Lusaka and Ndola, with regular outbreaks occurring during the rainy season since the 1970s (68). Previous cholera outbreaks have been linked to high fecal contamination of water sources and raw/prepared foods, inadequate safe water supply and sanitation, and insufficient drainage (68, 69, 71, 72, 337-339).

Hypertension and diabetes leading to heart disease and stroke are increasingly common due to urbanization, increase sedentary lifestyles and high salt and high fat diets. Stroke is now the 3^{rd} leading cause of death having increased by almost 60% from 2009 to 2019 and ischemic and hypertensive heart disease are ranked at 7^{th} and 10^{th} position respectively (335). Risk factors attributable to mortality and morbidity (disability) include water sanitation and hygiene (WaSH) in 4^{th} position and high blood pressure (BP), high body mass index, and dietary risks at 6^{th}-8^{th} position respectively (335).

We previously offered basic NTD/NCD education with a flip chart and a selection of services (blood pressure screening, urine dipstick for blood (schistosomiasis) and sugar (diabetes)) and commodities (hand soap, chlorine, deworming for the family, low sodium salt) to couples seeking joint HIV counseling and testing in Lusaka and Ndola, two of Zambia's largest cities (219), and these services were associated with increased follow-up for repeat HIV testing. However, health center (HC) staff reported that knowledge about NTD and NCD was poor, prompting us to develop a more intensive education program.

We present here knowledge and behaviors related to prevention, screening and treatment of common NTD and NCD in seroconcordant HIV-negative Zambian couples (CNC) who participated in a Good Health Package (GHP) comparator arm of a cluster randomized trial (CRT) described in detail elsewhere (277). Baseline information is compared to survey responses two weeks and six months after a video-based educational session with practicums and provision of low-cost commodities. Outcomes at six months are compared with CNC in clinics randomized to a contemporaneous and unrelated HIV prevention, also described in more depth elsewhere (277). Our findings will highlight successful couples-based prevention strategies to reduce the morbidity and mortality associated with NTD and NCD through education, practical training, low-cost commodity distribution and screening with treatment/referral.

Methods

Ethics

Approval has been granted by the OHRP-registered University of Zambia Biomedical Regulatory Ethics Committee and Emory University Institutional Review Board and retrospectively registered as NCT02744586 on ClinicalTrials.gov. Couples viewed a verbatim reading of the informed consent on a video, met with a counselor to discuss any questions or clarifications, and jointly signed consent (18, 290, 291). A unique alphanumeric ID was implemented for all data gathering tools. Locator information was stored separately from data to maintain privacy and confidentiality.

Study design

Ten participating clinics (8 in Ndola and 2 in Lusaka) included 5 dyads with non-overlapping catchment areas matched by clinic volume and HIV prevalence. Each dyad was randomized such that one clinic was assigned to the GHP arm and the other to the control arm. An enrollment visit was followed by receipt of the intervention several days later. The short-term impact was measured 1-2 weeks after the intervention with intervention-specific questionnaires. Long-term impact was measured at six months with the same assessments in GHP and control groups, including knowledge and behaviors related to NTDs/NCDs. The trial is ongoing (clinicaltrials.gov NCT02744586) with a 60-month follow-up visit to have more detailed comparisons of HIV risk factors between both arms and to assess longer-term knowledge and implementation of strategies in GHP arm. Hypotheses of the CRT are that the GHP arm will sustain improved knowledge and behaviors related to NTD/NCD prevention and treatment than the control arm. Conversely, the control arm will have a lower incidence of HIV risk factors, such as reported outside sexual contacts, incident HIV and STI than the GHP arm.

Objective: The purpose of this manuscript is to compare changes in NTD/NCD-related knowledge and behaviors in the GHP arm at baseline (pre-intervention) and post-intervention at two weeks and six months. This study will also compare knowledge and behaviors at six months post-intervention visit between GHP and a comparison group (control) that received an HIV intervention in order to assess potential secular trend due to other NTD/NCD programs.

Study Population

At Couples HIV Voluntary Counseling and Testing (CVCT) offered in government health centers in Lusaka and Ndola, two of Zambia's largest cities, couples underwent pre-test counseling, HIV rapid testing per national guidelines adapted for couples (289) and post-test counseling. According to Center for Disease Control and Prevention and World Health Organization (WHO) guidelines, couples received HIV results together and were counseled per their couple HIV status (17, 205). .

In 2016, couples who received CVCT services and met pre-screening eligibility (both partners HIV-negative, women aged 18-45 and men aged 18-65, cohabiting for >=3 months, interested, willing and capable of understanding and fulfilling study procedures and providing contact information) were invited the following weekend to return for screening and enrollment.

Study reimbursement:

At each visit, couples received approximately 3 USD per person-visit as study reimbursement to cover time at clinic and transport, as described in the informed consent. An additional 2 USD per person was given as a lunch allowance for more extended study visits.

Enrollment visit

After joint informed consent, the couple was separated, and a baseline questionnaire was administered to women by female counselors and men by male counselors and included socio-demographic characteristics, knowledge of and behaviors related to NTDs and NCDs. The visit lasted 2-3 hours.

Intervention visit: The “Good Health Package” (GHP) video rationale and content was developed based on previous use of health education flip chart and a choice of provision of commodities (deworming tablets, chlorine and hand soap) and health screenings (blood pressure, diabetes and schistosomiasis) related to NCDs and NTDs to improve follow-up HIV testing in couples in which at least one partner was HIV-negative (219). All materials were translated into the vernacular (Bemba and Nyanja) and content was equivalent to or below 8th grade level. During the visit, spouses watched a one-hour video that consisted of two-30-minute parts. Part one content covered risk groups; transmission and mechanism of action; signs and symptoms; key facts and statistics; and prevention strategies. In the first part of the video, spouses were separated into men and women’s groups; male counselors led the men’s groups, and female counselors led the women’s groups. Pauses were incorporated throughout the video in key areas; during these pauses, the counselor actively facilitated discussion points to allow for questions, answers and further discussions/clarifications if needed. Handwashing with soap to prevent respiratory and diarrheal infections and intestinal helminths was emphasized, and during breaks in the video, participants practiced under supervision. Use of drinking water treatment with chlorine to prevent cholera and other causes of diarrhea was described and again participants practiced putting the correct amount of chlorine into 5-liter (one measure of the top of the chlorine bottle cap) and 20-liter (one measure of the bottom of the chlorine bottle cap) containers. Schistosomiasis education highlighted how freshwater areas within a city could be potential sources of infection based on a recent study showing active infection in 10% of healthy adults in Lusaka (80). (Of note, we did not include discussions of malaria as we were not able to offer bed nets due to their high cost and the focus on pregnant women for available stock.)

Modifiable lifestyle changes related to salt and sugar intake, weight maintenance and physical activity were emphasized for prevention of hypertension and diabetes, and salt and sugar measurements were used to illustrate portion control. All couples came back together in part two of video which had a quiz related to topics in the video in addition to discussion on the importance of equal responsibility in terms of household health and implementing strategies at home to improve the family's health. Couples were provided with a bottle of chlorine sufficient for one year of use in an average household, hand soap, and one round of de-worming medication sufficient for the household. Blood pressures were taken, and urine dipsticks were used for detection of urinary schistosomiasis (hematuria) and diabetes (glucosuria). All couples received low sodium salt and messaging for hypertension prevention. Participants with a blood pressure >=140 mmHg systolic and/or >=90 mmHg diastolic received added lifestyle and dietary counseling and were referred for medical evaluation. Participants with elevated glucose (>=500mg/dl (27.77mmol/L)) in urine were also referred for medical evaluation. Those with hematuria were provided with free treatment for schistosomiasis with praziquantel. The visit lasted 3-4 hours.

Follow-up visits 1-2 weeks and 6 months post-intervention visit

GHP spouses were separated and administered a questionnaire about knowledge, implementation of strategies, sharing of household roles, and behaviors related to their intervention content. At the 6-month follow-up visit, couples in both GHP and control arms responded to the same questions on hypertension, diabetes, diarrheal diseases, schistosomiasis, and helminths.

Data management and analysis

Questionnaire data is managed using Microsoft Access and Research Electronic Data Capture (REDCap) electronic data capture tools hosted at Emory University (225) with IT support from Research and Woodruff Health IT Division grant support (UL1 TR000424). Responses to questionnaires are presented as frequencies. To establish significance, differences in responses between pre-and post-intervention and between men and women are assessed with chi-square tests. Because the number of participants is large, some statistically significant differences are not meaningful, and we thus only highlight in text significant differences of >5%. Data analysis is conducted using SAS 9.4 (SAS Institute, Cary, N.C.).

Results

Demographic characteristics

In the 570 couples who participated in the intervention and the first follow-up visit, the average age was 32 for men and 26 for women and the average duration of union was 5.9 years. The couple reported an average of 4.6 people in the household including an average of 2.1 children under 16. Literacy in the vernacular (Bemba or Nyanja) was good with 80% of men and 63% of women reporting reading easily. Most couples earned something with 99% of men and 71% of women reporting some income. Among men, 73% reported reading or understanding English easily compared with 55% of women.

A public tap was the most common source of water (33%) with outdoor tap piped into the yard (26%), a protected well (17%), and bore hole directly (15%) also common. Only 7% reported piped water in the home. Most could access water within a <15 min walk (82%) or a 16 to 20-minute walk (9%). Two percent of respondents reported having high blood pressure and 36% knew of family members with high blood pressure. Only two respondents reported diabetes though 19% of respondents reported had affected family members.

In the presentation of data from Tables 7.1-7.4 below, differences are significant unless specified and only significant differences of >5% are mentioned in text.

Knowledge and behaviors prior to and 1-2 weeks post GHP intervention (Table 7.1)

At baseline, 46% of respondents (49% of men and 43% of women) did not treat their drinking water, 31% boiled water, and 24% added chlorine. This increased to 96% using chlorine and 15% boiling two weeks post-intervention. Knowledge of how much chlorine to use for 5-liter and 20-liter containers rose from 29-35% to 96-98%. Most respondents knew that handwashing after using the toilet and before cooking and eating was important before the intervention. Handwashing after handling animals, dirty diapers, or rubbish were reported more often though respondents citing after sneezing or coughing into your hands or before and after caring for the sick remained suboptimal at 36-40%.

The techniques used during handwashing demonstration also improved with knowledge of scrubbing back of hands, palms, between fingers, and under fingernails, all increasing to >=70%. For length of time for handwashing (20 seconds), an increase was seen between baseline and post-intervention for self-report (23% to 66%) as well as observed (5% to 43%).

Reported ways to get intestinal worms at baseline included eating dirt/soil (46%), not properly washing raw vegetables and fruits (43%), and undercooked meat (22%), all of which increased to >=84% after the intervention. Less frequently reported ways to get intestinal worms at baseline, such as not washing hands after touching soil, using the toilet, and before handling food increased from <=14% to >=40% post-intervention. Prior to the video, 62% of respondents thought that deworming should include everyone in the home, and 26% thought it involved only the children. This increased to 99% volunteering that everyone in the home should be dewormed.

The knowledge that most hypertensive and/or diabetic patients did not have symptoms increased from 63% to 82%. Knowledge also increased that hypertension could lead to heart attacks (14% to 41%), stroke (26% to 61%) and death (65% to 83%). Only 6% of respondents correctly cited what value is considered high blood pressure (>=140/90 mmHg) before the intervention; this increased to 54% (61% of men and 48% of women).

Knowledge of lifestyle and dietary changes that people with hypertension should adopt improved for reducing salt intake (31% to 85%), taking prescribed medication (38% to 73%), and getting regular BP checks (28% to 66%). Interestingly, while knowledge of the importance of losing weight if overweight and exercising did improve, fewer than half of respondents mentioned those recommendations even after the intervention. Similar findings were noted with diabetes with reducing sugar intake (48% to 89%), taking prescribed medicine (32% to 71%), and getting sugar levels checked improving substantially (20% to 60%) but far less recall of diet and exercise recommendations.

Respondents did report behavior change after receiving GHP. Participants reporting adding none (or no salt) to their evening meal increased from 8% to 20% after the intervention visit. The percent increase in reporting no salt corresponded to a decrease in those reporting adding a ¼ tsp or more to their evening meal. Similarly, sugar added to a cup of tea of coffee shifted down with those reporting >=3 tsp dropping from 42% to 26%.

Follow-up, retention and the comparison group (control)

Of the GHP 570 couples who completed baseline, the intervention and the two-week follow-up, 480 completed the 6-month follow-up. The control arm, interviewed at 6 months for comparison, included 489 couples.

Adoption and maintenance of behavior change two weeks and six months post GHP intervention (Table 7.2)

The table presents strategies ordered by frequency mentioned two weeks post-intervention and compares analogous responses at 6 months. Implemented strategies mentioned at two weeks that were maintained at 6 months included chlorinating drinking water (97%), handwashing with soap (96%), deworming the family (81%) and reducing salt in cooking or using low sodium salt (76%). Some other behaviors adopted with lower frequency were also maintained, including avoiding areas with bilharzia (46%), avoiding salty foods (47% including 50% of men and 44% of women, not shown), and agreeing on food preparation together (35% including 39% of women and 31% of men, not shown).

Other reported health maintenance behaviors were less likely to be maintained over time including limiting sugary drinks, maintaining a healthy weight, avoiding stress, eating plenty of fruits and vegetables, exercising, avoiding tobacco products, limiting alcohol intake and drinking 2 liters of clean water/day.

Impact of the GHP intervention on sharing household duties (Table 7.3)

While men and women agreed that women usually collected water, the proportion reporting both partners collecting water increased from 15% before the intervention visit to 30% at 6 months, with men more likely to report sharing this duty (35% compared with 24% of women). Similarly, prior to the intervention visit, women assumed most of the responsibility for water chlorination in the 24% of households that used chlorine. After the intervention visit, sharing this responsibility increased to 47% in the 90% of households using chlorine, with the proportion of men reporting sharing 8-9% higher than their wives. Close to half (48%) of respondents at baseline reported sharing food purchasing duties, while a third reported the man took charge of this duty. Sharing food purchasing increased to 65% at two weeks and 79% at 6 months with similar reports from men and women. Food preparation was almost exclusively the woman's responsibility with a modest increase in shared responsibility (from 9% to 22% at two weeks) after the intervention visit. The proportion of couples sharing responsibility for taking care of sick persons in the household increased from 73% prior to the intervention visit to 95% at 6 months. Changing baby's nappy and doing dishes remained primarily a woman's job. Only 20% of households had animals, and handling animals was a shared duty before and after the intervention visit (not shown).

Comparison of knowledge uptake in GHP with the control group that received a different intervention to assess potential contribution of secular trend due to other programs (Table 7.4)

The control group that received an unrelated HIV intervention was interviewed at 6 months, contemporaneously with participants described in preceding tables, to assess the potential contribution of secular trend due to other water and sanitation, NTD and NCD programs. Knowledge of chlorine for water treatment (97% of GHP group *vs*. 35% of controls), and how to prepare potable water (96-97% *vs*. 37%-44%) were higher in the GHP group. When, how long, and the steps involved in handwashing including responses to questions and practical demonstrations were substantially better in the GHP group as was knowledge of how one could get worms and who in the house should be dewormed. The control group respondents reported adding more salt to food and sugar to tea/coffee. The control group was also less likely to know that hypertension and diabetes are usually asymptomatic and can result in heart attack or stroke. Lastly, knowledge of what blood pressure levels are considered high and actions to take if one has high blood pressure or diabetes were uniformly better in the GHP group.

Discussion

Neglected tropical diseases (NTDs) and non-communicable diseases (NCDs) are prominent causes of morbidity and mortality in Zambia. This study confirms the urgent need for information and practical training in basic hygiene and sanitation, deworming and dietary and lifestyle changes to prevent respiratory and diarrheal disease, helminthic infection, hypertension and diabetes. Video-based group discussions with practical training in preparation of chlorinated potable water and proper handwashing, combined with provision of chlorine and hand soap, prompted substantial improvements in knowledge and reported behavior. Education about transmission, prevention and treatment of helminths, along with distribution of mebendazole or albendazole for household de-worming, reinforced the importance of chlorine and handwashing. Screening with free treatment for schistosomiasis further heightened awareness of this prevalent but often asymptomatic NTD. Misconceptions about the clinical symptoms, sequelae, and management of hypertension and diabetes were reduced, and participants reported adding less salt to their food and sugar to their tea/coffee. These benefits were sustained over time, and a contemporaneous comparison with a group who received an unrelated HIV intervention confirmed that other health promotion programs had not resulted in a secular trend that might confound the interpretation of our findings.

Urban sanitation in Zambia is a challenge due to high population density, unplanned growth, and limited resources for conventional sanitation (340). In Lusaka and Ndola, pit-latrines combined with leaking sewerage discharge untreated human sewage directly into the aquifers which residents rely on for drinking water (76, 341-344). Cholera outbreaks occur when potable water is unavailable and basic hygiene is poor. In total, 34,950 cases of cholera were reported in Zambia between 2008 and 2017, and the country is considered endemic for cholera with crowded urban areas at highest risk (72-74). Respiratory and diarrheal diseases, among the leading causes of death in Zambia, particularly in children, along with common parasitic infections of the gut (345), can be prevented with handwashing, water chlorination, and periodic household anti-helminthic treatment (75, 163, 170, 346-351). WHO and UNICEF Joint Monitoring Programme indicators for Water Supply, Sanitation and Hygiene Models using Demographic and Health Surveys and other studies have predicted safely managed drinking water also reduces stunting and diarrhea in children (60, 352), thus averting negative health outcomes which may increase risk of NCD later in life (34, 353-355).

Zambia has attempted to address these problems through community-led total sanitation (CLTS), which has emerged as the most widely implemented policy intervention for improving rural sanitation in low-income countries (356). The Sanitation and Hygiene Applied Research for Equity Programme funded by the UK Department for International Development has also sponsored human resource strengthening in research capacity in Zambia (357). In November 2011, CTLS was featured as part of the Zambia Sanitation and Hygiene Program (ZSHP) in order to increase the use of improved sanitation facilities and adopt positive hygiene practices (358). In a pre- and post-assessment of national-scale CLTS programming in Zambia conducted from 2013 to 2016, the authors measured a 16% increase in access to improved sanitation facilities and modest increases in handwashing behavior and dedicated hand hygiene spaces (356). Our GHP intervention focused on improving knowledge and skills combined with provision of chlorine, hand soap, and deworming medication. As several CLTS survey areas overlapped with our study area (358), we compared our GHP group with our comparison (control) group that received an HIV intervention to assess the role of secular trend in hygiene and sanitation knowledge and behaviors. Our findings confirm that knowledge and use of chlorine remained poor in our comparison group (35% use compared with 97% in the GHP group), as did knowledge of when and how to effectively handwash and prepare food to reduce transmission and who in the household should be regularly dewormed. These findings reinforce the importance of ongoing and repeated education and commodity provision efforts.

We have recently shown that schistosomiasis is associated with HIV-1 transmission and death in Lusaka, possibly related to enhanced inflammatory responses caused by egg deposition in the lower genital tract (80, 359). A recent assessment based on literature review estimates nationwide prevalence of schistosome infection exceeding 30% with an adult prevalence of 54% (79). While our program used urine dipstick to assess prevalence of microhematuria suggestive of *Schistosoma haematobium*, hepatosplenic schistosomiasis due to *Schistosoma mansoni* is also a neglected problem in Zambia. On questioning, 68% (75/110) of Zambian patients with portal hypertension (88% of whom were ELISA positive for schistosoma antibodies) knew nothing about schistosomiasis transmission (360). Although this NTD is generally considered to be concentrated in rural areas or near bodies of water (361), our previous work has shown that 59% of Lusaka residents had positive ELISA titers (80). Further work is needed to improve knowledge, prevention, screening and treatment for schistosomiasis.

While NTDs, hygiene, and sanitation have long been a focus of concern in Africa, hypertension and diabetes have recently been identified as emerging public health problems. Several studies in Zambia have shown a high prevalence of hypertension in both urban and rural areas (47, 48). In Lusaka, 1,928 individuals participated in the survey, of which 33% were males. 21% of males and 49% of females were overweight or obese. The prevalence for hypertension was 35% (38% of men and 33% of women). Risk factors have been similar to those identified in western countries: older age, male sex, high body mass index, increased alcohol consumption, sedentary lifestyle, higher education and smoking (38, 49, 362). One study showed mean total weight of salt added to food was nearly double the WHO recommendation, with women adding significantly more salt to food than men (37). As in other studies in Africa, lack of and limited knowledge is a barrier to effective prevention, diagnosis, and management of NCDs in the region (40, 55, 195-198). Most individuals do not know that they have high BP and others do not take any medication (47). In focus groups, participants cited westernized diets, lack of physical activity, stress, psychological factors and urbanization as causative factors for hypertension. Participants lacked understanding of BP medications, healthy lifestyles, adherence to treatment and ongoing monitoring (37). Our study confirmed poor knowledge of the manifestations, sequelae, prevention and management of NCD and demonstrated sustained improvement in this knowledge after the intervention. Reported salt intake declined after the GHP intervention, with the proportion no longer adding salt rising from 8% to 20% and the proportion adding >=1/2 tsp declining from 16% to 5%. We provided low sodium salt (half potassium and half sodium chloride) which is available in Zambian stores and should be more closely studied. Future efforts to improve hypertension control should focus on population preventive care and primary healthcare provider education on individual management (363).

Surveys including measures in blood sugar have found a 15% prevalence of diabetes mellitus in Ndola bank employees (56). In a household survey in Lusaka adults, the prevalence for impaired glucose level or diabetes was 4% (364). As in the west, risk factors included obesity, physical inactivity, older age and mild hypertension. The authors conclude that interventions targeting the younger 25-34 age group should be put in place now to curtail the development of diabetes. Our survey confirmed the need for more education: the knowledge that diabetics should reduce sugar intake was only 48% before the intervention visit, rising to 89% afterwards, with corresponding increases in respondents citing taking prescribed medication and getting sugar levels tested regularly. This knowledge translated into reported behaviors with the proportion of respondents adding >=3 tsp to their cup of tea or coffee decreased from 42% before to 26% after receiving GHP.

In one qualitative study in Zambia, knowledge of cardiovascular disease risk factors was good but “risk factors were difficult to avoid due to ingrained taste preferences for high salt and sugar, increasingly busy lives that force them to use cooking oil to reduce preparation time, cultural preference for big body size or fatness, especially for women, stigmatized body image attached to HIV, stressful life or life events related to poverty, and financial barriers to affording quality foods and healthcare services” (39). We make a similar observation in our study: while use of salt and sugar declined and knowledge of manifestations and management increased, a minority of participants cited increasing physical activity, maintaining a healthy weight or eating plenty of vegetables and fruit as important strategies. Government clinic nurses who received training in delivering our intervention underwent screening. A number were found to be hypertensive, which was not surprising as they were generally women aged 40-50 age, and many were overweight by international standards. Their views echoed those mentioned above and reinforce the need to include perceptions of health care providers to better inform NCD policy (365).

Other studies have highlighted male involvement in traditionally women-oriented household roles in the context of maternal and child health (366-370). We have worked extensively with Zambian couples on HIV and unplanned pregnancy prevention, and collaboration between spouses is strongly associated with success in those domains (18, 273, 371). We noted an increase in shared household responsibilities relating to collecting and treating water, food purchasing and preparation and taking care of sick persons. This highlights opportunities to engage men in traditionally women-oriented household roles for the betterment of their family's health. This not only can improve family health but also gender equity within the couple.

Limitations

Our study was not without limitations. We acknowledge that a limitation was measuring the impact of knowledge uptake on disease outcomes. Given the increased burden of NTD and NCD in SSA, more studies linking biological markers with knowledge uptake are needed. Additionally, there were limitations in our methods of testing and treatment: our schistosomiasis screening did not include detection of *S. mansoni* as we used urine dipsticks; urine dipstick screening for glucose is less expensive but also less sensitive for diabetes screening than glucometers or HbA1c testing (372-374); and though we provided albendazole and mebendazole for deworming we understand that this may not adequately treat other helminth infections such as Taenia and protozoa including cryptosporidium, giardia and amoeba (345).

Conclusion

This study shows the feasibility of delivering multiple health education topics without compromising areas. Our study highlights that a video-based intervention focusing on NCDs and NTDs can lead to substantial and sustained knowledge uptake in Zambian couples. As we utilized a simplified flipchart-only version of this tool integrated with CVCT, we would propose expansion of this with CVCT and family planning which is shown to be effective.

Table 7.1: Knowledge and behaviors prior to and 1-2 weeks post GHP intervention

	Baseline pre-intervention						Two weeks post-intervention					
	Total (N=1140)		Men (N=570)		Women (n=570)		Total (N=1140)		Men (N=570)		Women (n=570)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
How do you treat your drinking water?												
I do not treat my drinking water	523	46%	278	49%	245	43%	17	1%	9	2%	8	1%
Boil	351	31%	162	28%	189	33%	172	15%	80	14%	92	16%
Add chlorine	275	24%	127	22%	148	26%	1095	96%	544	95%	551	97%
Strain it through a cloth/Water filter/Other/Don't know	90	8%	43	8%	47	8%	20	2%	11	2%	9	2%
How much chlorine do you need for a 20L container?												
Top of cap	115	10%	45	8%	70	12%	13	1%	9	2%	4	1%
Bottom of cap	404	35%	219	38%	185	32%	1115	98%	555	97%	560	98%
Other	76	7%	43	8%	33	6%	7	1%	4	1%	3	1%
Don't know	545	48%	263	46%	282	49%	5	0%	2	0%	3	1%
How much chlorine do you need for a 5L container?												
Top of cap	287	29%	147	30%	140	29%	1100	96%	549	96%	551	97%
Bottom of cap	59	6%	31	6%	28	6%	18	2%	9	2%	9	2%
Other	78	8%	43	9%	35	7%	13	1%	8	1%	5	1%
Don't know	555	57%	267	55%	288	59%	9	1%	4	1%	5	1%
When do you wash your hands?												
After using the toilet	1064	93%	527	92%	537	94%	1124	99%	565	99%	559	98%
Before cooking and eating	1018	89%	519	91%	499	88%	1104	97%	551	97%	553	97%
After handling animals, dirty diapers, or rubbish	529	46%	273	48%	256	45%	915	80%	453	79%	462	81%
Before and after caring for the sick	100	9%	44	8%	56	10%	453	40%	233	41%	220	39%
After coughing or sneezing into your hands	68	6%	31	5%	37	6%	416	36%	209	37%	207	36%
Other/Don't know	160	14%	84	15%	76	13%	101	9%	55	10%	46	8%

How much time should you spend scrubbing your hands while washing them?												
20 seconds or as long as it takes to sing or hum the 'Happy Birthday Song' twice	260	23%	132	23%	128	22%	747	66%	398	70%	349	61%
Other/Don't know	880	77%	438	77%	442	78%	390	34%	171	30%	219	39%
Can you demonstrate how to properly wash your hands?												
Wet hands with your hands with clean water	1055	93%	535	94%	520	91%	1137	100%	569	100%	568	100%
Apply soap to lather your entire hand	941	83%	442	78%	499	88%	1113	98%	548	96%	565	99%
Scrub back of hands	607	53%	333	58%	274	48%	985	86%	475	83%	510	89%
Scrub palms	587	51%	331	58%	256	45%	971	85%	475	83%	496	87%
Scrub between fingers	406	36%	231	41%	175	31%	982	86%	486	85%	496	87%
Scrub underneath fingernails	123	11%	71	12%	52	9%	799	70%	367	64%	432	76%
Scrub wrists	220	19%	123	22%	97	17%	774	68%	377	66%	397	70%
Rinse your hands with clean water and air dry	782	69%	386	68%	396	69%	935	82%	449	79%	486	85%
Scrub hands for 20 seconds or as long as it takes to sing or hum the Happy Birthday song twice	59	5%	42	7%	17	3%	493	43%	250	44%	243	43%
Did not demonstrate any of the steps	24	2%	7	1%	17	3%	0	0%	0	0%	0	0%
How can someone get worms?												
Eating dirt/soil	525	46%	202	35%	323	57%	963	84%	480	84%	483	85%
Not properly washed raw vegetables and fruits	486	43%	244	43%	242	42%	1035	91%	523	92%	512	90%
Undercooked meat	255	22%	148	26%	107	19%	1030	90%	522	92%	508	89%
Not washing your hands after touching soil	163	14%	82	14%	81	14%	574	50%	300	53%	274	48%
Not washing hands with soap after using toilet	54	5%	31	5%	23	4%	571	50%	311	55%	260	46%
Not washing hands before handling food	65	6%	42	7%	23	4%	460	40%	246	43%	214	38%
Other/Don't know	369	32%	217	38%	152	27%	37	3%	33	6%	4	1%

Who in your household should get dewormed?												
Myself	50	4%	9	2%	41	7%	0	0%	0	0%	0	0%
My spouse	37	3%	22	4%	15	3%	0	0%	0	0%	0	0%
My children	299	26%	145	25%	154	27%	12	1%	6	1%	6	1%
Everyone	708	62%	346	61%	362	64%	1126	99%	562	99%	564	99%
Other/Don't know	95	8%	58	10%	37	6%	1	0%	1	0%	0	0%
Do most people with high blood pressure (BP) or diabetes (sugar) have symptoms?												
Yes, people with one and/or both diseases usually have symptoms	418	37%	222	39%	196	34%	205	18%	94	17%	111	19%
No, most people with high BP and/or diabetes do not have symptoms	721	63%	347	61%	374	66%	934	82%	475	83%	459	81%
High blood pressure (BP) can lead to…?												
Heart disease or heart attack	157	14%	95	17%	62	11%	468	41%	232	41%	236	41%
Stroke	302	26%	141	25%	161	28%	698	61%	363	64%	335	59%
Death	737	65%	350	61%	387	68%	942	83%	496	87%	446	78%
Other/Don't know	265	23%	142	25%	123	22%	147	13%	77	14%	70	12%
What blood pressure is considered high?												
Greater than or equal to 140/90 mmHg	74	6%	33	6%	41	7%	617	54%	345	61%	272	48%
Other	76	7%	46	8%	30	5%	138	12%	56	10%	82	14%
Don't know	989	87%	491	86%	498	87%	384	34%	168	29%	216	38%
What should someone do if they have high BP?												
Reduce their salt intake	352	31%	182	32%	170	30%	969	85%	506	89%	463	81%
Take medicine prescribed by doctor	437	38%	216	38%	221	39%	828	73%	424	74%	404	71%
Get their BP checked regularly	319	28%	144	25%	175	31%	755	66%	383	67%	372	65%
Exercise	73	6%	43	8%	30	5%	483	42%	270	47%	213	37%
Lose weight if they are overweight	47	4%	17	3%	30	5%	375	33%	184	32%	191	34%

Get checked for diabetes (sugar)	44	4%	17	3%	27	5%	270	24%	132	23%	138	24%
Stop smoking	26	2%	14	2%	12	2%	250	22%	156	27%	94	16%
Other/Don't know	584	51%	294	52%	290	51%	244	21%	116	20%	128	22%
What should someone do if they have diabetes?												
Reduce their sugar intake	551	48%	290	51%	261	46%	1017	89%	529	93%	488	86%
Take medicine prescribed by doctor	363	32%	184	32%	179	31%	807	71%	399	70%	408	72%
Get their sugar checked regularly	228	20%	92	16%	136	24%	685	60%	336	59%	349	61%
Lose weight if they are overweight	41	4%	17	3%	24	4%	345	30%	157	28%	188	33%
Exercise	49	4%	29	5%	20	4%	411	36%	229	40%	182	32%
Get their BP checked	40	4%	16	3%	24	4%	280	25%	145	25%	135	24%
Other/Don't know	518	45%	251	44%	267	47%	170	15%	80	14%	90	16%
On average, how much salt do you add to your evening meal at the table?												
NONE	93	8%	35	6%	58	10%	232	20%	89	16%	143	25%
PINCH	728	64%	394	69%	334	59%	753	66%	397	70%	356	62%
¼ TSP	139	12%	80	14%	59	10%	101	9%	64	11%	37	6%
½ TSP	94	8%	34	6%	60	11%	42	4%	19	3%	23	4%
>=¾ TSP	86	8%	27	5%	59	10%	12	1%	1	0%	11	2%
On average, how much sugar do you add to your cup of tea or coffee?												
NONE	9	1%	6	1%	3	1%	11	1%	9	2%	2	0%
< 1 TSP	14	1%	10	2%	4	1%	23	2%	15	3%	8	1%
1 TSP	75	7%	33	6%	42	7%	109	10%	57	10%	52	9%
2 TSP	563	49%	274	48%	289	51%	697	61%	349	61%	348	61%
3 TSP	260	23%	144	25%	116	20%	185	16%	106	19%	79	14%
>=4 TSP	219	19%	103	18%	116	20%	115	10%	34	6%	81	14%

Table 7.2: Adoption and maintenance of behavior change two weeks and six months post GHP intervention

	Two weeks Total (N=1140)		6 months Total (N=961)	
	n/mean	%/SD	n/mean	%/SD
What strategies did you and your spouse began implementing?				
Chlorine for drinking water	1103	97%	933	97%
Soap (handwashing)	1085	95%	922	96%
Deworming the entire family	955	84%	779	81%
Reduce salt in cooking (use “Low Salt”)	862	76%	725	76%
Limiting exposure to areas with Bilharzia	525	46%	437	46%
Avoid eating foods with lots of salt (breads, crisps, processed meats such as polony, bacon, sausage)	559	49%	451	47%
Avoid adding a lot of sugar to drinks such as tea, coffee	468	41%	148	15%
Agree on food preparation together	448	39%	333	35%
Avoid or limit the number of drinks with a lot of sugar (soft drinks and alcohol)	435	38%	213	22%
Maintain healthy weight	337	30%	204	21%
Avoid stress	351	31%	192	20%
Eat plenty of fruits and vegetables, including greens	315	28%	110	11%
Increase physical activity (exercise)	309	27%	200	21%
Avoid/limit tobacco products like cigarettes	256	22%	119	12%
Limit alcohol intake	252	22%	76	8%

Drink at least 2 liters of clean water per day	223	20%	48	5%

Table 7.3: Impact of the GHP intervention on sharing household duties

	Baseline						6 months Post-Intervention					
	Total (N=1140)		Men (N=570)		Women (n=570)		Total (N=961)		Men (N=481)		Women (n=480)	
	N	%	N	%	N	%	N	%	N	%	N	%
In terms of your day to day activities in the household, who is primarily responsible for												
Collecting drinking water												
Myself	482	42%	31	5%	451	79%	354	37%	17	4%	337	71%
My spouse	407	36%	387	68%	20	4%	286	30%	277	58%	9	2%
Both of us	169	15%	116	20%	53	9%	284	30%	168	35%	116	24%
Other	75	7%	31	5%	44	8%	33	3%	17	4%	16	3%
NA	7	1%	5	1%	2	0%	1	0%	1	0%	0	0%
Treating drinking water with chlorine												
Myself	211	19%	27	5%	184	32%	280	29%	19	4%	261	54%
My spouse	121	11%	114	20%	7	1%	216	23%	209	44%	7	1%
Both of us	48	4%	35	6%	13	2%	450	47%	245	51%	205	43%
Other	7	1%	5	1%	2	0%	2	0%	1	0%	1	0%
NA	753	66%	389	68%	364	64%	11	1%	6	1%	5	1%
Purchasing food for the house												
Myself	323	28%	212	37%	111	19%	106	11%	61	13%	45	9%
My spouse	260	23%	81	14%	179	31%	99	10%	36	7%	63	13%
Both of us	551	48%	275	48%	276	48%	753	79%	384	80%	369	77%
Other	6	1%	2	0%	4	1%	1	0%	0	0%	1	0%
Preparing the food/ cooking												
Myself	540	47%	24	4%	516	91%	394	41%	14	3%	380	80%
My spouse	482	42%	470	82%	12	2%	375	39%	365	76%	10	2%
Both of us	101	9%	68	12%	33	6%	181	19%	98	20%	83	17%
Other	17	1%	8	1%	9	2%	8	1%	4	1%	4	1%
Taking care of sick persons in household												
Myself	206	18%	29	5%	177	20%	28	3%	3	1%	25	5%
My spouse	87	8%	80	14%	7	1%	21	2%	18	4%	3	1%
Both of us	832	73%	457	80%	375	78%	910	95%	459	95%	451	94%

NA	11	1%	3	1%	8	1%	1	0%	1	0%	0	0%
Changing baby's nappy												
Myself	408	36%	17	3%	391	69%	364	38%	13	3%	351	73%
My spouse	380	33%	375	66%	5	1%	342	36%	335	70%	7	1%
Both of us	73	6%	51	9%	22	4%	95	10%	62	13%	33	7%
NA	278	24%	127	22%	151	26%	159	17%	71	15%	88	18%
Washing the dishes												
Myself	494	43%	21	4%	473	83%	420	44%	13	3%	407	85%
My spouse	444	39%	438	77%	6	1%	390	41%	383	80%	7	1%
Both of us	98	9%	68	12%	30	5%	96	10%	62	13%	34	7%
Other	103	9%	42	7%	61	11%	53	6%	23	5%	30	6%

NA=Not Applicable

Table 7.4: Comparison of knowledge uptake in GHP group with the control group that received a different intervention to assess potential contribution of secular trend due to other programs

	GHP 6 months follow-up						SOV 6 months follow-up					
	Total (N=961)		Men (N=481)		Women (n=480)		Total (N=986)		Men (N=493)		Women (n=493)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
How do you treat your drinking water?												
Add chlorine	932	97%	463	96%	469	98%	347	35%	162	33%	185	38%
Boil	368	38%	181	38%	187	39%	294	30%	155	32%	139	28%
Strain it through a cloth	1	0%	1	0%	0	0%	6	1%	2	0%	4	1%
Use a water filter	13	1%	7	1%	6	1%	10	1%	4	1%	6	1%
Solar disinfection	2	0%	0	0%	2	0%	4	0%	2	0%	2	0%
I do not treat my drinking water	1	0%	1	0%	0	0%	396	40%	214	44%	182	37%
Other	2	0%	2	0%	0	0%	2	0%	2	0%	0	0%
Don't know	0	0%	0	0%	0	0%	9	1%	6	1%	3	1%
How much chlorine do you need for a 20L container?												
Top of cap	18	2%	13	3%	5	1%	178	18%	76	15%	102	21%
Bottom of cap	931	97%	462	96%	469	98%	434	44%	223	45%	211	43%
Other	5	1%	3	1%	2	0%	22	2%	10	2%	12	2%
Don't know	6	1%	3	1%	3	1%	348	35%	182	37%	166	34%
How much chlorine do you need for a 5L container?												
Top of cap	925	96%	463	96%	462	96%	361	37%	196	40%	165	34%
Bottom of cap	21	2%	12	2%	9	2%	116	12%	52	11%	64	13%
Other	8	1%	4	1%	4	1%	54	5%	26	5%	28	6%
Don't know	6	1%	2	0%	4	1%	452	46%	217	44%	235	48%
When do you wash your hands?												
After using the toilet	949	99%	473	98%	476	99%	936	95%	471	96%	465	95%
Before cooking and eating	928	97%	460	96%	468	98%	883	90%	443	90%	440	89%
After handling animals, dirty diapers, or rubbish	785	82%	377	78%	408	85%	638	65%	293	60%	345	70%
Before and after caring for the sick	332	35%	179	37%	153	32%	213	22%	112	23%	101	21%
After coughing or sneezing into your hands	278	29%	115	24%	163	34%	154	16%	66	13%	88	18%

Other/Don't know	34	4%	18	4%	16	3%	46	5%	15	3%	31	6%
How much time should you spend scrubbing your hands while washing them?												
20 seconds or as long as it takes to sing or hum the 'Happy Birthday Song' twice	670	70%	330	69%	340	71%	483	49%	220	45%	263	54%
Other	257	27%	141	29%	116	24%	283	29%	170	35%	113	23%
Don't know	33	3%	10	2%	23	5%	213	22%	99	20%	114	23%
Can you demonstrate how to properly wash your hands?												
Wet hands with your hands with clean water	946	99%	474	99%	472	99%	898	91%	442	90%	456	93%
Apply soap to lather your entire hand	926	96%	462	96%	464	97%	868	88%	420	86%	448	91%
Scrub between fingers	808	84%	400	83%	408	85%	524	53%	285	58%	239	49%
Scrub back of hands	836	87%	401	83%	435	91%	618	63%	349	71%	269	55%
Scrub palms	815	85%	404	84%	411	86%	579	59%	326	66%	253	51%
Scrub underneath fingernails	625	65%	265	55%	360	75%	146	15%	70	14%	76	15%
Scrub wrists	659	69%	335	70%	324	68%	312	32%	148	30%	164	33%
Rinse your hands with clean water and allow to air dry	835	87%	393	82%	442	92%	781	79%	388	79%	393	80%
Scrub hands for 20 seconds or as long as it takes to sing or hum the Happy Birthday song twice!	310	32%	161	33%	149	31%	25	3%	11	2%	14	3%
How can someone get worms?												
Undercooked meat	877	91%	437	91%	440	92%	347	35%	215	44%	132	27%
Not properly washed raw vegetables and fruits	872	91%	433	90%	439	92%	466	47%	261	53%	205	42%
Eating dirt/soil	810	84%	392	81%	418	87%	731	74%	343	70%	388	79%
Not washing your hands after touching soil	417	43%	200	42%	217	45%	137	14%	65	13%	72	15%
Not washing hands with soap after using toilet	360	38%	197	41%	163	34%	106	11%	62	13%	44	9%
Not washing hands before handling food	232	24%	116	24%	116	24%	84	9%	52	11%	32	7%

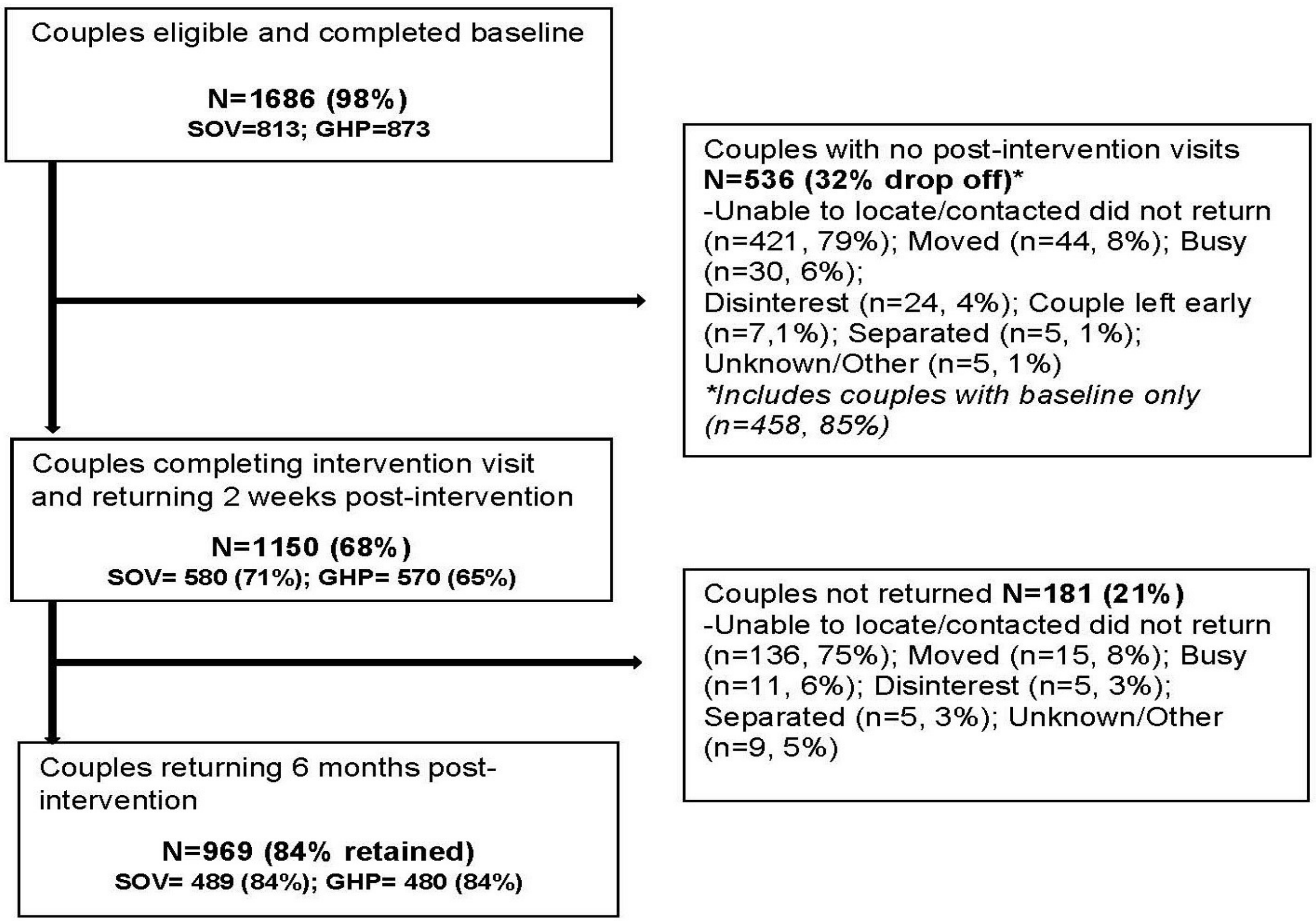
Other/Don't know	32	3%	23	5%	9	2%	133	14%	76	15%	57	12%
Who in your household should get dewormed?												
Myself	0	0%	0	0%	0	0%	18	2%	8	2%	10	2%
My spouse	0	0%	0	0%	0	0%	20	2%	14	3%	6	1%
My children	12	1%	8	2%	4	1%	231	23%	120	24%	111	23%
Everyone	944	98%	471	98%	473	99%	722	73%	350	71%	372	76%
Other/Don’t know	0	0%	0	0%	0	0%	29	3%	5	1%	6	1%
Bilharzia only affects children in rural areas.												
True	10	1%	6	1%	4	1%	52	5%	23	5%	29	6%
False	949	99%	475	99%	474	99%	907	92%	450	92%	457	93%
Don't know	0	0%	0	0%	0	0%	23	2%	18	4%	5	1%
People in my household can get bilharzia from bathing, washing and playing in contaminated water where snails are present.												
True	946	99%	475	99%	471	99%	922	94%	457	93%	465	95%
False	12	1%	6	1%	6	1%	35	4%	15	3%	20	4%
Don't know	1	0%	0	0%	1	0%	26	3%	19	4%	7	1%
Hypertension/Diabetes												
On average, how much salt do you add to your evening meal at the table?												
NONE	202	21%	82	17%	120	25%	125	13%	70	14%	55	11%
PINCH	570	59%	313	65%	257	54%	700	71%	346	70%	354	72%
¼ TSP	110	11%	65	14%	45	9%	84	9%	41	8%	43	9%
½ TSP	41	4%	10	2%	31	6%	62	6%	24	5%	38	8%
¾ TSP	0	0%	0	0%	0	0%	3	0%	2	0%	1	0%
>=1 TSP	37	4%	11	2%	26	5%	9	1%	8	2%	1	0%
On average, how much sugar do you add to your cup of tea or coffee?												
NONE	14	1%	6	1%	8	2%	7	1%	4	1%	3	1%
< 1 TSP	6	1%	3	1%	3	1%	8	1%	6	1%	2	0%
1 TSP	78	8%	45	9%	33	7%	41	4%	21	4%	20	4%
2 TSP	652	68%	314	65%	338	71%	500	51%	215	44%	285	58%
3 TSP	155	16%	92	19%	63	13%	343	35%	205	42%	138	28%
>=4 TSP	55	6%	21	4%	34	7%	82	8%	39	8%	43	9%

How many softies (Coca Cola, etc) do you drink per week? (mean)	2.8	3.2	3.3	3.7	2.3	2.5	2.7	2.7	3.3	3.2	2.1	2.0
Do most people with high blood pressure (BP) or diabetes (sugar) have symptoms?												
Yes, people with both diseases usually have symptoms	194	20%	83	17%	111	23%	356	37%	197	41%	159	32%
People with either high BP or diabetes usually have symptoms	22	2%	12	3%	10	2%	56	6%	31	6%	25	5%
No, most people with high BP and/or diabetes do not have symptoms	743	77%	385	80%	358	75%	561	58%	254	53%	307	63%
High blood pressure (BP) can lead to…?												
Heart disease or heart attack	308	32%	174	36%	134	28%	146	15%	89	18%	57	12%
Stroke	570	59%	308	64%	262	55%	377	38%	193	39%	184	37%
Death	875	91%	442	92%	433	90%	793	81%	391	80%	402	82%
Other/Don't know	66	7%	36	7%	30	6%	72	7%	42	9%	30	6%
What blood pressure is considered high?												
Greater than or equal to 140/90 mmHg	508	53%	266	55%	242	51%	103	10%	46	9%	57	12%
Other	98	10%	48	10%	50	10%	27	3%	15	3%	12	2%
Don’t know	354	37%	167	35%	187	39%	853	87%	430	88%	423	86%
What should someone do if they have high BP?												
Reduce their salt intake	850	89%	437	91%	413	86%	426	43%	187	38%	239	49%
Take medicine prescribed by doctor	708	74%	349	73%	359	75%	614	62%	313	64%	301	61%
Get their BP checked regularly	623	65%	294	61%	329	69%	444	45%	198	40%	246	50%
Exercise	436	45%	240	50%	196	41%	72	7%	48	10%	24	5%
Lose weight if they are overweight	280	29%	150	31%	130	27%	113	11%	46	9%	67	14%
Get checked for diabetes (sugar)	205	21%	98	20%	107	22%	59	6%	29	6%	30	6%
Stop smoking	179	19%	109	23%	70	15%	23	2%	15	3%	8	2%
Other/Don't know	198	21%	108	22%	90	19%	185	19%	85	17%	100	20%
What should someone do if they have diabetes?												
Reduce their sugar intake	862	90%	440	91%	422	88%	540	55%	275	56%	265	54%
Take medicine prescribed by doctor	707	74%	333	69%	374	78%	557	57%	296	60%	261	53%
Get their sugar checked regularly	516	54%	242	50%	274	57%	381	39%	176	36%	205	42%
Lose weight if they are overweight	281	29%	158	33%	123	26%	110	11%	52	11%	58	12%
Exercise	373	39%	198	41%	175	37%	41	4%	32	7%	9	2%
Get their BP checked	195	20%	101	21%	94	20%	52	5%	27	5%	25	5%

Other/Don't know	130	14%	68	14%	62	13%	167	17%	73	15%	94	19%

Figure S7.1 Supplemental information: retention at two weeks and six months post-intervention

As additional information for Research Papers 2 and 3, retention flow diagram including overall reasons for drop out and lost to follow-up have been included.



8. Chapter 8 General discussion, summary, and conclusion

8.1 Retention

None of the clinics randomized for the CRT was dropped. The drop-off rate for couples between baseline and intervention/ two weeks post-intervention was 68%. Retention between two weeks post-intervention to six months post-intervention was approximately 84%. The earlier drop-off rate of 32% was slightly higher than that observed in an observational study of Zambian DC where drop-off rates between enrollment and first follow-up were 24.9-30.5% (224). This finding supports *Kempf et al.* suggestion that consideration be given to run-in designs because of potential large drop-off rates seen before randomization (intervention) (224), which was the case here. The retention rate reported in this thesis was higher than the conservative retention rate of 58% cited in Research Paper 1. Additionally, the retention rate at six months post-intervention (84%) was higher than the mean average of 77.5% reported in a systematic review assessing retention in behavioral interventions with dyads (375). However, retention was slightly lower than other trials with couples related to HIV and sexual communication, which ranged from 87-93.3% (301, 376). Both spouses in CNC attended all study visits together and underwent similar procedures. In addition, both spouses were relatively healthy based on CNC status and their self-reported low prevalence of hypertension and diabetes (Research paper 3).

8.2 Overall findings of the thesis

These thesis findings showed how video-based, couples' interventions encouraged couples to communicate and negotiate sexual agreements to prevent HIV and increased knowledge, practical skills, and adopted behaviors to improve risk factors associated with HIV, NTD, and NCD. Research paper 2 showed CNC establishing negotiating explicit sexual agreements to address concurrent partners as a risk for HIV within their marriage was feasible. It is important to note that most of these discussions in Research Paper 2 were friendly, supportive, and comfortable. In addition, most couples stated they agreed on everything related to their sexual agreement (plan). Research paper 3 showed substantial increases in knowledge uptake of symptoms and adverse outcomes, recommendations on the management of NCD, identification of risk groups, and practiced behaviors: handwashing, water chlorination, and adding salt and sugar proportions to food. Research paper 3 also demonstrated that involving both spouses in strategies to improve household health may increase shared responsibilities.

8.2.1 Establishing explicit sexual agreements

In discussing sensitive topic matters like extramarital partners, couples in SOV were comfortable discussing topics related to sexual agreements and concurrent partners in the context of HIV prevention. In a feasibility study, heterosexual couples in the US showed willingness and acceptance for CVCT with a sexual agreement component (153). However, another study highlighted a potential challenge for couples in longer-term relationships: discussing condom use or concurrent partners may raise concerns about fidelity and trust (153, 377). SOV tackles this by framing these challenges within harm reduction approaches. In SOV, HIV prevention strategies were combined with abstract scenarios on threats to remaining HIV. In addition, SOV included an option for using a nonverbal, gender-neutral cue, the “yellow card,” to initiate discussion on disclosure of potential HIV exposure. Both threats and yellow card were discussed with in men and women focus groups of CNC during the formative phase of the trial.

8.2.2 Monogamy as sexual agreement

A majority of SOV spouses (97%) chose monogamy as their primary sexual agreement (one of the strategies in the “Together HIV Free” plan). The choice for monogamy may seem likely given expectations of sexual exclusivity in married or longer-term cohabiting couples (292). In Zambia, a majority of men (83%) and women (97%) reported being in a monogamous union (2). Zambia also identifies itself as a “Christian Nation.” Past interventions suggested marriage as a safe haven and that HIV risk was in casual relationships (292). Research Paper 2’s finding of overwhelming choice for monogamy while 25% of SOV couples had at least one HIV risk factor at baseline could reflect historical and not current risk, as couples had been together ~ 6 years on average. Spouses may also perceive their HIV risk to be low, given their CNC status. A study in Zambia found that women perceived their HIV risk was low due to marriage (378). Men also thought their HIV risk was low, though were more likely to have an outside partner (378). In high HIV prevalent countries like Zambia, engaging in unprotected extramarital sex with partners whose HIV status is unknown puts couples at elevated risk. Though perceived low risk and marital norms could have influenced the decision of monogamy, SOV likely influenced spousal choice more.

In SOV, monogamy is defined as having sex only with your spouse to prevent HIV from extramarital sex. This distinction is important, as monogamy traditionally has been promoted without HIV (292). In addition, having unclear definitions of “monogamy” has led to misunderstandings by professionals and the public, contributing to its reported low adherence and ineffectiveness as an STI prevention strategy (288). In SOV, couples were presented with alternatives to monogamy, such as condom use and having sex with outside partners only if HIV status was known, though this choice was low (n=49, 4.2%). However, all spouses choose a backup SA to protect their spouse in case of HIV exposure with outside partners. This back-up SA included using condoms (71%) or abstaining (27%) from sex with their spouse until a retest for HIV in 30 days. Couples reinforced their commitment in cited vows to remain HIV-free and protect their spouse.

SOV is framed within HR. Thus, the reality that extramarital sexual partnerships in marriages occur and can put one's marriage at risk for HIV is acknowledged. Instead of pretending the issue does not exist, SOV empowered couples to have a contingency SA for couples to communicate and take action to protect their spouse if needed. An excerpt from the SOV intervention highlighted this sentiment: **"Pretending that risks do not exist does not help keep you safe from HIV. In fact, it increases your risk."** In HR, avoidant strategies such as monogamy and abstinence for HIV prevention are included with options for condom use and testing together with outside partners.

A study in Australia examining sexual agreements and sexual exclusivity in heterosexual men and women (159) shed light on why creating and establishing sexual agreements are important. *Richters and colleagues* reported that most partners (96%) expected sexual exclusivity, though approximately half of men and two-thirds of women conveyed this to their partners (159). During a follow-up one year later, the majority of persons reporting outside partners stated they were in a sexually exclusive relationship (159). These findings show the potential challenges of assumed sexual exclusivity in heterosexual relationships and not explicitly communicating this with their partners. Perception of a partner's sexual exclusivity in other studies has also highlighted that perception and reality were not always in agreement (157, 285) and that these false assumptions may put partners at risk for HIV and other STIs (286). Their findings on sexual exclusivity and the misperceptions of risk showed the potential benefit of having sexual agreements to convey primary intention while addressing the realities of extramarital partnerships since monogamy by itself may not be protective against HIV if the partner's behavior is not monogamous (160, 379).

In SOV, spouses were encouraged to communicate to protect each other from HIV, emphasizing their commitment together through SOV vows to keep their marriage HIV-free. A study in young heterosexual couples by *Warren et al.* noted that having monogamy agreements were more likely in couples with greater health-protective communication and commitment (157). The choice of monogamy stated by 96% of men and women in Research Paper 2 was confirmed across three separate questions- *what agreement they chose for themselves*, *what agreement their spouse communicated to them at home, and what agreement they wanted to inform their spouse of in the presence of the counselor.*

Monogamy as an effective strategy for STI prevention has been debated primarily due to the term's ambiguity. *Conley and colleagues* cited several reasons why monogamy as a prevention strategy should be considered cautiously. Authors acknowledged that monogamy was efficacious against STIs, though debated its effectiveness as compliance remained a challenge (288). Additionally, monogamous relationships may suffer from relapses over a long period (288). Authors stated that condom use might be challenging as it could signal infidelity, and providing more information on condom use or abstinence may not be enough to change behavior (288). SOV mentions condom use or abstaining with the spouse until retested for HIV as well as includes condom use and HIV testing with outside partners. In addition, SOV acknowledges that taking protective action or discussing extramarital partners may be difficult as the partner may be sad, disappointed, or angry with them. However, SOV emphasizes, **"HIV does not go away. If you are putting your partner at risk, you must do something to protect them."** SOV provides tips to spouses who may struggle with communicating. These tips reemphasize that both have a shared agreement, goal, and commitment to remain HIV-free for themselves and their family. Couples are advised not to dwell on the past, to have solution-based discussions, not to blame, to stay calm, to take their time, and to be respectful. Thus, SOV is more than just information on safer sex practices. SOV provides realistic scenarios of threats that can lead to having extramarital partners and how couples can use communication and protective behaviors within these scenarios to prevent HIV. *Conley and authors* also recommended that mutual monogamy be done with couples and not individually (288), which SOV does.

8.2.3 Nonverbal communication

One of the most memorable topics in SOV was the yellow card (71-73%). Regarding using the yellow card in case of HIV exposure, 58% of men and women said they would like to use it to start discussions on protecting their spouse. A study examining communication strategies and condom use in Latino and African-American couples showed that one-fifth of women used non-verbal communication to indicate condom use to their partner (380). Within this group, a small proportion of women noted the movement or act of giving condoms to their partners to negotiate safe sex (380). Thus, this study by *Zukoski and colleagues,* in addition to SOV, highlights the need for nonverbal safer sex communication options for couples, whether for condom use or alerting the spouse of potential HIV exposure from an outside partner.

8.2.4 Threats to remaining HIV free

When indicating threats to remaining monogamous, men and women's top four threats included alcohol use, financial pressures, traveling for work, and tension or disagreements at home, as highlighted in Research Paper 2. The threats indicated among CNC were similar to threats highlighted in the literature shown to be risk factors for HIV. SOV men and women agreed that man's biggest threat was alcohol use. In SSA, alcohol consumption has increased (305, 381). In Zambia, men were reported to consume six times more alcohol than women (8.4 liters versus 1.4 liters), which was also higher than the African region average of 6.3 liters (381). The lack of written policies and enforcement of alcohol have created vulnerabilities, which has increased issues surrounding harmful drinking (305, 381). Alcohol use has been associated with inconsistent condom use and continued outside partner risk in Zambian couples (19, 382). In addition, alcohol use may be a potential barrier to the effective use of CVCT in Zambia (19).

Financial pressures were the most common threat to remaining HIV-free for women cited by both SOV men and women. Financial pressures in this thesis meant having financial insecurity due to insufficient income. Financial insecurities, including food security, have been identified as drivers of HIV (306-308). Women may engage in outside sex for financial reasons and food to support the family. A qualitative study of married Kenyan couples in fishing communities examined risk factors for extramarital relationships and noted insufficient financial support as an HIV risk (299). Both women and men mentioned that women may engage in extramarital sex to support their children and provide food (299). Women noted reasons for this as husbands often traveling for work without leaving money or spending it on alcohol (299). Women are often vulnerable due to their financial dependence on their spouses, putting them at increased risk for HIV. Baseline characteristics of women in this thesis and ZDHS showed women generally had lower literacy and income than men (2, 277). Thus, women may seek an outside partner(s) to support their family's basic needs. This ongoing cycle between alcohol use and financial pressures places both men and women at increased risk for HIV. Furthermore, alcohol use and financial pressures may cause tensions or disagreements within the union. Traveling may strain resources at home if monies are not budgeted sufficiently to support men and their families while away (299). In addition, physical separation for prolonged periods can be challenging for couples with frequent intra-marital sex (299). Traveling far for work with money may also increase the risk for some men as they may spend it on extramarital sex (299). Dealing with the complexities of these issues requires a multilayered dialogue. In SOV, a scenario often incorporated multiple threats to be more reflective of real life. An example used in SOV was the husband traveling but not having sufficient money to leave at home. Struggling, the wife sought financial assistance from an acquaintance she eventually had sex with to keep paying for things needed at home. SOV couples discussed what risks the couple faced; what each could do to avoid risk; since exposed to HIV what should the couple do; and what they may do to be successful. In this scenario, couples explored how the couple in the example could mitigate their risk. Options included making budgets and discussing household needs before the husband travels for work; using condoms and HIV testing with outside partners; initiating a need to discuss a potential outside exposure using the “yellow card;” using condoms with the spouse until retested in 30 days; and discussing an agreement about sex with extramarital partners to keep their marriage HIV free. Thus, SOV facilitated discussions with couples on extramarital sex and HIV by talking through potential real threats in examples.

8.2.5 Knowledge, adoption, and recommendations of Good Health Package strategies

8.2.5.1 Water chlorination and handwashing with soap

Correctly adding chlorine to water at 5L and 20L increased and was sustained at >96% at six months in Research Paper 3. Having participants actively engaged in procedural steps of water chlorination reinforced new information learned. The increase in learned skills was also reflected in the reduced number of participants reporting not treating their water (46% to 0%). Water chlorination had the highest adoption and maintenance of all strategies.

Practical skills associated with handwashing also increased post-intervention. Self-report and observations for the length of time for handwashing (20 seconds) increased (23% to 66%) and (5% to 43%). Though the observed practice was not as high as self-report, a positive trend was seen in both. Self-report of handwashing length of time steadily increased; however, the observed practice continued to wan (43% to 32%). Like water chlorination, handwashing with soap also saw high adoption and maintenance rates. The low observed practice of length of time for handwashing was less than moderate post-intervention and continued to wan over time. This indicates that added emphasis may need to be placed on the length of time to wash hands during initial training. Additionally, as mentioned in Research Paper 3, continued education is needed.

Lower baseline knowledge with increased post-intervention knowledge and sustained adoption of strategies for handwashing and water chlorination highlight the importance of Zambia MOH's stance on improving health literacy and hygiene behaviors to eliminate diseases like cholera by 2025 (383).

8.2.5.2 Neglected tropical diseases

Most participants answered correctly that people in their household can get bilharzia from bathing, washing, and playing in contaminated water where snails are present. Adopting and maintaining a strategy to limit exposure to bilharzia was moderate (46%) but sustained. The moderate adoption reported may be due to a lack of alternatives for clean, safe water sources or perceiving their daily exposure to contaminated water sources to be low. Lusaka Province has been characterized as a high-risk area (>=50% prevalence) for schistosomiasis (82). *Wall and colleagues* found schistosome antibody prevalence among 2,195 individuals in Lusaka, Zambia, at 59% (80). Increasing evidence has shown an association between female urogenital schistosomiasis caused by *S. hematobium* and elevated HIV risk in HIV-negative women (80). The authors also found that men and women who have positive schistosome antibodies were more likely to have partners who were also positive (80). Given the increased evidence in this Zambian study as well as other studies in SSA, an added component of HIV and schistosomiasis should be covered in an integrated SOV and GHP with CVCT. Educating couples on schistosomiasis as a risk factor for HIV will provide important information to the current messaging, which may increase the adoption to limit exposure to schistosomiasis.

Knowledge to deworm the entire household was increased and sustained for up to six months. At baseline, 62% of participants reported the entire household, while 26% noted only children. This response increased post-intervention and was a highly adopted and maintained strategy. Twenty-six percent of participants stating that only children should be dewormed may be reflective of MDA campaigns that primarily target children. A review by *Bizimana et al.* has suggested that MDA alone may not be sufficient to eliminate NTD-STH and schistosomiasis (179). These elimination campaigns often focused on MDA without providing health education to the community and adults (87, 192). Issues with complete eradication may partly be due to this knowledge gap and negative perceptions of MDA within the community. Initially, MDA campaigns targeted adults but not children who had the highest disease burden (385). Currently, many MDA efforts target children but have not consistently included adults (82), such as caregivers/parents. Thus, educating parents will be necessary, as it will likely translate to increased uptake of MDA in children, households, and communities. Additionally, without health education, parents may not know that doing ordinary activities like laundry at contaminated water sources can pose a reinfection risk in children (192) and themselves.

Of particular note, when asked *how does someone get worms*, compared to undercooked meat (91%), not properly washing raw vegetables and fruits (91%), and eating dirt/soil (84%), lower responses were seen *for not washing hands* (24-43%). However, when asked *when do you wash your hands*, 97-99% noted before cooking/eating and after using the toilet, respectively. Though increased knowledge was seen between pre and post-intervention, overall knowledge uptake had lower findings *for not washing hands* in the context of STH prevention. When reviewing GHP content, the reason may be that the top three responses above were covered in the first main talking points to the group. Not washing hands was covered many times but was not among the earlier talking points. Including this information with the first initial points may improve knowledge uptake.

Findings of lack of or limited knowledge among couples at baseline may reflect Zambia's not having a health promotion program for preventing and reducing NTD and capacity to do MDA, which was highlighted as a limitation in the 2017-2021 National Health Strategic Plan (NHSP) (12). The 2017-2021 NHSP planned to include a health promotion program for NTD (11).

8.2.5.3 Non-communicable diseases

Couples who participated in the GHP demonstrated increased knowledge related to most people with hypertension or diabetes being asymptomatic as well as identifying adverse health outcomes associated with undiagnosed, untreated disease. Couples also showed increased knowledge of recommendations to manage the diagnosed conditions, such as reducing salt/sugar intake, taking medications, and getting BP/sugar checked.

8.2.5.3.1 Reducing salt and sugar intake

Decreases seen in participants adding >=1/4 of salt to dinner were also seen in increased recommendations to reduce salt intake to manage hypertension. Three-quarters of participants adopted reducing salt in cooking, which was maintained. Avoiding salty foods was moderately adopted by participants and sustained. Similar to salt, decreases seen in participants adding >= 3 tsp of sugar to their tea/coffee aligned with increased recommendations to reduce sugar intake for management of diabetes. Forty-one percent of participants adopted avoiding adding a lot of sugar to tea and coffee. However, unlike the adoption to reduce salt, reducing sugar intake was not sustained. A similar trend was noted on maintenance of avoiding or limiting sugary drinks. In Zambia, initiatives to reduce sugar-sweetening beverages through taxation have been proposed but met challenges due to conflicting interests between the beverage industry and public health (386). GRZ's commitment to creating fair competition in local and global industries led to incoherent policies with taxation well below ZMOH and WHO recommendations, thus lessening its health impact (386).

8.2.5.3.2 Losing weight and physical activity

An increase in weight loss and exercise recommendations for managing diabetes and hypertension was noted, though it never exceeded 50%. These recommendations started to wan by six months post-intervention. Low adoption and decreased maintenance of maintaining a healthy weight and increasing physical activity were also found. Decreases in participants' recommendations and personal adoption and maintenance of exercise may be cultural. A qualitative study by *Oelke et al.* noted that Zambian views on exercise did not align with Western views (37). Though participants understood its importance, it was not common practice and was seen as something that could be negatively viewed by the community (37). These different views may explain why most Zambians (~75%) were reported as physically inactive (34). In addition, Zambians may engage in other physical activities that may be adequate substitutes for exercise by Western standards, such as walking longer distances and doing more manual jobs (37). Similarly, being overweight may be considered good health in women as historically thinness has been associated negatively with HIV in some African cultures (39, 49, 386, 387). Inclusion of more information on physical activity content, e.g., types and duration, may be needed in GHP.

8.2.5.3.3 Low adoption of some strategies

Lower adoption of strategies related to maintaining a healthy weight, avoiding stress, avoiding sugar, eating vegetables and fruits, increasing exercise, smoking, alcohol, and drinking water may be due to this being the first time receiving health messages, perception these issues did not apply to them and the short period to fully adopt them. In Zambia, one study noted that >90% of adults were not eating the recommended daily five servings of fruits and vegetables (34). An inadequate diet combined with other unhealthy lifestyles contributed to ~25% of adults being overweight and ~8% being obese (386) in one study. *Tateyama and colleagues* alluded to being unable to afford healthier options due to socioeconomic status (39). The authors noted, however, that participants had awareness that the problem was present but had limited knowledge (39). *Mukanu and authors'* interviews with stakeholders also revealed poor public knowledge about nutrition-related NCD (386). In addition, increased competition between sugar-related industries has often led to marketing language like 'nutrition' and 'real' in addition to using children to advertise these products (386). This marketing language has led to misinformation about food and drinks as no organizations were present to disseminate correct information to the public (386). Alcohol has faced similar issues with sugar regarding using taxation on alcohol industries to curb harmful drinking. As a result, over two years, taxation was reduced from 75% to 40% to support the expansion of industry for the economy (386). Like sugar, policy for alcohol use in Zambia has also been insufficient to address harmful drinking. These policy-based prevention initiatives, though found to be effective (388), have been slow to implement in SSA. However, depending on these policy initiatives alone is not ideal. More research may be needed to identify and include locally available, affordable food options that taste good in the messaging to address the barriers to healthier food.

Information learned from GHP translated to increased observed behaviors, recommendations, adoption, and even maintenance of some implemented strategies. Interestingly, the four most adopted and maintained strategies also had related commodities given to GHP couples. These commodities were chlorine, soap, deworming tablets, and low-sodium salt. Additionally, chlorine and handwashing, which had adoption and maintenance rates of >95%, further highlight the importance of demonstration and practical training. Providing a visual tool for nonverbal communication in SOV also resulted in most participants citing this as the preferred method to signal any future potential HIV exposure in the union. This observation highlights how low-cost commodities and visual aids can help reinforce knowledge and skills learned and create alternative ways to communicate.

Anecdotally, when GHP services were offered to improve HIV retesting at follow-up, handwashing soap and chlorine were the most commonly selected services, followed by deworming and screenings for hypertension, diabetes, and schistosomiasis (unpublished). In this thesis, handwashing and water chlorination were the most commonly adopted and maintained strategies cited. Though limiting alcohol and tobacco use, reducing sugar and salt intake in foods and drinks, maintaining a healthy weight, drinking water, and increasing physical activity had the lowest adoption rates, most participants (>96%) reported no barriers or challenges to implementing strategies (unpublished).

8.2.5.4 GHP within an HR approach

Unlike SOV, GHP was not created within HR. GHP was based on simplified health education with screenings and commodities as part of HIV retesting strategies in CVCT implementation projects. Knowledge gap was noted as an issue by health staff, and thus an expanded package was created. Like SOV, GHP includes modifiable behaviors that can be incorporated into HR approaches as follows:

- GHP study team were also CVCT counselors and received human subjects training and thus were trained to treat individuals with dignity, respect, and compassion.
- GHP did not focus on avoidance, as risk behaviors will always exist. The purpose of GHP was to educate participants on how to minimize harmful effects by modifying their lifestyles. However, this may be less true as correct and consistent practices for handwashing, washing raw vegetables and fruit, properly cooking meat, not eating dirt/soil, deworming family, and having treated water are fundamental for preventing and controlling NTD.
- GHP did not prescribe only avoidance of harmful lifestyle behaviors. One can still have processed or fried foods, sweets, and alcohol. However, emphasis was placed on moderation. Participants were given various strategies to prevent NTD and NCD.

- GHP educated participants on what behaviors may lead to a harm. GHP clearly stated adverse outcomes of not modifying behaviors to prevent NCD and NTD, such as stroke, heart attack, and death.
- The consequences of inaction on preventing NCD and NTD increased the likelihood of adverse morbidity and mortality outcomes. These consequences not only affected their health but also that of the family.
- GHP highlighted that having diarrheal diseases can affect one's ability to go to work, school, or take care of the home. GHP also noted that carrying out normal routine behaviors such as walking in, swimming, bathing, or laundry may affect one's risk if in infected waters. In this example, infected stool was highlighted as a cause. Post GHP, possible reasons for low adoption of some strategies may be personal preferences for food preparation, perceptions of weight and physical activity, difficulties in reducing alcohol, and lack of financial resources. More content may be needed on how their economic, social, and personal issues may affect their risk and ability to modify their behaviors.
- Couples were encouraged to use the strategies covered in the group session and work together at home to implement them to improve their household health.
- Counselors and study team training emphasized on not being judgmental and avoiding personal biases.
- Strategies included in GHP were relevant and practical to implement. Deworming and chlorine were low-cost and easily accessible. Limiting salt and sugar intake, sugary drinks, alcohol, tobacco, and processed, fried foods could be presented as actions that may reduce spending.

- General solutions to prevent the NCD and NTD covered were provided. Adoption and implementation of strategies would depend on individuals/couples. There was no structured selection of choices, thus allowing flexibility.

Overall, GHP fits well within an HR approach. However, interviews or focus groups with couples may shed more light on why the adoption of some strategies was not very high or sustained.

8.2.5.5 Video-based interventions

Other studies have highlighted the impact of video-based interventions on health outcomes. Video-based interventions have been effective in cancer screening and prevention (389, 390), health education on infectious diseases in schools (391), HIV testing (390), STI treatment (390), and female condom use (390). In other studies with couples, video-based interventions resulted in increased uptake of modern contraceptive methods in serodiscordant and concordant positive couples (392) and reduced unintended incident pregnancies in baseline contracepting concordant positive couples who watched a family planning methods video on implants and intrauterine device (393).

8.3 Comparing SOV/GHP to other studies on sexual agreements, sexual communication, and other couple-based interventions in heterosexual couples

Several studies from Uganda, Rwanda, South Africa, Ethiopia, the US, and Kazakstan with an emphasis on communication were reviewed. Study populations varied, with some including couples, individuals, and community or a mix. Topics covered in these interventions were mostly HIV and/or intimate partner or gender-based violence (IPV or

GBV) and drug and/or alcohol abuse and were mostly characterized as gender-specific or gender transformative.

8.3.1 Comparison of intervention components

These behavioral interventions' most common features were communication, HIV risk behavior and/or incidence, IPV/GBV, and alcohol/drugs. Approximately half of these studies included the community, and three-quarters included couples in their study designs. In two studies, couples had to be CNC or DC by testing or knowing one another's HIV status. This thesis' intervention components were similar to some studies as it includes communication and HIV risk behaviors and incidence, though HIV outcomes of interest were not part of this thesis. Many studies included IPV/GBV or drug use, though GBV and drug abuse are not part of this CRT. In addition, NTD and NCD prevention was included in this thesis in a non-HIV arm but not the other studies reviewed. This thesis did not have content specifically related to relationship quality or dynamics.

8.3.2 Comparison of outcomes of interests

Outcomes of interest in these studies included IPV (376, 394-400); HIV knowledge (376, 401); incident HIV (301, 395, 396, 399, 401); incident STI (399, 401, 402); STI symptoms (161), condom use (301, 376, 399-403), unprotected sex (161, 301, 395, 401, 402, 404); CVCT uptake (401, 404); ability to refuse sex (403); opposing HIV stigma (402); relationship control (402); outside partners (161, 395, 399-401, 403); alcohol use (301, 398-401); drug use (401); gender norms and household roles/tasks (376, 397, 398, 403). Approximately half of these studies measured communication. Communication parameters measured included discussing with the partner on condom use (403); HIV testing (403); sexual matters (also family) (395); fertility goals (403); family planning (397); sexual pleasure (403); worries (398, 403); feelings (398); daily events (403); HIV risks and sex with partners (376) and risk reduction (401). In addition, comfortability discussing sex/sexuality issues at home (395) and partner communication (402) were also assessed. Some outcomes measured by these studies were to the main CRT to which this thesis belongs. These outcomes include communication, HIV knowledge, incident HIV and STI, outside partners, condom use, alcohol use, and household roles. In this thesis, communication (sexual agreements), HIV knowledge, threats to remaining HIV negative, household roles, and knowledge, adoption, and maintenance of strategies related to NTD/NCD were assessed. Parameters not assessed in the CRT and this thesis were IPV, gender equity, relationship quality, drug use, disclosure of HIV results, and partner appreciation. Disclosure of HIV results did not apply to this thesis as CNC did this as part of CVCT. Though SOV/GHP did not measure gender equity, CVCT incorporates elements of gender equity as both partners discussed together with a counselor on next steps based on their CNC result. In addition, couples were encouraged to negotiate sexual agreements, implement strategies and share household responsibilities, which would suggest some level of gender equity being assessed.

8.3.3 Comparison of those studies to this thesis findings

A positive communication effect was seen in men in SASA! and women, though not significant in women (403). SASA! also found significant positive effects in men for IPV (394), discussing condom use with partners (403), using condoms (403), discussing HIV testing and doing HIV testing (403), helping with household tasks (403), showing appreciation to partners (403), discussing sexual pleasure (403), discussing what happens during the day as well as worries (403) and feelings (403). In women, these outcomes were insignificant except for making important decisions with partners (403).

A modest effect was seen in openness and communication in the IMAGE trial as it related to communication of sexual matters, particularly to family members, though this did not translate to reduced HIV risk behaviors and HIV rates by 18 months (395). Reductions in IPV were also noted (395). Authors attributed no reductions in HIV risk behavior and rates to diffusion taking about 2-3 years before impact may be observed (395). Communicating about family planning was shown to increase contraceptive uptake in the Bandebereho trial (397). Decreased male-dominating decision-making and IPV were observed in addition to increased male reporting of shared household duties/childcare and maternal/child health (MCH) visits (397). Authors cited this was also similar to findings seen in gender transformative trials, including a family planning component with couples in Counseling Husbands to Achieve Reproductive Health and Marital Equity (CHARM) study (405) or men in the Malawi Male Motivator Project (397, 406). In the Indashyrikirwa trial, couples had improved communication related to discussing worries and feelings, improved trust, household earnings, food security, conflict management, and decreased IPV (398). In United for Better Life (UBL), couples, women, and men saw significant improvements related to discussion on HIV, though only couples and men had significant improvements noted for discussing sex with partners (376). It is important to report that in terms of communication across the three arms, receiving the intervention as a couple yielded greater impact than individually (376). In addition, UBL increased condom use with couples compared to individuals and increased equitability in household decisions, HIV testing, and sharing home tasks (376). Decreases were noted in terms of HIV risk behaviors, and IPV reports amongst men (376) but not in women.

In Stepping Stones, decreased IPV and HSV-2 incidence was observed in addition to some evidence of a lowered proportion of casual partners (399). In a later Stepping Stones trial, increases were seen in the gender equitable men scale (GEMS) amongst men, while no effect was observed in terms of outside partners, IPV, and drinking (400). In the SISTA trial, decreases were observed in the frequency of vaginal sex and unprotected vaginal sex, while increases were noted in HIV knowledge, perceived control with sexual partners, and preference for no dry sex (402). There was no effect in partner communication, condom use and its efficacy, attitudes towards condoms, and STI incidence (402). The Our Love study showed improved uptake in CHTC, including time to CHTC, though overall, there was no effect for decreased unprotected sex except at three months follow-up (404). In Project Connect, the likelihood of reporting unprotected sex decreased while reporting of protective behaviors increased (161). In related studies Connect 2, Project Eban, Project Impact, and Project Renaissance, decreases were seen in unprotected sex acts (all); increased condom use (except Project Impact); and fewer sex partners (Project Impact) (401). In Couples Health Co-op, men in the CHC arm were less likely to report heavy drinking and more likely to report regular condom use (301). In addition, CHC showed lower HIV incidence amongst couples compared to the individual groups (301). In the Safe Homes and Respect for Everyone (SHARE) trial, authors mentioned that increased disclosure of HIV results likely suggested an increase in communication between partners as it relates to HIV risk reduction (396). In addition, decreased reports of IPV amongst women and HIV incidence were reported, though reduced HIV incidence was not sustained (396).

In my thesis, communication on negotiating sexual agreements was overwhelmingly positive, with >96% of men and women agreeing to remain HIV free primarily through monogamy. In addition, all couples selected an alternative agreement in case of potential HIV exposure. Similar to the studies cited above, male involvement in household roles improved. Improved knowledge, adoption, and sustained maintenance of strategies were also observed in GHP two weeks and six months after the intervention.

Two key aspects of this thesis, which are unique compared to most of the studies above, are the inclusion of a structured but flexible, explicit SA based on proven strategies to reduce HIV risks, such as condom use, CVCT, and SA. In addition, SA was flexible and explicit. The only study to explore any agreement was the Couples Health Co-Op (CHC) trial, which included a commitment pledge of monogamy (92). In the formative work for CHC, faithfulness and monogamy were discussed (407), though it was unclear if HIV prevention was in the pledge.

SOV was created on the premise that monogamy or abstinence may be difficult to practice in real life. This premise is an important and practical concern, given that outside sexual partners are a key driver of the HIV epidemic in SSA. SOV better equips spouses to protect themselves and their partners in case of potential HIV exposure. Many heterosexual relationships may have implicit monogamy, which may be falsely based on an assumption of no risk. However, this presents problems, as both partners may not have the same understanding of or have explicitly mentioned monogamy.

GHP is unique as there is limited literature with couples on knowledge uptake, adoption, or maintenance of strategies in SSA concerning WASH, NTD, and NCD interventions. The thesis findings further support literature highlighting a gap in knowledge on these conditions and highlighting that there may still be much work to do in educating the public on these important health issues.

8.3.4 SOV and GHP within a gender-responsive continuum

SOV and GHP interventions can best be categorized as between gender-specific and gender transformative according to the WHO and Canadian gender-responsive assessment scale for programs and policies (408) and health research (409). SOV and GHP go beyond gender-specific as spouses are either communicating on how to keep HIV out of marriages or working together to implement strategies to make their households healthy. Figure 8.1 below shows where SOV and GHP may lie on a gender-responsive assessment continuum.

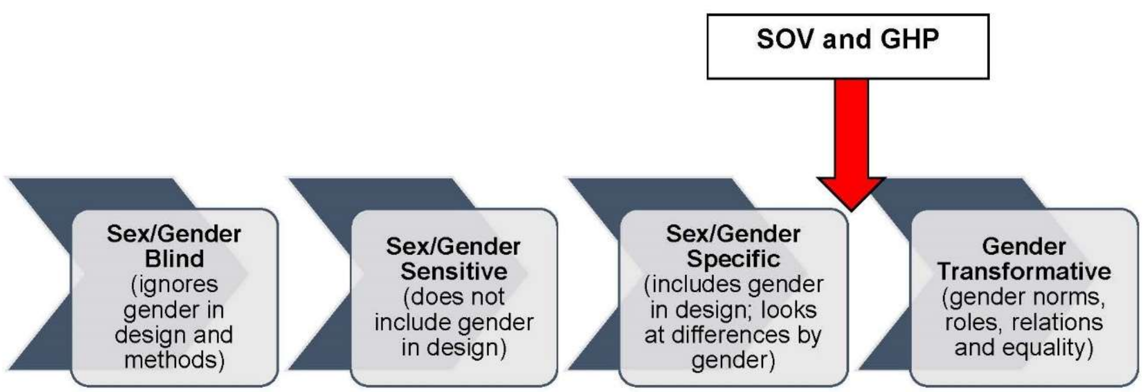


Figure 8.1: SOV/GHP on Canadian Health Institute of Research's Gender Responsive Assessment Scale for Research

Though this thesis does not meet the full definition of gender transformation, there are elements of gender transformation worth noting. In SOV and GHP, spouses were equally involved in strategies preventing HIV, NTD, and NCD. An example of this in SOV was men and women reporting positive communication and negotiations at home on SA. In addition, we saw improvements in both spouses related to the uptake of knowledge and skills in GHP. In terms of norms, male participation increased in some household roles men do not traditionally do. Finally, SOV and GHP are rooted in CVCT. A qualitative study by *Bhagwanjee and the authors* highlighted the benefit of CVCT in creating a more equitable environment where couples can discuss treatment and prevention together as well as sensitive topics (410).

8.4 Assessing potential limitations of the thesis

CRT design may have some inherent disadvantages and limitations. *Hayes and Moulton* mentioned four areas where CRT may be susceptible. They include efficiency, selection bias, arm imbalance, and generalizability (411). In addition, limitations were assessed for social desirability bias, self-efficacy, insufficient content on gender-based violence, alcohol use, relationship quality, and relationship dynamics.

8.4.1 CRT as study design

Efficiency, e.g., statistical and cost, may have been impacted due to budgetary and logistical constraints, which limited the number of clinics. Only 10 clinics, five per arm, were used in this CRT. As mentioned in Research Paper 1, the power for this study was calculated based on individuals instead of the number of clusters. Similarly, to ensure at least 58% retention, the number of couples enrolled instead of clusters increased. In

CRT, ideally, the number of clusters should be increased and not individuals. To address this, though not within the scope of the thesis, follow-up was extended to include a visit 60 months post-intervention. *Hayes and Moulton* noted added follow-up as a way to address the potential loss of power (411).

8.4.2 Selection bias

Selection bias was minimized for this CRT by having the intervention and comparator structured the same as highlighted in Research Paper 1. The only difference was health topic content and approach, i.e., communication related to HIV prevention in SOV versus implementation related to NCD and NTD prevention in GHP. All couples signed the same informed consent, which listed all health topics but stated that they would receive one or more of the topics listed. Couples were not aware of the type of video session they would receive until the intervention visit. However, their unawareness may not have been sustained over time due to couples talking about their study experiences within their community. The clinic and, by default, the community surrounding the clinic received the health topic that the clinic was randomized to minimize contamination. Even with these measures put in place, selection bias cannot be eliminated entirely given the 32% drop-off rate between baseline and within two weeks post-intervention. However, this may still be within an acceptable limit given that similar drop-off rates were observed in Zambian DC after CVCT (204). Additionally, the retention rates observed were higher than the 58% conservative rate noted in Research Paper 1.

8.4.3 The imbalance between study arms

At baseline, there were differences noted for some sociodemographic characteristics between SOV and GHP; however, the preliminary assessment showed that balance was maintained as it related to outcomes of interest. CRT with fewer clusters are more likely to be susceptible to imbalances (411). Matching clinics, which was done for this study, can be used to address imbalances, though it may not always work as was evident with sociodemographic characteristics at baseline. Imbalanced covariates will be discussed at the final CRT analysis. Future considerations should consider not only cluster characteristics for matching but also include the sociodemographic characteristics of the catchment areas within the vicinity of the cluster if data is available. Per Research Paper 1, matching was based on the number of couples tested, distribution of HIV serostatus, and follow-up testing visits.

8.4.4 Generalizability

Broadly, thesis findings may be generalizable to cohabiting CNC who have received CVCT. In GHP, findings will be more applicable to couples who had at least two children in the household < 16 years old, had good vernacular literacy (women, 63% and men, 80%), and earned some income (99% of men and 71% of women). Though percentages of GHP men and women who had income were higher than Zambia DHS, the disparities between men and women were similar. Literacy rates in women and men were similar to Zambia DHS (66% and 82%) (2). Similar trends in literacy and income also exist in other SSA countries. Half of Zambian households in DHS reported having children < 17 years of age (2). Though participants did not have a high prevalence of hypertension and diabetes, their self-report of family members' prevalence rates were 36% and 19%, respectively. These family prevalence rates were similar to hypertension prevalence ranges of 25.9% to 32.8% (11, 34, 37, 38, 46-48) and diabetes ranging from 2.9%-15% (55) (56) seen in the literature.

8.4.5 Social desirability bias

Research with self-reported behaviors is susceptible to social desirability bias, where participants may report more favorable, positive responses to conform to social norms or avoid being judged or disappointing persons administering questionnaires. In this thesis, areas for potential social desirability bias included choosing monogamy as the main sexual agreement and other self-reported behaviors for NTD and NCD. Here, mitigation to prevent social desirability bias was summarized. In addition, different strategies used to prevent this specific bias have been highlighted for possible future use.

8.4.5.1 Use of multiple questions (triangulation)

To assess for social desirability bias, comparisons of spousal responses in SOV for monogamy as a sexual agreement and comparisons of self-reported versus observed action, recommendations, and adopted and maintained behaviors in GHP were done. Though some observed practices were lower than self-report in GHP, the overall trend was in the same direction for both spouses. In negotiating sexual agreements, three questions found that a very high percentage chose monogamy among men and women.

8.4.5.2 Observing participants performing techniques

Spouses were asked to demonstrate handwashing and water chlorination techniques at the clinic. Except for the length of time for washing hands, thesis findings show spouses had increased knowledge and skills post-intervention. However, it may not accurately reflect their routines at home, as noted by *Moffa and colleagues* (412). Authors suggested that more structured observations at critical handwashing points may be warranted to reduce social desirability bias further (412). One study noted that consideration for observation of practical skills such as handwashing be done at the participant's home to assess whether soap was being used consistently and identify the proximity of the handwashing station to latrine and food preparation (413). *Chidziwisano and colleagues* noted that even home observations could have social desirability bias as routine behaviors likely change in presence of observers (413). To mitigate this they suggested repeated observations without specifying reason for the visit; however, this may not be pragmatic given the resources and time needed to send staff to participant's home to verify (413). An alternative to going to one's home, may be a script based overt recall which using real life scenarios and ask participants to explain or demonstrate actions within that scenario which may mimic home conditions (414). Though script-based overt recall may further reduce social desirability bias for handwashing, it found to be more accurate in aggregate versus individual (414). Regardless of the method, none fully removed the potential for social desirability bias.

8.4.5.3 Use of study procedures

In addition to the cross-validation of responses, study procedures may have mitigated social desirability bias. All participants were provided information about study procedures during consenting in a standardized format with videos, administering questionnaires to each spouse separately, in private, with a same-gender interviewer. Before the first post-intervention visit, couples likely established rapport with the clinic team during their previous study visits. The questionnaire structure, review of study procedures with participants, previous study visits to the clinic, and offering a private area with gender-matched interviewer to elicit more candid and open responses may have reduced social desirability bias. A study by *Bergen and Labonté* highlighted practical approaches that may minimize social desirability bias, such as gender matching, privacy, review of study procedures, and rapport (317, 318). However, one study cautioned that rapport building may not always lead to less social desirability biases (415).

8.4.5.4 Measuring biological markers

In GHP, disease outcomes were not measured. This is a limitation in Research Paper 3. With an increased budget, biological measurements would have been done in both arms at designated time points and included blood pressure measurements, weighing, glucometer or HbA1c for diabetes, urine filtration and Kato-Katz for schistosomiasis, and stool examinations for helminths. Though not part of the thesis analysis, urine dipstick (reagent) strips were used to screen for the presence of hematuria in urine as proxy detection for schistosomiasis due to its low cost and easy use. Other studies have used urine reagent dipstick (strip) for the detection of microhematuria as a proxy for the diagnosis of *S. hematobium* (85, 385, 416, 417). Dipstick sensitivity and specificity have been cited at 87% and 91% (417), respectively, though sensitivity is lower (65%) (417) in areas with low prevalence and light intensity of infection (417, 418). Given this challenge, urine filtration may be more suitable for *S. hematobium* detection in the future. Not testing for *S. mansoni* was a limitation, as it is also common in Zambia. Detection of elevated glucose in urine was used to refer for diabetes assessment. Other studies in SSA have used urine dipsticks for monitoring glucose for screening and management of diabetes in resource-limited settings (372, 373), though it is less sensitive.

8.4.5.5 Other methods to minimize social desirability bias

Other methods used to reduce social desirability bias have been cited in the literature. Standardized tools include Marlowe-Crowne Social Desirability Scale (MCSDS) (419-421); Martin-Larsen Approval Motivation Score (422); list experiments (423); randomized response technique (424, 425); visual imagery (426); and nonverbal response card (427, 428) with MCSDS being most frequently used (429). Other approaches include triangulation through observations (430); word choice patterns (317), though may be subjective (429); nonverbal response cards (427, 428); polling vote method (431); and computer and mobile-based technologies such as audio computer-assisted software interactive (ACASI) (432), CASI (433), SMS-CASI (434), and sms/text (435). Some approaches have mixed findings (429, 433, 435) compared to traditional face-to-face interviews. Costs (436) and practical and technical barriers (437) should be considered when using computer and mobile technologies. Anecdotally with studies in Zambia, including this thesis, some participants had sim cards but no phone, no reliable electricity to charge phones, and experienced network connection issues. Similar challenges with practical and technical barriers (network issues, changing sims/phones and charging phones) to using sms to collect daily sexual behavioral data was cited in a qualitative study with a subset of trial participants (437). Also, literacy barriers either language or computer may hinder a participant's ability to fully engage in these platforms (433, 436). Furthermore, these technologies may not be fully optimized if participants are skeptical of their purpose and intended use (438).

8.4.6 Assessment of self-efficacy

In Research Paper 2, a limitation was not assessing couples' sexual communication self-efficacy (SCSE). SCSE is defined as a couple's ability to discuss reducing sexual risks (333). *Leddy and authors* recommended using a couple SCSE, given SCSE resulted in higher odds of using condoms (333). Authors found that knowing each other's HIV status did not influence the use of condoms consistently (333). For this study, it is not clear what parameters were assessed on the 8-item SCSE scale to determine if any parameters were covered in SOV or if the scale could be used for future studies. In SOV, spouses were asked if they were comfortable discussing sexual agreements with the spouse with 99% of men and women in Research Paper 2 responded "friendly and supportive." Spouses were also asked if there were challenges to remaining HIV-free. The most common challenges (8-18%) cited were not being able to tell the spouse about exposure, not being able to test with an outside partner, using condoms with the spouse, and inability to avoid risks/challenges. Less frequently (2-7%) reported challenges were partners not keeping the agreement and using condoms with outside partners. Regarding their ability to remain HIV-free, 9-13% of women and men noted concerns as being unable to test with outside sexual partners in their area, insufficient money, suspicions or confirmation of an extramarital partner, and spouses not using condoms.

In GHP, a self-efficacy scale was also not used. However, spouses were asked about their ability to apply the strategies learned at home; what were challenges and barriers; and how they would overcome them.

8.4.7 Alcohol use and GBV prevention in sexual agreements

SOV did not include alcohol use or GBV/IPV as part of the sexual agreements, though alcohol use was covered as a threat in one of the scenarios. Though GBV/IPV was not explicitly included in the intervention, couples were guided in handling difficult communication due to discussing potential HIV exposure. SOV provided tips when struggling to communicate: focusing on agreement and commitment to it to remain HIV, focusing on the future, and discussing issues when calm. If needed, suggestions were given to do a countdown or take a short break. In addition, spouses were reminded to be respectful by not insulting and shouting. It is recognized that alcohol use and GBV/IPV are prevailing issues in Zambia (2) and are known risk factors for HIV. Men and women in SOV reported alcohol use in men to be the biggest threat to keeping the union HIV-free. However, as mentioned in Research Paper 2, alcohol reduction as an HIV prevention strategy has been studied but with mixed findings (305). There have been studies that tackle GBV/IPV and HIV. SASA! showed significant effects with reduced reporting of IPV and improved HIV preventive behaviors among men but not in women (394, 403). In UBL, significant decreases in reporting of IPV were observed in men and protective behaviors improved for couples (376). Stepping Stones also saw significant decreases in men's reporting of IPV, though not women (399); there were also significant decreases in HSV-2 but not HIV (399). In SHARE, significant decreases in reporting of IPV were noted in women, but not men, with increases seen in protective behaviors such as disclosing HIV results (396); reductions in HIV were seen though not sustained (396). These studies showed significant decreases in self-report of IPV did not occur consistently in women and men. Additionally, there were varying levels of effectiveness seen in HIV incidence or risk factors. Only one study recruited couples. Thus, evidence of strategies to reduce IPV in both sexes with improved HIV outcomes has not been adequate. Future expansions on SOV should explore the best evidence before including alcohol and IPV reduction as part of HIV prevention strategies.

8.4.8 Intervention content on relationship quality and dynamics

The thesis did not include content and directly measure relationship quality and dynamics (e.g., commitment, trust, satisfaction, intimacy, finances, and appreciation). However, some elements of these concepts were incorporated into the interventions and measured. For example, SOV and GHP included couples' commitment to either keep each other HIV-free and/or their household healthy. Counselors were also committed to working with couples to achieve their goals. In addition, for SOV, couples cited vows to remain HIV-free and protect their spouse in case of exposure due to unprotected, extramarital sex. Planning money/resources for home was also highlighted as a strategy to deal with threats to remaining HIV-free in SOV. In terms of sexual satisfaction, alternatives to sexual intercourse, such as masturbation while apart and satisfying each other without penetration, were included in a scenario where the wife was in her six-week post-partum period. Furthermore, ensuring adequate monies were left at home if a partner traveled for work was covered in scenarios. Spousal appreciation was also mentioned in the SOV content.

Relationship questions were not asked directly; however, responses were unsolicited and dependent on the question. When spouses were asked about the most difficult challenge to using the SA, 5% stated they did not <u>trust</u> their spouse could keep the SA. For threats, most men and women responded that women's biggest threat was <u>financial pressure</u>.

For sexual satisfaction, 12-17% cited lack of sexual satisfaction as a potential HIV threat for either themselves or their spouse. When asked about the ability to remain HIV-free, a very small percentage (2-3%) mentioned not having enough money as a concern.

8.9 Strengths of the thesis

8.9.1 Foundation in CVCT and couples-based research

In this thesis, the couple's HIV serostatus was known before screening and baseline. No other studies highlighted in the review enrolled couples who had undergone CVCT. However, some studies measured outcomes, such as uptake of CHTC, discussing HIV testing, or disclosing HIV results. Disclosure of HIV results by oneself can be daunting, especially in instances of HIV-positivity and being a woman. Where one partner may be HIV-positive, a more neutral environment is created through facilitated mutual disclosure with spouses and counselors. This neutral environment helps mitigate concerns regarding abandonment, separation, and violence, particularly among women (284). In addition, this prevents an unfair burden from being placed on women who may already experience inequalities.

Most of SSA can be characterized as having a generalized HIV epidemic where HIV transmission happens primarily in heterosexual couples. With SDG and 90-90-90 and 95-95-95 targets, the emphasis has been put on individual testing and ARV. In Zambia, they recently stated their 90-90-90 target as being reached. However, most couples are still unaware of their joint HIV status, which increases their HIV risk. Undergoing CVCT before enrolling in interventions helps to address issues related to gender equality, problem-solving, and improvements in communication, as both partners have to work together to support and protect each other. Undergoing CVCT better prepares partners to be more open and receptive to other couple-based interventions, whether behavioral or biomedical.

CVCT has increased protective behaviors. Couples-based intervention, such as in the UBL trial, which included a couple arm, also showed couples had more positive protective behaviors (n=4) compared to men (n=3) and women (n=1) (376). Their finding is consistent with the literature that shows protective behaviors such as condom use are better in couples versus individuals. *Leddy et al.* noted consistent condom use in dyads may be due to high couples SCSE and not likely influenced by knowing joint HIV serostatus (333). However, literature assessing the impact of couples SCSE on condom use and CVCT appears to be scarce.

Knowing the couple's HIV serostatus at baseline provides richer study analysis comparisons. In addition, any study findings can better inform HIV prevention policy, particularly in generalized epidemics. In addition, interventions can be tailored based on the couple's HIV serostatus. Without knowing their joint HIV serostatus, couples cannot make realistic plans to mitigate risk. Thus, including CVCT makes sense, given the low cost per HIV infection averted.

Including couples in the study design would strengthen recommendations while reducing the need to call for additional studies. Several studies reviewed covered intimate topics like GBV/IPV and HIV prevention; however, half did not recruit couples. These study findings of decreased self-report of IPV/GBV in men but not women, with one exception in the opposite direction, which may be due to not recruiting couples. SASA! studied highlighted several significant increased HIV-preventative behaviors in men but not many in women (403). The authors mentioned a limitation of not recruiting couples (403). Though gender normative behaviors may be rooted within the community, given the intimate nature of IPV and HIV, the group most directly affected by these adverse outcomes are the couples themselves.

Not including couples may have decreased the magnitude of impact for some of these studies, as the design and outcomes were related to communication and sexual behaviors, which works optimally with both partners.

Couples knowing or learning their joint HIV serostatus should be included in the design, especially given that many countries in SSA have high HIV prevalence. Knowing HIV status together is empowering the couple. Thus, studies classified as gender transformative should include couples in the design, particularly in generalized HIV epidemics or areas where at-risk groups include couples.

8.9.2 Sexual communication and HIV prevention through sexual agreements

Several studies reviewed included some level of communication, negotiation, and problem-solving. Improved general communication skills within the couple may indirectly reduce HIV risks. However, disclosing one’s HIV status can be daunting; thus, special considerations are needed to provide couples with sexual communication skills to discuss HIV and concurrent partners. In addition, ensuring a neutral space and person, such as a trained clinic counselor, is available to discuss is needed. *Montgomery and authors* noted that most couples felt more comfortable discussing sensitive topics at the clinic (439).

Wechsberg and colleagues included a pledge for monogamy as part of the study design (301). Two studies included discussion of monogamy as part of risk reduction and potential barriers to HIV/STI protection (401). SOV goes a step further by including additional prevention strategies for monogamy, such as condom use, knowing the outside partner's HIV status, CVCT with the outside partner, and using condoms or abstaining from sex with the spouse until retested in the event of exposure.

8.9.3 Improving gender norms

In addition to HIV prevention strategies, couples-based approaches have shown that including men in various health initiatives can result in positive health outcomes for men, women, and children and can positively affect gender norms. Similar to our findings on household duties, a few reviewed studies also showed improved male involvement (376, 397, 403). In GHP, increases were seen in men’s sharing roles traditionally done by women, such as collecting and chlorinating water, purchasing food, and taking care of the sick.

8.9.4 Focus on NTD and NCD prevention within couples

This thesis features a couple-based intervention that tackles improving knowledge and adopting strategies for preventing NTD and NCD. Most NTD and NCD interventions in SSA have focused on communities or mobile units, integrating NCD screenings, including malaria and TB with HIV (440, 441). Dyadic research may be more common in NCD than NTD, though mostly focused on partner(s) with a chronic condition and their support partners (375). In GHP, both partners were relatively healthy, as indicated by the very low self-reported prevalence of diabetes and hypertension and their CNC status.

8.9.5 Highlighting knowledge gap in NTD and NCD

Knowledge and skills to prevent health issues serve as the cornerstone for any public health prevention strategies. For schistosomiasis and STH, lack of knowledge in the adult populations was a reason for not completely eliminating these NTD. In Zambia, where there is limited capacity to do MDA, focusing on health education will be essential to ensure adequate uptake of MDA. Additionally, lack of knowledge on NCD in SSA is important given the increasing prevalence of hypertension and diabetes, with these conditions often not well-controlled. A systematic review highlighted that lack of health literacy, particularly knowledge and skills, was a significant determinant of obesity and BMI in children and adults (442). Thus, to have well-rounded intervention and program efforts, educating the public on these health issues should be a high priority.

8.10 Why couples as an intervention target for HIV prevention?

8.10.1 Incorporation into HIV testing services

Many HIV testing programs can support couples. These include home-based, community-based, self-testing, and VCT. The Zambian HIV testing services guidelines support the inclusion of couples testing within these services (443).

8.10.2 Better outcomes when combined in biomedical interventions

Biomedical interventions with couples, such as VMMC, ART, and PrEP, have been shown to be efficacious in preventing HIV in HIV-negative partners. The Spear and Shield Project study in Zambia saw an increase in male uptake of circumcision, likely linked to increased women's acceptance of VMMC (444). PrEP was 96% efficacious in reducing HIV transmission in HIV-negative partners in DC (445). A modeling study further supported trial results that saw PrEP/ART reduce HIV incidence in negative partners in DC from 5% to 0.5% (446). Part of ART and PrEP success has been attributed to couples' counseling (95).

8.10.3 Better protective behaviors

As previously noted, increased protective behaviors have been seen in couples who undergo CVCT versus VCT. These protective behaviors were sustained over time in couples (29). After CVCT, increased protective measures by HIV-positive women were seen in terms of preventing HIV infection and being more likely to receive and take nevirapine to prevent mother-to-child transmission (PMTCT) (23, 26). Additionally, targeting men at ANC for VCT and couple counseling resulted in increased uptake of nevirapine and formula feeding in HIV+ women and an increased likelihood of condom use among DC (447). In addition to HIV prevention, couples-based interventions have also shown improved communication about fertility desires and increased uptake for family planning methods (258, 273, 448, 449).

A qualitative study with DC in Uganda and women only in Zambia showed that Ugandan DC had increases in consenting, attendance of couples' counseling, sharing HIV results, and strong spousal support for study adherence and retention (439). Zambian women experienced more issues as the study team engaged male partners where males may not have been aware of their partner's participation (439). In Zambian women, the motivation and the momentum to propel behavior change related to study participation indicators were absent (439).

A qualitative study in Kenya, among pregnant couples where at least one partner was HIV-negative, highlighted couples who had motivations that were more relationship-centered and participated in more health-enhancing behaviors like testing together, disclosing their results, and working as a unit to improve clinic attendance and treatment adherence (334).

8.11 Couple-based behavioral versus biomedical interventions

In VMMC, three RCT were shown to reduce HIV transmission in men and possibly indirectly among women (450). The effectiveness of VMMC was sustained over time (450). In addition to HIV, VMMC has also been associated with reduced incident syphilis (451). However, a recent study on VMMC and HIV in Lesotho alluded to a possible change in the relationship between HIV and VMMC, citing no change in HIV incidence or prevalence since the introduction of VMMC in that population (452). In addition, no impact on HIV in couples was observed with similar transmission rates from male to female and female to male (452). *Garenne* attributed decreases observed in HIV to educated males who primarily uptake VMMC (452). A recent review and commentary similarly suggested that decreases in HIV were likely primarily not due to VMMC but who accessed the service and their HIV risk (453, 454). The impact of VMMC on reduced HIV transmissions in real-world settings may be attributable to other factors that may not be considered during analysis, such as health education campaigns and changing socioeconomic demographics over time (453, 454). Also, stigma and ethical concerns may outweigh the benefits (453, 454). In Zambia, VMMC was observed to increase some risk behaviors, albeit small (454). Thus, VMMC, as a population-based HIV prevention strategy, has had mixed findings and may depend on the HIV epidemic within each country (453, 454).

Though couples-based biomedical interventions that include PrEP/ART have been shown to be efficacious under trial conditions, their uptake and efficacy are lowered in real-world conditions. PrEP and ART efficacy in DC under real-world conditions were cited between 70-77% (455). Many factors contribute to lower uptake, including logistical costs, infrastructure, side effects, and stigma associated with antiretrovirals (95, 445). For CNC the target population under investigation in this thesis, PrEP may not be obtainable given the low HIV incidence after CVCT of 0.57% (18). CVCT is an ideal prevention strategy, though its implementation in Zambia also faces challenges. Implementation barriers to CVCT will be explored further in the organizational and policy analysis.

8.12 Integration

8.12.1 Feasibility of integration of thesis findings within CVCT

This thesis is an extension of CVCT for which the findings are planned to be incorporated. During CVCT, risk reduction counseling is done during post-testing counseling, which mentions outside partners. In addition, a basic GHP was already introduced during the CVCT implementation project. As both of these areas were already incorporated into CVCT on a smaller scale, incorporating sexual agreements into the existing CVCT curriculum while expanding health education, health screenings, and provision of low-cost commodities related to GHP seems feasible.

Recommendations in another study support the integration of CVCT with clinic and community-based services to maximize the benefit of HIV prevention efforts (5). Offering couples a set of evidence-based interventions once their joint HIV status is known can significantly reduce HIV incidence and, if implemented in sufficient scale and coverage, can have a broader HIV prevention impact at the population level (5).

8.12.2 Importance of integration

In SSA, HIV and NTD continue to be of public health importance. This combined with the increasing disease burden for hypertension and diabetes due to urbanization, lifestyle behaviors, and an increasing aging population puts added strain on health systems, particularly in resource-limited settings. Co-morbidities of HIV, NTD, or NCD negatively affect disease progression or increase risk. Approximately 62% of adults aged 20-64 in SSA have reported symptoms that suggest having multiple morbidities (456). Integrating health education content and services will be critical to address many coexisting diseases. In addition, integration is a way to achieve SDG targets (457). My thesis shows opportunities to integrate strategies addressing HIV, NTD, and NCD based on the CVCT foundation. Literature highlighting various examples of integrating services for HIV and WASH, HIV and NCD, HIV and NTD, and HIV and sexual reproductive health (SRH) services, such as FP and maternal child health (MCH) are noted below.

8.12.2.1 Examples of integration in the literature

8.12.2.1.1 WASH and HIV

WHO and PEPFAR have recognized the need for improved WASH conditions among PLHIV as the disease burden is high (458). Thus, policy reforms have been called to integrate WASH activities into HIV programs (458). Several WASH interventions have shown reduced morbidity in PLHIV and frequency of diarrheal episodes in PLHIV and their HIV-negative household members (459) (458). A modeling study assessing a hypothetical, integrative intervention targeting HIV testing, safe water, and malaria control in Kenya concluded that integrative campaigns were practical with the ability to cover multiple diseases of public health importance and be economically feasible (460). *Kahn and colleagues* (460) noted that repeating campaigns or, in this thesis, health education messages, will be important. Similarly, *Yates and colleagues* pointed out that some WASH interventions were cost-effective, especially in combination with programs that compliment WASH activities (459).

8.12.2.1.2 HIV and NCD

A global priority backed by WHO, UNAIDS, and SDG agenda has called for integrating NCD into existing HIV care infrastructure (461). This global priority facilitates joint care and may destigmatize HIV services within clinics by offering other services (461). Integration of services HIV and NCD has recognized HIV, TB, and diabetes as HIV in SSA and TB in Asia are drivers of the TB epidemic (462). Addressing these three diseases is important as an estimated 33-50% of persons affected were unaware of their diagnosis (462). Integration of HIV and hypertension has also become of interest due to the increasing prevalence of hypertension among PLHIV in Eastern and Southern Africa (463). A review by *Bulstra and authors* looking at the integration of non-HIV services within HIV and vice-versa identified one study evaluating the integration of HIV, diabetes, and hypertension in South Africa (464). This study found low HIV testing uptake due to inadequate staffing and training (464). The SEARCH trial compared the costs of integrating hypertension with HIV in Uganda to standalone NCD services in three African countries (461). In Uganda, integration resulted in 2.4-4% increase in costs of HIV services (6.29-11.39 USD per person per year) compared to Tanzania (30-41 USD); Kenya (26-234 USD); and Nigeria (67 USD) (461). SEARCH leveraged already existing staff, resources, and infrastructure from HIV services to incorporate NCD, which kept costs low (461).

8.12.2.1.3 HIV and NTD

Most NTD integration programs have been with WASH, immunization, primary healthcare, and malaria (465). The WHO has recommended the integration of NTD within existing services such as HIV/AIDS, malaria, MCH, WASH, and other NTD, with the UN further expanding this to universal health (465). In addition to UNAIDS and WHO, other international groups and global health initiatives have recognized the need to integrate HIV, female genital schistosomiasis, and cervical cancer (466) (467). Given the mounting evidence linking schistosomiasis and HIV (80, 468, 469), integration of HIV and NTD in this area is needed.

8.12.2.1.4 HIV and sexual reproductive health

HIV and sexual reproductive health (SRH) have a long history of integrative efforts (470). HIV services have been integrated with PMTCT, FP, and ANC. Many of these integrative efforts have resulted in increased use of family planning and HIV testing (471). In a review on integrating FP into HIV services, *Wilcher and colleagues* found increased uptake of FP and completed referrals from HIV to FP services (472). Authors also noted studies where FP uptake was higher when men underwent joint testing from HIV services (472). Another study showed men's preference for wanting to receive FP information during HIV services (471). Integration of HIV services into FP has also resulted in increased uptake of HIV testing (473). However, there has been no consensus on where integration should occur (471). *Malama and authors* demonstrated the successful integration of CVCT and couples family planning counseling at GRZ health clinics, where the percentage of couples receiving joint HIV testing and counseling increased from 11% to 89% (273). Most referrals came from HIV testing services (32%), outpatient (31%), FP (16%), and under-five infant vaccination (15%) (273). Antenatal clinics may also be an area to integrate HIV services; however, *Inambao and colleagues* observed that CVCT uptake in ANC in GRZ clinics was inconsistent (272). Factors that need to be addressed to improve this were management, staffing, provision of HIV test kits for men, inclusion of couple HIV indicators in logbooks, addressing stigma, addressing working men, and relationship issues, like trust and communication (272).

8.12.2.2 Impact of integration

A systematic review examining the integration of HIV services with at least one non-HIV service showed that integration improves health and health systems outcomes (464). A noted increase in VCT uptake and treatment for non-HIV health issues was seen in integrated programs. *Bulstra and colleagues* also said that the costs of basic HIV and non-HIV services were generally lower in integrated programs (464). Integration has been shown to improve efficiencies at the clinic (474); reduce client wait times (474); reduce clinic visits by clients (474); increase the productivity of health providers (474); offer a multidisciplinary approach to health, improve quality of joint services (474); better retention (464, 474); adherence to medication (474); increase access (464); and may reduce costs to patients (464, 474). Additional benefits of integration included reduced time and inconvenience for patients since multiple conditions or diseases were assessed during the same visit, which could have enhanced patient experience (464). In addition, resource allocation and processes with providers could be improved (464). Though these are commonly cited benefits of integration, these findings may be mixed depending on the context of integration (457, 475).

A potential challenge associated with integration is increased costs and reduced efficiency as a non-specialist could take longer to address multiple health concerns (464). In addition, integration could potentially overburden health care workers (457, 464) and existing infrastructure (457), especially in higher HIV prevalent areas. Additional barriers cited in the literature include supply chain issues, training of staff, turnover, referral systems, patient records, monitoring and evaluation, funds, and resources, particularly in the context of donor requirements (476). Longer wait times in clinic (474), low staff awareness of a health issue (466), complexities in clinical and laboratory diagnosis (466), and the ability to link patient records between departments (457) may also hinder integration efforts. Additionally, there is limited research on patient values, preferences, and economics, which may affect the acceptability of services and clinical outcomes (457). In terms of measurement of impact, the effectiveness of integration studies remain limited with mixed findings (457). Most integrative research findings show uptake of services; however, studies have shown little to no impact on health outcomes and quality of service (457).

8.12.2.3 Considerations for integration

Integrating services alone is likely insufficient to ensure long-term sustainability and does not resolve inadequate resources (457). The sustainability of integration programs requires a strengthened health system (470). Integration will require a willingness to be flexible with current roles and to task shift responsibilities among health care workers and laypersons (477). Allowing clinic staff to work together to create solutions in a supportive environment has also been highlighted as a key aspect of integration success (470, 478).

For an implementation roll-out plan for CVCT in Zambia, *Wall and authors* proposed integrating CVCT into existing VCT services (19) using the same staff who provide VCT to reduce costs (18). Non-HIV services proposed for integration included ANC, VMMC, and family planning (19). Other testing service platforms where CVCT can be incorporated include home-based, mobile, and self-testing, though authors noted that more understanding may be needed (19). Barriers to CVCT implementation, noted by authors, included budgets for integrated services, ongoing M&E, training of providers, accessibility to GRZ clinics, costs and affordability, service delivery hours and platforms, and targets and indicators (19).

8.12.2.4 Presence of integration in GRZ documents

Integration has been highlighted in NASF for HIV and SRH, including nutrition and food security; for social behavioral change communication with PMTCT, HTS, VMMC, GBV, FP, PREP/PEP, and SRH; for STI and primary health care; for HTS with other services within the clinic and in the community; and for HIV and NCD, STI, MCH and SRH (12). The ZNHSP also mentioned integrating nutrition services in maternal and adolescent health, HIV care, TB, and NCD (11). Also, the integration of STI increased within health services and NTD would be incorporated into PHC activities (11). Integrating health promotion across various sectors was also included (11). To improve the quality of care, integration was noted as needed in human resources, equipment, and infrastructure planning to increase access to services and facilitate equity (11). Collaboration between MOH and sector partners would improve capacity building and sustainability while ensuring maximum integration within MOH policies and programs (11). Noted potential challenges in ZHSP included integrating information between various programs and issues with data collection and data entry timeliness and quality within health management information system (11).

Avenues for integration based on CVCT implementation projects seem possible. Based on existing frameworks and health strategic plans in Zambia, *Wall and authors (18, 19), and Malama and colleagues (273)*, ideal areas for integrating CVCT + SOV/GHP would be HTS, MCH, SRH, FP, NCD, NTD, VMMC, ART including PREP/PEP, STI, and under five vaccinations. In addition to activities within primary health care, CVCT could also be included in home-based and community services. However, integrative efforts cannot be sustained unless CVCT implementation barriers are first addressed. Barriers to CVCT implementation will be explored more in the organizational policy analysis (OPA).

8.12.2.2.5 SOV/GHP, integration, and SDG

The ability to integrate health education and skills building in HIV, NTD and NCD within the couple captures the essence of the UN SDG, which emphasizes integration and equality. The health topics covered for HIV, NCD, and NTD in this thesis directly or indirectly covers eight out of the seventeen SDG, most of which are captured by the NTD in this thesis alone. The following show how thesis topics may be incorporated into SDG using examples provided by *Bangert and colleagues (479)*:

- SDG1: Ending poverty. HIV, NCD, and NTDs may result in disability and debilitating sequelae. This may affect productivity, finances, and increase time spent caring for sick and medical costs.
- SDG 2: End hunger and improve nutrition. Schistosomiasis and STH infections can lead to poor nutrition uptake due to competition with the host. This affects child development and work productivity.
- SDG 3: Ensure healthy lives and promote well-being for all.
- SDG 4: Ensure inclusive and equitable quality education and promote lifelong learning. Schistosomiasis and NTD can affect attendance and education of SAC. There also may be stigma and exclusion due to physical changes that occur with some infections. SOV and GHP educate both spouses. By acquiring new knowledge, couples can implement strategies at home to prevent these infections.
- SDG 5: Achieve gender equality and empower women. SOV and GHP have partners equally responsible for keeping HIV out of the union and keeping their households healthy.
- SDG 6: Ensure access to water and sanitation. Schistosomiasis and STH are associated with poor WASH conditions. Accessibility to water also means it is clean and safe. Couples in GHP learned to treat their water with chlorine and properly wash their hands. Also, health education covered avoiding contaminated water sources.

- SDG 8: Promote inclusive and sustainable economic growth, employment, and decent work for all. NTD, NCD, and HIV impact the productivity of work.
- SDG 9: Reduce inequality. Sharing the same content with all groups decreases disparities between socioeconomic status.

8.13 Implications of COVID-19 on HIV interventions and programmatic efforts in SSA

COVID-19 impacted non-COVID-19 interventions and programs globally, particularly in SSA, where resource-limited health systems were already strained (480). In addition, essential health services like HIV, STI, and NTD were disrupted (4, 481, 482). COVID led to competing priorities with HIV/STI (481) and NTD programs (482); reallocating staff (480); diverting reagents for STI (481); reducing HIV testing services (4); disrupting linkage of care and treatment services for HIV (481); reducing community activities for NTD (482); and other resources to deal with COVID. To put it in perspective, pre-pandemic activities and monies for diabetes were 3%, while HIV and infectious diseases were 6% and 19%, respectively (483). However, for COVID-19, support and activities were ~ 55-71% (483). COVID-19 was the most common term for scientific research and clinical trial funding (483). COVID-19 disrupted clinic services and programs and negatively affected health outcomes for people living with diabetes and hypertension (484, 485) and HIV (485).

At the beginning of the pandemic, many opportunities were missed to take advantage of the existing programs' infrastructure and systems. For example, in the case of NTD, many programs stopped operating (482). However, WASH health messages, used frequently as part of NTD prevention, could have been leveraged to mitigate COVID-19 risks (482). *Gravett and Marrazzo* highlighted that, like HIV and STI harm reduction approaches can be applied to COVID-19 as well (481). During the COVID pandemic, the WHO noted some successes within HIV services, where HIV testing and ART distribution continued in some areas due to existing infrastructure for community-level services (4).

In a COVID-19 era and for future pandemics, the findings of this thesis remain relevant and highlight a potential strength. One key theme from COVID-19 lessons learned was leveraging existing infrastructure and programs. HIV, NTD, and NCD services can and should be leveraged to address emerging public health threats like COVID-19, especially given that health outcomes worsened for many of the diseases combined with COVID. This further highlights why integrative services are important. Though this thesis does not measure health outcomes, it includes health education as a critical aspect of health prevention. Lack of awareness, knowledge, and misconceptions about diseases have affected health outcomes, progress in elimination programs, such as schistosomiasis, and increased risk. The health topics this thesis covers focus primarily on prevention, though many existing integrative services have focused on disease control and maintenance. In a hypothetical example, CVCT plus interventions in HTS could be a foundation for which other services could be added or vice versa. Looking at leveraging opportunities in light of COVID-19, CVCT, and health education components of these interventions could still be provided through community-level services. In addition, self-testing was also utilized during COVID-19. As Zambia also includes self-testing as part of HIV testing services for couples, counseling and testing could have continued as self-testing has to be done with couples. Some information in GHP for WASH and NTD prevention can also be applied to COVID-19. In addition, given the increased interest in NCD scientific research and clinical trial funding, particularly in diabetes research, as *Smith and authors* point out, another opportunity presents where HIV, diabetes, and COVID-19 can be covered integratively through health education. As pointed out in GHP, having one condition can increase the risk of another, such as the case of hypertension and diabetes for example. A key aspect of the materials used for this intervention is that they are living documents that can be adaptable to local context and prevailing public health priorities.

8.14 Contributions of thesis findings to literature

My thesis findings add to the literature of dyadic research on sexual communication using sexual agreements as a potential HIV prevention strategy with heterosexual CNC to reduce HIV risk factors. Findings showed couples were able to negotiate SA in a friendly, supportive environment at home. In addition, this thesis also shows how a couple-based intervention with enhanced health educational content on diarrheal/respiratory diseases, STH, schistosomiasis, hypertension, and diabetes resulted in significantly increased knowledge uptake, adoption, and maintenance of strategies to keep themselves and their families healthy. The thesis addresses gaps noted in the literature regarding the lack of studies on explicit sexual agreements in heterosexual couples. This study is unique because it focuses on CNC in SSA, who are rarely included in HIV interventions. Additionally, findings add to the literature in SSA that highlights a critical gap in knowledge on NCD and NTD. The interventions studied here should be cost-effective for most couples, though this thesis or study design did not include costing.

8.15 Areas of further research

8.15.1 Adolescents and young adults and men

In this thesis, 52% of couples (unpublished) had at least one female in the AGYW group. Future studies should include recruiting young couples, given this age group's increased risk for HIV. With young women being at the highest risk, incorporating communication skills about negotiating sexual agreements earlier in the relationship may be more impactful. Another potential area for exploration may be couples where men are 50+ years of age. Men in this age group have also been identified as a risk group for HIV due to intergenerational relationships with young women.

8.15.2 Relationship quality and dynamics

In terms of sexual agreements, this thesis did not explore relationship quality or dynamics and how this may affect how sexual agreements once established. Relationship dynamics have been explored more extensively in gender transformative studies and with MSM and SA. Thus, sexual agreements in heterosexual couples may be further enhanced if these areas are explored.

8.15.3 GBV and alcohol

Sexual agreements did not include content on GBV or alcohol. Future expansion of research in SA in heterosexual should explore this further. Especially as approximately one-third of women in Zambia experience some level of GBV or IPV in their lifetime (2), with alcohol use exacerbating this issue. GBV is also important as it represents power imbalance and inequalities within the relationship, which can elevate a woman's risk for HIV. However, the inclusion of GBV into sexual agreements should be further explored as literature has shown more men reporting less GBV than women.

8.15.4 Examining low adoption and waning of strategies

It was observed some strategies had low adoption and/or waned over time. Conducting smaller qualitative studies with couples may allude to reasons why this is, particularly in a context where spouses are reporting no challenges.

8.15.5 Barriers to implementation in CVCT

As these thesis findings will be incorporated into CVCT, it is important to identify barriers that may affect its implementation currently in Zambia. At current CVCT is in Zambia's national health policy; however, this has not translated into practice. My OPA research will further explore this aspect.

8.16 Policy relevance of research

Based on a review of GRZ documents, Zambia's focus appears to be the integration of services and collaboration between sectors to improve health outcomes. This thesis looks to integrate HIV, NCD, and NTD by focusing on couple sexual communication, health education and screenings, improving skills, and provision of commodities. SOV and previous studies on CVCT and couples family planning counseling showed that HIV, STI, and SRH services can be integrated. In addition, GRZ has recognized the impact and disease burden associated with schistosomiasis and other NTD and thus has included them as areas of focus in the NHSP (11). This thesis highlights NTD, as an important public health issue and includes health education, screening, and provision of commodities to tackle this issue. A review by *Muthuri and colleagues* noted that there was a lack of studies on awareness and health education of NCD in communities (486). This thesis only focused on knowledge and skills uptake, recommendation, adoption, and maintenance of strategies but not GHP-related biological markers as outcomes. However, *Mukanu and authors'* policy analysis of Zambia's Non-communicable Disease Strategic Health Plan (ZNCDSHP) 2013-2016 found that health education was not well utilized as a potential intervention (487). Like ZNCDSHP (200), GHP included most of the modifiable lifestyles reflected in that document. GHP showing improved knowledge and skills uptake can be a beneficial reference for GRZ in future planning. Thus, I believe this thesis and study findings are timely and can influence policy adoption and implementation related to HIV, NCD, and NTD prevention. However, a better understanding of how research or program findings translate to implementation, particularly for CVCT, will be important.

9. Overall discussion and conclusion

9.1 Overall Discussion

Overall, this thesis demonstrates that video-based interventions on HIV, NCD, and NTD are practical and feasible for couple-focused prevention strategies in clinic and resource-limited settings. CNC knowledge of NTD and NCD was initially limited; however, their knowledge substantially increased once couples received health education, health screenings, and commodities. This finding supports literature that highlights a knowledge gap on NTD (185) (384) (11) and NCD (386) in SSA. The substantial increases observed in NCD between baseline and post-intervention may further support Mukanu and authors' policy analysis of Zambia's NCD strategic health plan, where authors suggested health education was underutilized as a prevention strategy (487). Video was an ideal medium for delivering health prevention topics due to its uniformity in messaging, explanation of processes, imagery, and scenarios. The video format also keeps the facilitators engaged with pauses to discuss, demonstrate, and observe participants' practice. Complementary flipcharts were also used to keep talking points standardized. This thesis' findings highlight the potential of couples-based prevention strategies to improve sexual communication, knowledge uptake, adoption, and maintenance of HIV, NCD, and NTD prevention strategies with CVCT as its foundation. Though not covered in this thesis, Malama and authors highlighted how combining CVCT and family planning prevented HIV infections and unintended pregnancies in Zambian couples (273). Thus, the potential application for combining these strategies into one comprehensive package captures the essence of the United Nations SDG. Elements of SOV and GHP, like family planning, are currently present in the CVCT curriculum (205), which will facilitate integration efforts. Integrating these health topics addresses eight of seventeen United Nations Sustainable Development Goals (479). In addition, there may be indirect benefits to offering these integrated services. For example, the use of basic GHP post CVCT to increase HIV retesting rates post CVCT in couples (219).

Though outcomes for most parameters of this thesis were as expected, there are some caveats for consideration. These caveats will explore hypotheses with sample size estimate and power calculations, biases, imbalance of baseline covariates and tests of interaction, how HIV risk was assessed pre-trial, rationale for GHP with mixed components, possible dilution of treatment effects because of mixing of interventions, preconditions to trial participation, and quality studies within the CRT. In addition, implications for future research and practice and generalizability will be discussed.

9.2 Methods

9.2.1 Hypothesis testing with sample size estimation and power

In this thesis, three hypotheses were tested. However, for outcomes measured in thesis, significance testing was conducted using an alpha of 5% and power of 80%. For research hypothesis #1, SOV and GHP couples have no significant differences in sociodemographic, reproductive, and sexual behavioral/history characteristics at baseline. For research hypothesis #2, SOV men and women have no significant differences in how they communicate and negotiate their sexual agreements. Of note, comparisons of men's and women's reporting of communication and negotiation of sexual agreements included an additional 5% difference given the large sample size, with some statistically significant differences not being meaningful. For research hypothesis #3, the GHP will significantly increase knowledge uptake, adoption, and maintenance of NCD and NTD and their prevention strategies at post-intervention visits compared to baseline. For all three hypotheses, the null hypothesis will be testing under the assumption of no statistically significant differences. For the first null hypothesis, this thesis rejects the null hypothesis of no relationship as statistically significant differences were observed between SOV and GHP. However, this thesis fails to reject the null hypothesis for sexual behavior/history characteristics, as there were no statistically significant differences observed between arms. Of importance, many sexual behavior covariates are outcomes of interest (couple HIV risk factors) for the main CRT. In hypothesis #2, overall, this thesis fails to reject the null hypothesis as no statistically significant differences between men and women communicating and negotiating sexual agreements. For hypothesis #3, overall, this thesis rejects the null hypothesis as statistically significant increases were observed between baseline and post-intervention visits for uptake of knowledge and prevention strategies for NCD and NTD. Overall, the results for this thesis mostly aligned with the research hypothesis.

9.2.2 Biases

Besides social desirability and selection biases highlighted earlier in the thesis, other potential biases may influence the interpretation of thesis' findings. Strategies that likely mitigated these biases have been discussed as well. These biases include dilution bias, cross-contamination bias, bias in the concealment of intervention allocation, and detection bias.

9.2.2.1 Dilution bias

In dilution bias, discussions of health topics or repeated questions related to the outcome of interests indirectly stimulate behaviors being targeted by an intervention (488). Dilution bias may result in findings showing no effect. All CNC received posttest counseling as part of CVCT. Posttest counseling included simplified risk reduction strategies such as having only one sexual partner, using condoms with outside sexual contacts and spouses in the case of unprotected exposure, HIV testing with and knowing the HIV status of outside partners, and impaired decision-making due to alcohol use. Of note, many of these strategies are included in SOV's sexual agreements and outcomes of interests being measured. Though the main CRT's outcomes of interest are not part of this thesis', this may introduce some level of dilution bias. However, dilution bias may be mitigated as questions pertaining to the main CRT's outcomes of interest are spaced at 3, 6, and 60 months post-intervention. Some level of dilution bias due to CVCT is anticipated, given CVCT's impact in reducing HIV transmission in CNC. This thesis supports Rwanda Zambia Health Research Group's stance that offering CVCT to cohabiting married couples in generalized HIV epidemics is an ethical responsibility. Thus, couples' counseling and testing should be offered before or included within new HIV prevention interventions being studied. Of note, testing for HIV individually or together and having mutual disclosure of HIV results has been cited as key components to having negotiated sexual agreements (147). Within the SOV arm, dilution bias was likely mitigated. Formative work with CNC prior to the trial suggested that sexual agreements were not a social norm in Zambia. Additionally, questions were not asked about knowledge of and prior/current use of a sexual agreement at baseline. Including intervention components in procedures before administering the intervention was cautioned in one study as they might affect the study's ability to measure impact (330). In GHP, CNC may have received an introduction to basic GHP, which included simple messaging about NTD and NCD, as part of CVCT. However, dilution bias is believed to have been mitigated. Anecdotally while delivering basic GHP information, counselors observed that couples had limited knowledge of NTD and NCD. The GHP arm was expanded to incorporate all health topics in a video, to provide interactive demonstration and practice of strategies, and to provide all commodities at the same visit. In addition, for GHP, dilution bias was assessed as GHP and SOV were asked the same GHP questions at six months post-intervention. SOV served as a contemporaneous comparator to assess secular trends. The GHP arm showed substantial increases in knowledge uptake, adoption, and maintenance of prevention strategies for NCD and NTD compared to SOV.

9.2.2.2 Concealment of allocation bias

Allocation of concealment can potentially bias the treatment effect towards the null if the person performing randomization knows which study groups participants will be allocated to. The concern is that the person overseeing randomization may influence how participants are allocated to a study arm based on a participant's background or characteristics. Issues with concealment of allocation can result in selection bias (489). In this thesis, various strategies were used to minimize the staff member, who conducted randomization from knowing participants' intervention allocation. Firstly, the staff member was not involved in the recruitment and daily operations of the trial. Secondly, the staff member did not interact with the research counselors at the clinics who administered the intervention. Thirdly, the person performing randomization did not reside in Zambia.

9.2.2.3 Cross-contamination bias

Cross-contamination bias occurs when participant(s) from one arm receives the opposite arm's intervention. This bias can lead to difficulties in detecting true differences between arms. For the CRT, biometric identification using fingerprints was used to prevent co-enrollments. In addition, biometric verification was done to ensure the same enrolled couples were returning for their study visits. Anecdotally, 2-3 couples were identified as having attended opposite arms through biometrics. In addition to biometrics, data collection tools included a question about attendance at other clinics since the participant's last study visit. In both instances, the number of couples identified and reported to have attended a clinic in the opposite arm where they enrolled was very small. Thus, cross-contamination bias is likely negligible. Data with the affected couple IDs were removed from the analysis.

9.2.2.4 Detection bias

Detection bias occurs when research counselors and participants become aware of study hypotheses and know whether study arms are invention versus comparator or control.

To minimize detection bias, research counselors and couples were blinded to the knowledge of study hypotheses and which arm was intervention versus comparator. As consents and study visits and procedures, except for video content and questionnaires, were the same, it would be difficult to ascertain which arm was the intervention. At baseline, both arms used the same consent and questionnaire.

In addition, they did not know about the video content in the opposite arm. The participants' informed consent stated that they may receive health talks on one or more health topics but did not specify which ones. In addition, the health topics were broad and did not reveal any video content. Research counselors only trained and knew their clinic's arm intervention and questionnaires. CVCT counselors were not trained on the CRT and was only involved in prescreening. Furthermore, research counselors only attended trainings and meetings related to their clinic's arm assignment. As an added precaution, each study arm had a training or meeting on its own day. Oversight of research counselors were done by the main research site team at CFHRZ, who received extensive training only on the study arm they were assigned to support. In addition, most visits were done during the weekend when there was less services offered at the clinic.

9.2.3 Imbalance in baseline characteristics

An imbalance in sociodemographic and reproductive characteristics was found at baseline. Having imbalances of covariates at baseline may potentially affect the interpretation of results and validity of the trial. Various strategies can be used in CRT to minimize imbalance at baseline, such as randomization techniques, stratification, and matching. Matching was ideal for this CRT due to the small number of clusters (n=10). One possible reason for the observed imbalances of participants' baseline sociodemographic and reproductive characteristics may be due to matching done using HIV testing covariates. HIV testing covariates included couple serostatus distribution, number of couples tested, and couple follow-up testing rates in the previous year. A study by Austin and colleagues noted that some level of imbalance may be present for covariates not used to match clusters (490). Future studies should explore the inclusion of sociodemographic and reproductive in addition to HIV testing covariates when matching clusters. As matching was assumed successful, only unadjusted analysis was done formally and presented in research paper 1. Informally, however, baseline covariates were assessed for multicollinearity. Covariates not highly correlated were then modeled by a couple HIV risk factor covariate using GEE (unpublished) to assess whether there were differences in sociodemographic and reproductive covariates by couple HIV risk (Yes or No). Adjusted analysis revealed an imbalance for one baseline covariate, women's literacy in English. However, this covariate may be less relevant for imbalance as the main vernacular languages in Zambia are Nyanja and Bemba, which were balanced. Tests of interaction assess whether a relationship observed between two covariates depends on a third covariate. Regarding the covariates used in this thesis, there did not appear to be covariates that fit the definition criteria.

9.2.4 Assessment of HIV risk before trial participation

Other than HIV test results, no other HIV risk covariates were assessed for trial eligibility. At CVCT, no HIV behavioral risk factors were collected. In addition, this data is not available at the national level by catchment area. For this CRT, HIV risk was first assessed at baseline. The HIV risk factors assessed were collectively called the couple HIV risk factor composite. This covariate included self-reported outside sexual partners; condomless sex and alcohol use with outside partners; HIV testing with and knowledge of HIV status of outside partner; and treatment of STI.

Baseline analysis found that 24% of couples had at least one HIV risk factor. In addition, this was not statistically significant between arms. The level of risk calculated is sufficient to assess the overall impact of the intervention. To recruit higher risk couples, stricter screening criteria could be applied to include recent HIV risk. Of note, in research paper 2, authors cited a reason for the choice of monogamy might be due to past and not current HIV risk as couples had been cohabiting about 6 years. In addition, questions for baseline HIV risk was framed as since married. Anecdotally, in observational and clinical research with single women at high risk for HIV, recruitment targeted women with recent and multiple HIV risk factors. However, the recruitment of CNC with the highest HIV risk would likely increase the recruitment period, which has cost implications. An alternative approach would be to use catchment data on sexual behaviors if available. For this study, retrieval of HIV behavioral risk factors at the clinic or catchment area level would present challenges as data is typically packaged at the district, provincial, and national levels. In addition, clinic data is likely not collecting HIV behavioral risk data and may not be available by couple. While conducting an organizational and policy analysis to explore barriers to CVCT implementation in Zambia, inconsistencies were found in couple's definitions and indicators in the national documents (491). In addition, stakeholders provided mixed responses when discussing recording of couple-level HIV indicators (491). Of note, sexual behavioral and demographic health surveys data are conducted in Zambia periodically; however, only national reports, for the most part, have been available.

Of interest, approximately 52% of women participants in this thesis were 18-24 years of age (unpublished). This finding is important as young women in this age group are at high of HIV infection. To ensure recruitment of higher risk CNC, future studies with a budget may consider recruiting high-risk CNC with recent (within the past year) HIV risk.

9.2.5 Justification of the rationale for the use of a comparator arm (GHP) with many mixed components of NCD, NTD

For this CRT, a comparator arm of mixed components was chosen instead of the conventional control or HIV prevention standard of care. The decision to use GHP with mixed components originated from the organization's experience using a more simplified version of it at post-CVCT services to increase HIV retesting (219). The senior study team felt that having mixed components such as NCD and NTD was acceptable, given their public health importance in Zambia. In addition, the video group session included simple health education messages with videos, images, demonstrations, and practice. The use of mixed components may present a challenge of oversaturation, which may affect the retention of information. In GHP, mixed components were packaged and delivered under a central theme of everyone having an equal responsibility for their family's health. Commodities and health screening were provided to reinforce further the information learned. In addition, commodities allowed couples to have the tools to begin immediately implementing at home. Some health topics shared similar modifiable behaviors, such as WASH practices for preventing diarrhea and soil-transmitted helminths and healthy lifestyles for preventing hypertension and diabetes. Improvements in knowledge uptake, adoption, and maintenance of strategies highlight the overall success of using mixed components, though there are caveats for consideration.

At two weeks and six months post-intervention, knowledge uptake increased across many covariates, which was sustained. However, some covariates showed significant increases in knowledge between baseline and post-intervention, though most participants did not have increased knowledge for each response. This observation may suggest some level of dilution of treatment. To address this, future studies could add additional health education sessions. Interestingly, for health topics where commodities, such as water treatment, handwashing, deworming for family, and low sodium salt for cooking, were provided, adopting strategies was high and maintained. Areas that typically had lower adoption and maintenance were related to modifiable lifestyle behavior changes for hypertension and diabetes. Thus, the provision of commodities targeting those modifiable lifestyle behavior changes could be explored for future studies. Though not an issue in this study, caution should be taken when distributing common commodities to promote a health behavior being measured. If the commodity is commonly available to the public, it can indirectly contribute to contamination bias (488). Future studies should explore how culture, costs, and preferences may influence adoption of strategies.

9.2.6 Potential dilution of treatment effect due to mixing of interventions

Potential dilution of treatment has been cited (411) as a potential concern across study arms. One possible reason for dilution of treatment across arms may be study arms covering similar health topics. In this thesis, SOV and GHP covered entirely different topics; thus, prevention strategies to address diseases did not overlap. Another reason for potential dilution of treatment effect due to mixing of interventions may be positive behavioral changes, which may inadvertently change how a participant approaches health. Though this is possible, this scenario was likely mitigated through each arm's design. For instance, the methods that couples used to execute their arm's prevention strategies were different. For example, SOV was communication-focused focused, while GHP was implementation-focused. Thus, due to the differences in health topics, prevention strategies, and methods of execution, it is unlikely that participants would naturally begin adapting strategies used in the opposite arm. In addition, the study team informally monitored whether other health interventions were occurring within the catchment areas of the clinics.

9.2.7 Considerations for monogamy

Though an overwhelming majority of spouses selected a primary sexual agreement of monogamy, some caveats need further exploration. Approximately three-fourths of couples did not have a baseline couple HIV risk factor. This finding may suggest an existing monogamous marriage. The presence of a monogamy agreement at baseline was not asked to ensure that differences detected between arms could be attributed to the intervention. Not asking a baseline sexual agreement question was cited as a limitation in this thesis. An alternative reason, though not likely, for their overwhelming choice of monogamy for HIV prevention was societal and marital norms. The rationale for why this is not likely is three-fold. Firstly, monogamy agreements in heterosexual couples are likely mostly implicit. Secondly, most monogamy agreements are not likely focused on HIV and STI prevention. Thirdly, our formative work in focus groups and interviews of men and women of Zambian CNC highlighted the absence of sexual agreements and difficulties in discussing extramarital partners. These pre-trial findings suggest that couples enrolled in this CRT likely did not have explicit monogamy agreements for HIV prevention. A key part of SOV was communication and explicitly negotiating sexual agreements to protect against potential unprotected, extramarital sex. In addition, all spouses were encouraged to choose an alternative sexual agreement to protect their spouse in case of an unprotected, outside sexual encounter. This harm reduction approach provides a realistic and pragmatic solution, as 100% monogamy may not be possible for all participants. For SOV, all couples chose an alternative sexual agreement to abstain or use condoms with their spouse for 30 days until retested for HIV. In addition, negotiated sexual agreements are beneficial to all couples, whether they practice monogamy or not. For example, all couples could choose from primary sexual agreements other than monogamy, which included condom use with an outside partner and joint HIV testing with the outside partners to know HIV status.

CVCT encourages couples to start a dialogue on HIV prevention based on their mutually disclosed couple HIV results. SOV equips CNC to expand on this dialogue by discussing threats to HIV in their marriage and steps they will take to protect their marriage. In Zambia and much of SSA, the highest risk to CNC is unprotected, extramarital sex. Though having these discussions are important, SOV recognizes it may be challenging. The SOV intervention helps couples navigate this through viewing scenarios, discussing with counselors, and having discussions at home. Though low risk compared to serodiscordant couples, CNC are at risk for HIV as they live in areas with generalized HIV epidemics and make up half of all HIV infections in stable unions (6). Thus, if shown to be successful, SOV should be included in the HIV prevention tool kit. Having multiple options for couples are important to public health while empowering couples. Though SOV has not been officially costed, additional costs are anticipated to be low, given the recommendation to include it as an extension of CVCT, which has been shown to be cost-effective (18).

9.2.8 Preconditions to trial participation

One key precondition for couples participating in SOV and GHP is having undergone CVCT. CVCT serves as a solid foundation for couple-based prevention strategies. CVCT offers a safe environment for partners to disclose results and discuss the way forward with counselors. Discussions are catered per couple HIV result and include risk reduction counseling, family planning, and may include information on maintaining a healthy life (205). SOV and GHP require partners to work together towards a joint health goal. Though CVCT can be offered to any couple at any relationship stage, this thesis suggests SOV be offered to couples that have cohabited or been married for at least three months. In addition, couples in this thesis were recruited from provinces in Zambia considered non-polygamous. Couples were of reproductive age, 18-45 for women and 18-65 for men. Couples had to reside in the city for the study duration. For this CRT, couples could not be using antiretrovirals. In addition, couples had to indicate willingness to participate in the study, including attending study visits and doing study procedures. However, couples were free to decline study procedures or withdraw if they wanted. For this study, couples were biometrically identified and verified to prevent contamination.

9.2.9 Qualitative studies

Formative work for the CRT was done before CRT. That research identified themes from counselors and CNC, which shaped the intervention for SOV. The CRT study design is quantitative due to the number of participants. The multiple-choice format allowed for quantification of results. No additional qualitative research was performed in this thesis. However, qualitative studies are important as they can provide context into why specific observations are seen. Future studies should incorporate qualitative components in study design at key time points. The qualitative study could consist of interviews or focus groups. For SOV, key time points may be after negotiating their sexual agreements, when an agreement is broken, and trial exit or last visit. For GHP, important time points would be two weeks and six months post intervention and the trial exit/last visit.

In addition, this thesis recommends conducting qualitative studies during the formative phase of clinical trials. These studies should target beneficiaries and intervention administrators to inquire about their knowledge of a topic and whether an intervention is feasible or acceptable. In addition, the involvement of CAB could be beneficial as they understand the community in which the intervention will be conducted. This feedback allows for local adaptation of the intervention. In addition, the intervention and data collection tools should be pilot-tested before the study starts.

9.3 Summary of key thesis strengths and limitations

9.3.1 Strengths

A key strength of this thesis lies in its couple-focused approach. Couple-based prevention strategies as shown in this thesis not only benefited the couple but potentially their families. A second strength is the potential for integrating a prevention package that combines HIV, NCD, and NTD.

9.3.2 Limitations

A key limitation of the thesis was the imbalance observed in sociodemographic and reproductive characteristics between arms at baseline. Of importance, no imbalance was noted between arms on most sexual behavior/history characteristics. In addition, most baseline covariates were balanced when compared by presence of a couple HIV risk. Suggestions for future studies include matching covariates for sociodemographic and reproductive characteristics if available.

9.4 Implications for future research and practice

If shown to be effective, this thesis recommends that SOV and GHP be added to posttest counseling for CNC who have received CVCT. Introduction of SOV and GHP at post-test counseling is recommended as sexual agreement components are included in post-test counseling, and GHP was introduced at post-test counseling during CVCT implementation. The SOV frames these risk reduction messages into a couple-focused HIV prevention intervention, where both partners, individually and collectively, are encouraged to identify threats to maintaining an HIV-free marriage. Couples then choose and negotiate an agreement that fits their particular needs. SOV could be easily incorporated with other prevention strategies, such as VMMC, self-testing, PEP, and PrEP. These prevention strategies have been explored in African heterosexual couples and are included in couples' HIV testing guidance with serodiscordant couples (17, 280). In addition, anecdotally, referrals for VMMC services have been offered to all HIV-negative men as part of CVCT in Zambia. Currently, CNC are not considered a priority group for PrEP, given their low HIV incidence. LMIC and LIC countries may not have sufficient funding for therapeutic prevention strategies due to the costs, logistics, and infrastructure needed to maintain drug supply and monitoring. In high HIV prevalent areas, immediate prioritization for antiretroviral therapy treatment and prevention are typical for HIV patients, SDC, and other key populations. In addition, given current issues with targeting intended key populations for PrEP (492) in Zambia, priority for CNC is likely low. Most ART funding in Zambia has been subsidized or paid for by donor and funding agencies. Of note, some donors like PEPFAR have begun transitioning funding responsibilities of HIV programs to their country partners; however, this appears to be occurring in stages. It is not fully known if and when complete country-level sustainability of an HIV treatment and prevention program will occur. Given the cost implications of antiretrovirals as prevention, the inclusion of other non-biomedical prevention strategies will be critical.

Thus, SOV would be recommended as part of HIV prevention services to most cohabiting CNC couples in SSA where the HIV epidemic is generalized. Sexual agreements may be beneficial earlier in the relationship. The recommendation to offer SOV earlier in a couple's cohabiting or married relationship aligns with some senior-level stakeholders and CFHRZ staff working in HIV prevention, who suggested offering CVCT to premarital couples. This thesis does not recommend SOV for couples where GBV is suspected. GBV was not included as part of SOV and was cited as a limitation of this thesis. Several gender transformative studies have targeted GBV, but mostly at the community level. Long-term solutions are needed to address GBV in the communities and relationships so that the couples affected can receive the potential same benefit from CVCT and SOV as other couples. This thesis' recommendation related to GBV aligns with the concerns of a few stakeholders (491) and national (443) and international guidance (17) that cautions against offering CVCT to couples with a risk of GBV.

Outside of married, cohabiting CNC in generalized HIV epidemics, more studies are needed to explore the feasibility of SOV in non-generalized HIV epidemics, discordant couples, key populations, and non-cohabiting partners. Current HIV prevention efforts have focused on individuals and key populations in efforts to reach 95-95-95 SDG targets. However, the HIV prevention approach should be holistic, integrative, and inclusive of all groups at risk for HIV, which includes couples.

9.5 Generalizability

Approximately three-quarters of SOV couples reported no couple HIV risk factor. This data suggests that many SOV couples likely practice monogamy. Of note, this study was conducted in Lusaka and Copperbelt Provinces where polygyny practice is low (2). Thus, this thesis' findings are potentially generalizable to cohabiting, heterosexual CNC who underwent CVCT and live in non-polygynous provinces/areas of SSA countries considered to have a generalized HIV epidemic. In this thesis, almost all couples chose monogamy as their primary sexual agreement. Even where monogamy practices are common, this thesis' finding is important as these practices are likely not in the context of HIV prevention. Several reasons why monogamy should also be framed in the context of HIV prevention have been highlighted. In Zambia and many SSA countries, HIV prevalence remains high. This thesis suggests that the SOV intervention and GHP be repeated and adapted to fit the local population's needs and behaviors. Future study recommendations include possible research of SOV in areas where polygyny is practiced and where couples may not be cohabiting or married.

9.6 Implementation barriers to CVCT

If the SOV is effective, this thesis recommends that SOV and the expansion of GHP be included as part of CVCT. However, in Zambia, CVCT faces implementation challenges at the national level. A qualitative study was conducted to understand stakeholders' perceptions and knowledge of CVCT and discuss barriers and solutions to CVCT implementation in Zambia (491). In summary, this research highlighted several important findings. Overall, stakeholders knew key CVCT concepts, though their knowledge of HIV epidemiology was limited. In addition, there were misconceptions about the main sources of new HIV infections in Zambia, where most stakeholders noted key populations. Of note, the evidence of CVCT's impact was presented to stakeholders in motivational statements throughout the interview, which likely contributed to the majority of stakeholders allocating at least 5% of their hypothetical HIV budget for Zambia to CVCT. The 5% threshold is important as this was cited as the amount of annual PEPFAR budget needed to implement CVCT in Zambia (18). Stakeholders suggested where CVCT could be offered and solutions to barriers to CVCT in Zambia. Key barriers to implementation noted were lack of male involvement and dissemination of evidence. Of note, this study highlighted inconsistencies in couples' definitions and indicators and the waning of CVCT presence in the HIV strategic framework. However, couples' counseling and testing remain relevant in some national documents. Recommendations on potential next steps for CVCT implementation have been disseminated to the health regulatory authority, the host organization-CFHRZ, and stakeholders. The long-term success of SOV and GHP depends on CVCT implementation in Zambia. Given implementation issues with CVCT in Zambia, alternative delivery pathways for couples' counseling and testing, such as partner notification testing (493), may need to be explored. An executive summary has been provided to some senior- level HIV prevention stakeholders and the health authority. The summary includes key findings from this thesis in order to further strengthen the case for CVCT implementation in Zambia.

9.7 Key recommendations

Suggested recommendations for SOV and GHP are as follows:

1. Determine the status of CVCT implementation in Zambia
2. Dissemination of key preliminary thesis' findings to senior-level HIV prevention stakeholders through policy briefs
3. Update CVCT guidance to incorporate key findings from SOV and GHP

4. Cost-effective analysis of the interventions if feasible. Particular focus on the cost of an integrated package

9.8 Overall conclusion

In conclusion, this thesis demonstrates the feasibility of couples-based video sessions on improving communication, knowledge, and skills to prevent HIV, NCD, and NTD. Most hypotheses for the thesis were proven with couples communicating and negotiating sexual agreements in SOV and couples demonstrating increased and sustained knowledge uptake, adoption, and maintenance of prevention strategies on NTD and NCD covariates in GHP. The potential to offer integrated video-based prevention services for couples through CVCT appears reasonable, given the historical use of its components within the CVCT program. In addition, the added costs are anticipated to be minimal. However, implementation challenges of couples' counseling and testing programs may minimize SOV and GHP's full impact. Thus, alternative strategies to offer couples' counseling and testing may need to be explored.

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11. Supplement: Appendices

APPENDIX 11.1: Official publication for Research Paper 1 in *Contemporary Clinical Trials Communications*

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A cluster randomized trial to reduce HIV risk from outside partnerships in Zambian HIV-Negative couples using a novel behavioral intervention, "Strengthening Our Vows": Study protocol and baseline data

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ABSTRACT

Background: Heterosexual couples contribute to most new HIV infections in areas of generalized HIV epidemics in sub-Saharan Africa. After Couples' Voluntary HIV Counseling and Testing (CVCT), heterosexual concordant HIV negative couples (CNC) in cohabiting unions contribute to approximately 47% of residual new infections in couples. These infections are attributed to concurrent sexual partners, a key driver of the HIV epidemic in Zambia.

Methods/design: Ten Zambian government clinics in two of the largest cities were randomized in matched pairs to a Strengthening Our Vows (SOV) intervention or a Good Health Package (GHP) comparison arm. SOV addressed preventing HIV infection from concurrent partners and protecting spouses after exposures outside the relationship. GHP focused on handwashing; water chlorination; household deworming; and screening for hypertension, diabetes and schistosomiasis. CNC were referred from CVCT services in government clinics. Follow-up includes post-intervention questionnaires and outcome assessments through 60 months. Longitudinal outcomes of interest include self-report and laboratory markers of condomless sex with outside partners and reported sexual agreements. We present baseline characteristics and factors associated with study arm and reported risk using descriptive statistics.

Results: The mean age of men was 32 and 26 for women. On average, couples cohabited for 6 years and had 2 children. Baseline analyses demonstrated some failures of randomization by study arm which will be considered in future primary analyses of longitudinal data. An HIV/STI risk factor composite was not different in the two study arms. Almost one-quarter of couples had an HIV risk factor at baseline.

Discussion: In preparation for future biomedical and behavioral interventions in sub-Saharan Africa, it is critical to understand and decrease HIV risk within CNC.

1. Introduction

Most incident HIV infections in sub-Saharan Africa (SSA) occur in cohabiting heterosexual couples, including discordant and concordant HIV negative (HIV-) couples [1,2]. Couples' Voluntary Counseling and Testing (CVCT) was developed by CDC [3] in collaboration with the Rwanda Zambia HIV Research Group and endorsed by WHO for HIV prevention in 2012 [4]. In Zambia, a demonstration project in 73 government health centers provided CVCT to 207,428 couples of whom 13% were concordant HIV+, 8% were discordant (DC), and 79% were concordant negative couples (CNC). CVCT reduced transmission in both DC and CNC. Though the DC remained at comparatively higher risk (1.78/100 Couple-Years HIV incidence after CVCT + condoms + ART)

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Abbreviations

ART	Anti-Retroviral Treatment
CAB	Community Advisory Board
CAS	Condomless Anal Sex
CDC	Centers for Disease Control and Prevention
CFHRZ	Center for Family Health Research in Zambia
CVCT	Couples' HIV Voluntary Counseling and Testing
CNC	Concordant HIV-negative couples
DHS	Demographic Health Survey
GHP	Good Health Package
MSM	men who have sex with men
PrEP	Pre-Exposure Prophylaxis
RPR	Rapid Plasma Reagin
STI	Sexually Transmitted Infections
SOV	Strengthening Our Vows
SSA	sub-Saharan Africa
V0–V5	Visit 1-Visit 5
WHO	World Health Organization

than the CNC (0.53/100 CY), the CNC were a much larger percentage of all couples. As a result, 47% of the new infections that occurred after CVCT were in CNC and 53% were in DC [5].

Having multiple and concurrent partners results in extended sexual networks which increases opportunities for HIV transmission [6,7], and multiple, concurrent partnerships are one of the key drivers of the Zambian HIV epidemic [8]. In Zambia's 2013-2014 Demographic Health Survey (DHS), approximately 20% of men and 1% of women who are married/cohabiting report having two or more partners in the past 12 months [9]. This is similar to literature from other countries that show men report more multiple and concurrent partners than women [10,11]. Couples-based HIV interventions tailored for CNCs could enhance the impact of CVCT to further reduce HIV risk in this group.

Other prevention modalities, like pre-exposure prophylaxis (PrEP), have been shown to reduce HIV transmission. However, PrEP implementation has been slow due to costs, clinic capacity, communication and awareness, supplies, and access [5,12]. Additionally, from the end-user perspective, drug adherence, access, side effects, stigma, and perceptions of safety and effectiveness pose challenges to uptake [13, 14]. In Zambia, given the low incidence of HIV following CVCT [5], CNC do not qualify for PrEP based on WHO Guidelines.

Previous work with negotiated agreements in western couples provided the template for our work. Much of this work was done with men who have sex with men (MSM) couples, in whom the majority of new infections are also acquired from a main partner [15–17]. Gass et al. found that MSM were more likely to have condomless anal sex (CAS) with the main partner [18]. In 1999, Crawford et al. reported that when sexual partners engage in negotiated safety agreements, they usually did not practice unsafe sex [19]. In 2001, the same group interviewed MSM with regular partners and found a variety of agreements including negotiated safety (29%); no CAS (34%); and unsafe sex (11%) [20]. Kippax et al. published similar findings from the pre-HAART era, with 91% of concordant HIV- men reporting no outside CAS with use of a negotiated agreement in 82% [21,22]. A 2014 longitudinal study by Darbes et al. found that higher investment in sexual agreement and communication were among the factors that significantly predicted less CAS with outside partners for seroconcordant MSM couples [23]. Hoff et al. and Gomez et al. have assessed predictors of broken agreements [24] and the effects of relationship characteristics and serostatus differences on sexual agreements in MSM couples [24–26]. Mitchell et al. explored the influence of substance use on adherence to sexual agreements among MSM [27]. Stephenson et al. found that partnered HIV-MSM were less likely to seek regular HIV testing compared with MSM in an open relationship [28]. In a 2015 qualitative study of heterosexual clients attending Sexually Transmitted Infections (STI) services in the US, Stephenson et al. showed high levels of willingness to be jointly tested and counseled for HIV and to discuss sexual agreements [29].

We developed the Strengthening Our Vows (SOV) intervention to reduce HIV risk among Zambian CNC through modeling and supporting negotiation for sexual agreements between husband and wife. This intervention is relevant and timely as couple-based strategies may be more impactful than individually focused approaches in reducing sexual risk behaviors but no study has yet evaluated sexual agreements in heterosexual African couples [30–32]. In this randomized trial, we include a comparator arm with an intervention focused on neglected tropical and non-communicable diseases, in keeping with UN Development goals [33].

2. Methods

2.1. Pre-trial planning

2.1.1. Focus groups and interviews

The pre-pilot and pilot phases for developing SOV were conducted from 2011-2014. We present the summary of the phases in Table 1. Focus groups and individual interviews were conducted with convenience samples of heterosexual CNC, CNC in which one or both partners had become HIV infected due to exposure outside the relationship, and CVCT counselors. All participants provided written informed consent. Focus groups with couples were sex-separated with facilitators and note takers of the same gender as participants to encourage candid discussions on concurrent partners and relationship agreement in the context of HIV prevention. These trained facilitators and note takers were senior counselors, who spoke the local languages Nyanja and Bemba, and had extensive training and experience in CVCT and conducting focus groups and interviews. Focus groups with couples were done in a local language while focus groups with CVCT counselors included both men and women and were conducted in English. Focus group sessions were audio recorded but not transcribed verbatim. Rather, recordings were reviewed later and compared against notes to ensure accuracy of thematic identification. Interviews were conducted with each spouse separately in the local language and were not recorded.

Focus groups and interviews typically lasted from 30 to 60 min. At end of each session, study staff met, reviewed the participants' responses, and noted repeating themes. Recruitment for focus groups concluded when saturation of themes was reached. The purpose of the formative work was to discuss counselor's experiences managing concurrent partners during CVCT; highlight couples and counselors' perceptions of negotiated sexual agreements as an HIV prevention strategy; determine feasibility and acceptability of sexual agreements for CNC; identify threats in a union that might lead to a potential HIV exposure from concurrent partners; explore issues that may impact facilitating sexual agreements with CNC; and develop a pragmatic behavioral intervention to guide couples on taking preventative actions to protect their marriage from HIV exposure from outside partners.

From the pre-pilot phase, we identified key considerations and themes such as discussing hypothetical concurrent partners in the abstract during counseling; not disclosing outside partners without spouse's permission; providing discrete referrals for CVCT with outside partners; ensuring gender balance when discussing threats that lead to HIV exposure; and ensuring neutrality and confidentiality throughout counseling. Important messages highlighted by participants included an emphasis on the window period between exposure and seroconversion during which individuals are very contagious, and alternatives to monogamy including testing with outside partners prior to sex and using condoms during all outside sexual contacts. Interviews with men and women of seroconverted CNC highlighted threats that might lead to potential HIV exposure outside the relationship such as traveling, the desire for extra money and goods, post-partum abstinence, discord

Table 1
Phases of formative work for strengthening our vows.

Phase	Time frame	Participants	Facilitated by	Topics	Key Considerations/Themes for Intervention/ Activities
Pre-Pilot					
FGD	Dec 2011–May 2013	CVCT Counselors in GRZ clinics, 11 sessions, 29 M, 91 F and 13 sex not indicated	CFHRZ counselors	Frequency of discussions on concurrent partnerships during CVCT, counseling couples on concurrent sexual partners, and developing concurrent partner modules	•Counseling couples on scenarios for risk reduction and concurrent partners using abstract examples •Ensuring the intervention allows for opportunities for spouses who want to disclose outside partnerships with spouse and faciliate testing at CVCT with those outside partners •Ensuring counseling messaging targets HIV prevention and concurrent partnerships equally between men and women as it is sometimes assumed that only men are involved in extramarital affairs •Ensuring counselors do not interject their personal opinions or judgements into the counseling sessions •Training counselors on concurrent partnerships to ensure they are comfortable with the messages •Providing additional training to counselors to ensure confidentiality and disclosure with individuals/couples in context of multiple concurrent partners
IDI	Jan 2012–Feb 2012	HIV Concordant Negative Couples, 4 M and 3 F	CFHRZ nurse counselors/ physicians	Initial feedback on whether couples would want to discuss outside partners	•Initial interviews showed couples seemed to be open to discussing outside partners
FGD	Jul 2012–Jun 2013	HIV Concordant Negative Couples, 16 sessions, 31 M and 31 F	gender-matched counselors (CFHRZ and GRZ)	Discussion with spouse about outside partners, relationship contracts, benefits and disadvantages of discussing outside partners with spouse, how they would like counselor to bring up outside partners during counseling, how concurrent partners impact HIV transmission, how can we better facilitate this, what are the top 3 things you would like included if you created your own contract	•Partners open to having concurrent partners discussed during counseling •Preferences to discussing concurrent partners using abstract examples • Ensuring discreteness when testing with outside partners at the clinics; no special procedures • Counseling should encourage disclosure only if partner wants to • Partners were open to their spouses protecting them and testing with outside partners but may not want to know themselves • Couples generally supporting the concept of relationship contracts as it set limits and helps to maintain relationship • Partners stating that though concurrent partners exist it is not a social norm • Discussing concurrent partnerships could help someone realize their HIV risk • Ensuring confidentiality • Emphasizing counseling should not focus on blame but risk reduction and protecting spouse
IDI	Feb 2014–Apr 2014	7 HIV seroconvertors[a] and 3 spouses, 5 M and 5 F	CFHRZ nurse counselors/ physicians	CVCT knowledge, impact of testing program on the couple, threats to avoiding exposure to HIV, coping with situation, advice/recommendations to friends in simular situation	• Emphasis on window period as participants seemed surprise of themselves or spouse becoming infected in a short period of time 1–2 months • Threats that led to partner seroconversion: traveling spouse; desire for extra money, goods; desire to be paid attention to; taking spouse for granted • Testing with outside partners together is important before engaging in sex; one should not take verbal indication of being test to be truth. •If outside partner refuses to test, use condoms
Pilot					
FGD @ V1	Feb 2014–Mar 2014	HIV Concordant Negative Couples, 8 sessions, 30 M and 30 F	gender-matched counselors (CFHRZ and GRZ)	Piloting "Strengthening Our Vows" Intervention	•Developing intervention visit length and logistic planning for the visit •Conducting mock intervention •Identifying potential threats to remaining HIV free: lack of money or goods; traveling for work; dissatisfaction with spouse; peer and family influence; and alcohol use

(continued on next page)

Table 1 (*continued*)

Phase	Time frame	Participants	Facilitated by	Topics	Key Considerations/Themes for Intervention/ Activities
FUP IDI @ V2	Mar 2014	HIV Concordant Negative Couples, 18 M and 17 F	CFHRZ and GRZ counselors	Piloting post-intervention questionnaire	•Receiving feedback from the CFHRZ counselors on intervention guide after pilot focus groups •Incorporating strategies to communicate risk non-verbally; introduction of yellow card as a non-verbal communication cue •Introducing CFHRZ team to draft post intervention questionnaire •Administering post intervention questionnaires in an open-ended format until saturation of responses reached •Assessing comprehension, comfort, timing of post-intervention questionnaires •Receiving feedback from the CFHRZ counselors on the post intervention visit flow •Refining questionnaire based on counselor feedback and couple responses

Abbreviations: CFHRZ, Center for Family Health Research in Zambia; FGD, focus group discussions; GRZ, Government Republic of Zambia; IDI, in-depth interviews; M, male; F, female.

[a] 1 concordant negative HIV couple where both spouses seroconverted.

within the marriage, and inattentive spouses. Some participants mentioned that, as long as their spouse protected them from HIV, they did not need to know the details of their outside sexual contacts. These findings were incorporated into the intervention and open-ended, post-intervention questionnaire that would be used during the pilot phase with CNC. During the pilot phase, staff were trained on the draft tools. We performed mock intervention and post intervention visits with CNC to assess visit flow, length of visit, and further refined the questionnaire based on responses from couples and feedback from counselors. During this period, identifying potential threats to remaining HIV free and using a non-verbal communication cue were further explored and incorporated into the intervention and post-intervention questionnaire.

The construct of the questionnaires used to assess the impact on SOV was based on our 27 years of experience on sexual behavior in cohabiting Zambian heterosexual couples. These questionnaires were consistent with our previous work with regard to measurement of standard behavioral outcomes, such as outside partners, condom use, alcohol use, joint testing and self-reported STI treatment.

2.1.2. Intervention and comparator content

The intervention and comparator arm materials included client videos and complementary counselor flip charts. The structure of the video and flip chart aligned in terms of headings, pause points, and content covered; the flip chart provided counselor structure to highlight key important points during pauses. This was done through group brainstorming as well as questions and answers. All materials were translated into local languages, Bemba and Nyanja and content was equivalent to or below 8th grade level. Video run-time for each arm was approximately 1 h. We present the intervention content in Table 2.

The SOV video was structured in two segments and included the HIV prevention agreements within the plans: "Together HIV Free" and "Protecting My Spouse" with guidance to finalize the plan in "Making Your Plan." The first segment included the same content presented separately to men only and women only groups. "Together HIV Free" focused on keeping HIV from entering the marriage by 1) not having sexual partners outside of the relationship, 2) testing jointly with outside partners and only having sex with those who are also HIV-, and/or 3) using condoms every time with an outside partner [34,35]. "Protecting My Spouse" discussed ways to avoid passing the virus on in the event of an unprotected sexual exposure to an outside partner with HIV + or unknown HIV status and included 1) abstaining from sex with the spouse or 2) using condoms consistently with the spouse until HIV retest after the "window period" of 30 days. The "window period" was emphasized in the video as a particularly infectious period prior to development of anti-HIV antibodies.

For the second segment, husbands and wives were brought together into one group to view and discuss six scripted video scenarios depicting hypothetical couples with various risk factors identified from the formative research. Each video scenario highlighted different potential threats to remaining HIV free including longstanding outside partners ("old boyfriends/girlfriends"); traveling and working away from home; alcohol use [36–38]; receipt of attention, money and gifts; and sexual inactivity due to wife's postpartum abstinence and menstruation. The creation of the scenarios was guided by the harm reduction approach where potential real-life threats to remaining HIV free are acted out and couples discussed and used various strategies from "Together HIV Free" and "Protecting My Spouse" to prevent HIV from entering the union. There were pauses in the video after each scenario for counselors to use the flip chart for further discussion of the HIV risk the couples in each scenario faced; what actions could reduce risk of HIV; and what couples could agree to do to prevent HIV in the future. The video also featured communicating the need for using "Protecting My Spouse" and included tips on how to deal with difficult communication and disclosure. An alternative and unique concept for communicating the need to use the "Protecting My Spouse" plan was the "yellow card", a visual cue derived from soccer, to signify a non-verbal signal to the spouse about a potential HIV exposure and need for caution. The familiarity and understanding of the use of the yellow card in soccer made it a neutral tool for men and women to use given the sport's popularity in Zambia. The yellow card, which all intervention couples received, was used in scenarios to illustrate how the card can be used to indicate the need to have a conversation about a potential HIV exposure and need for an alternative/interim plan to ensure protection from HIV within the relationship. The final part of the video, "Making Your Plan", asked couples to discuss risk reduction plans together and return in one to two weeks for a counseling session to finalize their agreement and 'take their vows'. Vows were an opportunity for the couple to discuss and identify their mutual agreement and commitment to keeping each other HIV free and to provide both partners with an opportunity to verbally communicate directly to their partner regarding their agreement and commitment.

Flip chart-based GHP had been previously developed for use at government clinics to improve follow-up testing rates after CVCT [39] and covered education, prevention and screening of diarrheal diseases, intestinal helminths, hypertension, diabetes, and schistosomiasis. The diseases were chosen as they are common health issues in Zambia in addition to being a simple, low cost service that could be easily integrated into CVCT. For this study, we further expanded GHP to include

Table 2
Intervention content.

Visit	Video segments	SOV arm	GHP arm
V01	Part 1	Watch 1 h SOV intervention video	Watch 1 h GHP comparator video
		Separate into men and women groups; facilitated by same sex counselor using a complimentary flipchart to the video	Separate into men and women groups; facilitated by same sex counselor using a complimentary flipchart to the video
		"Together HIV Free" plan	"Everyone has an equal responsibility in keeping our family healthy"
		Be monogamous and only have sex with your spouse	Importance of household roles in maintaining good household health
		Always use a condom with outside partners and/or	Health education (risk groups; information on transmission and mechanism of action; signs and symptoms) for Diarrhea and Worms, hypertension, diabetes, and schistomiasis were covered.
		Only have sex with outside partners if you have tested with those partners and you know that they are also HIV-	Modifiable lifestyle choices for prevention of hypertension and diabetes were emphasized
		"Protecting My Spouse" plan	Illustration of portion control with salt and sugar measurements
		Abstain/NOT have sex or use condoms with their spouse until HIV retest in 1 month after the potential exposure	Proper Handwashing technique with practical
		If continuing to have sex with other partner(s)also	Water chlorination 5L and 20 L with practical
		Test for HIV as a couple with that other partner(s). Some couples test for HIV with their spouse and their boy/girlfriend at the same time	Health screenings hypertension, diabetes and schistosomiasis
		Abstain from sex or use condoms with the other partner until they know that partner's HIV status	Barriers to implementing GHP
		Consider ending the relationship with the boyfriend or girlfriend.	
	Part 2	Couples All Together	Couples All Together
		Six scripted scenarios covering potential threats to remaining HIV free:	Game: GHP review (mini-quiz (6 questions)) non-graded
		Longstanding outside partners; traveling and working away from home; alcohol use; receipt of attention, money and gifts; and sexual inactivity due to wife's postpartum abstinence and menstruation	Couples talked about what the phrase "Everyone has an equal responsibility in keeping our family healthy" meant to them
			Receipt of commodities: low sodium salt, deworming pills for family, chlorine and hand soap
			Treatment and referral for any abnormal result
		"Making Your Plan" 3-way agreement	3-way agreement Each of you commits to keeping yourself and your household healthy
		Each person commits to keeping yourself and your spouse HIV free	Counselors commit to help you achieve this goal
		Counselors commit to helping you achieve this goal	The success of implementing these strategies is ultimately your responsibility as individuals and as a family.
		The ultimate responsibility of this agreement lies with you individually as well as a couple	
		Not assigning blame if a partner makes a mistake, but trying to focus on the original agreement from today of keeping HIV out of the marriage	
		Couples asked to agree that if someone makes a mistake, they will put the health of one another first. After that, you can also discuss how to minimize future threats. Can you agree to that?	
		Encourage coupled to go home and discuss and decide on plans together	Encouraged couples to go home and think about keeping a healthy household, keep this key message in mind: "Everyone has an equal responsibility in keeping our family healthy"
		Couples given yellow card	
V05	Part 1	All couples watch GHP video for 1 h	All couples watch SOV video for 1 h

more health education content on each of the diseases; practicum for handwashing and water treatment with chlorine; and barriers to applying GHP at home. Pauses were incorporated throughout the video in key areas to cover flip chart talking points and allow for questions. Similar to SOV, GHP had two segments, with couples being separated into groups of men only and women only in the first segment and being brought back together in the second segment. The first segment opened with the theme "Everyone has an equal responsibility in keeping our family healthy" and covered each health topic; risk groups; information on transmission and mechanism of action; signs and symptoms; key facts and statistics; and prevention strategies. Modifiable lifestyle choices related to diet, salt intake and physical activity were emphasized for prevention of hypertension and diabetes. Schistosomiasis education highlighted how freshwater areas within a city could be potentially infected as a recent study had shown active infection in 10% of Lusaka adults [40]. Pauses in the video also allowed counselors to demonstrate and for participants to practice proper handwashing techniques, preparation of potable water by measuring chlorine for 5L and 20L containers, and portion size of salt and sugar. The second segment consisted of mini quiz game where couples were asked about content covered and practiced preparing chlorinated water and handwashing. This segment closed with couples talking about what the theme "Everyone has an equal responsibility in keeping our family healthy" meant to them. Participants were provided with a bottle of chlorine, hand soap and deworming pills for the family to take home.

2.1.3. Rationale for the comparator

The comparator GHP was designed to be unrelated to HIV but to include a similar format (videos and group discussions) and to require a similar amount of time with beneficial health messaging unrelated to HIV, STI or sexual behavior. All couples received CVCT prior to joining the study. Post-test counseling in CVCT covered HIV risk reduction strategies with basic messaging on monogamy, alcohol awareness, condom use with outside partners, and repeat HIV testing if exposed. The GHP arm was family focused while SOV was couple focused.

2.2. Study objectives

This trial has primary and secondary objectives related to both the intervention, Strengthening Our Vows, and the comparator, Good Health Package.

2.2.1. Primary objectives

1. Compare the impact of 'Strengthening our Vows' (SOV) negotiated sexual agreement intervention versus a comparison arm on reduction in a composite of HIV risk factors from concurrent partners. The HIV risk factors include incident HIV and sexually transmitted infections (STIs) diagnosed and by self-report of outside treatment as well as self-report of outside partners, condom and alcohol use during sex with outside partners, knowledge of outside partner HIV status, and joint HIV testing with outside partners
2. Describe the types of risk couples report for acquisition of HIV in the marriage and the HIV prevention agreements SOV couples develop to reduce those risks
3. In the comparison arm that receives a "Good Health Practices" (GHP) intervention focusing on prevention of neglected tropical and non-communicable diseases, measure improvement in knowledge of

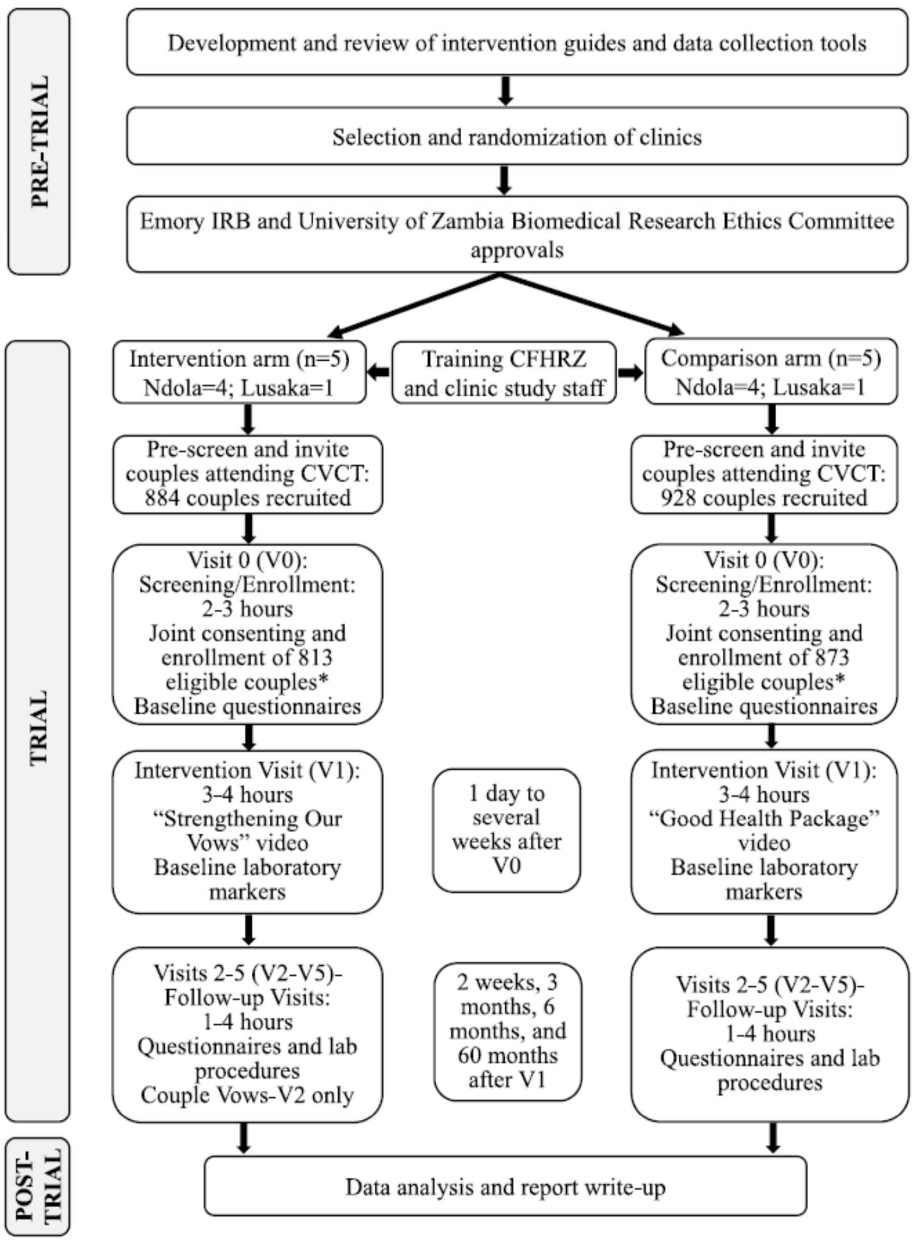

Fig. 1. *Reasons for exclusion (couples may be excluded for multiple reasons): not CNC (8); age (23); not available for follow-up (21); cohabiting <3 months (20); not willing to participate (14); not willing to provide contact information (5); unable to understand study (1); false couple (23); did not return for enrollment (16); outside acceptable window for enroll (6); impairment (2); co-enrolled (3); unknown (3).

prevention and treatment of diarrheal and respiratory diseases, intestinal helminths, hypertension, diabetes, and schistosomiasis

2.2.2. Secondary objectives

1. Assess the ability of an e-fingerprinting system to enhance follow-up and detection of study outcomes, multiple enrollments and potential spillover effect
2. Disseminate and incorporate successful strategies learned from the SOV and GHP into current CVCT and Couples' Family Planning Counseling guidelines

2.3. Ethics

Approval for this trial has been granted by the OHRP-registered University of Zambia Biomedical Regulatory Ethics Committee and Emory University Institutional Review Board. This trial is registered at the US National Institutes of Health (ClinicalTrials.gov) as NCT02744586. Couples viewed a verbatim reading of the informed consent on a video, met with a counselor to discuss any questions or clarifications, and jointly signed consent. A unique alphanumeric ID was implemented for all data gathering tools. Locator information was stored separately from data to maintain privacy and confidentiality. As stated in the informed consent, couples may withdraw from the study at any time without losing their entitled benefits. The study involves some risks and discomforts, such as blood draws, answering personal questions, and discussions at home related to study topics. Participants may opt out of questions or discussions if they are not comfortable and can seek additional counseling at the clinic, individually or with their spouse. Information a spouse provides individually is confidential and is only disclosed to the spouse with explicit permission. Initial and ongoing training and supervision of the study team is conducted to mitigate risk.

2.4. Community advisory board (CAB)

Before the beginning of the trial, the study team engaged the CABs in Lusaka and Ndola to review protocol, informed consents and discuss recruitment. The CAB has representation from media; education; health; faith-based institutions; law enforcement, young adults; community leaders; people living with HIV; as well as at-risk HIV populations. The CAB continues to be updated throughout the trial on study progress. At each meeting, a light lunch and an honorarium are given.

2.5. Trial design overview

We illustrate the trial design and procedures in Fig. 1. This is a clinic-randomized trial among CNC. We selected government health clinics as the unit of randomization since the intervention is provided in a group setting. Clinics in matched dyads were randomly assigned to either intervention or comparison arm via a coin toss. Eligible couples attending their neighborhood clinics automatically received the arm assignment for the clinic. At the final visit, the alternative intervention is offered so that participants can benefit from both interventions.

2.6. Clinic selection and randomization

The cluster randomized trial comprises urban, government health clinics in Ndola and Lusaka Zambia which provided Couples' HIV Voluntary Counseling Testing (CVCT) services in collaboration with the Center for Family Health Research in Zambia (CFHRZ). Of 55 clinics offering CVCT, 10 clinics were selected based on urban location (catchment population of 10,000–145,000 people) from "The 2012 List of Health Facilities in Zambia" preliminary report (Republic of Zambia Ministry of Health, 2012). The first selection criteria were that the clinics be far enough apart to have low risk of spillover and that in the aggregate they have the volume of CVCT that would ensure recruitment of a sufficient number of couples for the trial.

To detect possible patient spillover due to bus routes and walking trails not reflected on maps, the study team and drivers mapped transport routes to high-volume clinics and checked with clinic staff about their clientele to ensure that chances of spillover would be low. Clinics were then matched by clinic volume (number of couples tested), distribution of couple HIV serostatus, and follow-up testing rates in the year following CVCT [39]. The five dyads were randomized via coin toss by an unbiased staff member not directly involved with the clinics. Coin toss was done for the first clinic in each dyad. The second clinic in the dyad received the opposite arm by default.

2.7. Study population

Couples who received CVCT services at the clinics in Ndola ($n = 8$) and Lusaka ($n = 2$) were pre-screened. Those meeting initial eligibility at pre-screen were invited for screening, enrollment, receipt of SOV intervention/GHP comparator, and follow-up.

2.8. Trial procedures

Trial procedures are outlined in Fig. 1: Trial Design and Procedures. Trial procedures for couples include a baseline visit (V0), intervention visit (V1) and four post-intervention visits (V2–V5).

2.8.1. Staff training and quality assurance

As in our past training programs, we administered pre and post-didactic training tests [41] to select government clinic nurses and counselors who worked with us on CVCT. The purpose of the pre and post tests were to identify knowledge gaps and assess knowledge uptake after training. The trainees for this study were selected by our team based on their experience and performance with the CVCT program. Trainees who passed the didactic test proceeded to practicums observed by trainers and including obtaining informed consent, leading the video group discussion, and administering questionnaires. The flip chart provided to the counselor for use during video sessions included explicit instructions to ensure that important topics were emphasized during Q and A and were consistently delivered over time. It is traditional in Zambia for counselors and nurses to use "call and response" [42] when doing health talks in the clinics, which is an excellent way to ensure audience participation and comprehension. Each clinic was staffed by a senior research nurse who provided ongoing monitoring and mentorship to ensure fidelity to the study procedures. In addition, "mystery couples" [43] were selected from among community health workers who had collaborated with the research team for many years. They were trained on checklists of procedures to pay attention to and interviewed by study trainers after each visit. Their feedback was relayed to the research nurse for inclusion in oversight duties.

2.8.2. Study reimbursement

At each visit, couples receive study reimbursement to cover time at clinic and transport, as described in the informed consent. Reimbursement is 30 kwacha (approximately 3 USD) per person. An additional 20 kwacha (approximately 2 USD) per person is given as a lunch allowance for longer study visits.

2.8.3. Pre-screening at CVCT

At CVCT services in government health centers, couples underwent pre-test counseling, HIV rapid testing per national guidelines adapted for couples (screening with HIV with Alere Determine HIV1/2 and confirmation with either Trinity Biotech Uni-Gold HIV or Standard Diagnostics (SD) Bioline HIV-1/2 3.0), and post-test counseling provided by government counselors. Couples received HIV results together and were counseled per their couple HIV status according to CDC and WHO guidelines [3,4]. Each couple was given a unique couple ID during CVCT, which they maintained throughout the trial. Eligible and interested couples were referred for additional screening procedures.

2.8.4. Visit 0 (V0): screening and enrollment

2.8.4.1. Screening. Screening and enrollment procedures based on Inclusion and Exclusion Criteria, Table 3 occurred on Saturday or Sunday when the clinics were less busy and group activities could be conducted without disruption to regular clinic flow. This visit lasted 2–3 h. Participants were given a membership card recording their study ID, appointment dates, and fingerprints.

2.8.4.2. Enrollment. A baseline questionnaire was administered to each spouse separately by a gender-matched counselor and included socio-demographic characteristics (income, number of persons/children in the household and literacy) and past and recent sexual history questions were asked related to HIV risk behaviors, such as age at sexual debut, number of lifetime sexual partners, frequency of sex with spouse, outside partners since married, condom use with outside partners, alcohol use during sex with outside partners and ever being treated for an STI. In addition, to measure unrelated outcomes addressed in the comparator arm, participants were asked about roles in the household for daily activities (collecting and treating water, preparing and purchasing food, taking care of sick persons, changing baby's nappy, washing dishes and handling animals). Spouses were also asked about knowledge and behavior related to communicable and non-communicable diseases addressed in the GHP comparison program. Couples consented to storage of blood, urine and vaginal swab samples.

2.8.5. Visit 1 (V1): intervention visit

Participants were scheduled for the intervention one or two weekends after enrollment. Testing for HIV was repeated as described above in CVCT in addition to syphilis testing with SD Syphilis 3.0 Bioline and microscopic exam of wet mount for detection of vaginal trichomoniasis. Quality control testing was performed at our research laboratories with wet mount microscopy for vaginal trichomoniasis and IMMUNOTREP RPR® by Omega Diagnostics for syphilis. While laboratory tests were underway, couples in both intervention and comparison arms attended their arm specific video group sessions. The content and format of the videos and discussions is presented above. Participants with positive syphilis tests were provided with treatment at no cost. This visit lasted 3–4 h.

2.8.5.1. Intervention arm: Strengthening Our Vows (SOV). At the end of the visit, each spouse was offered a yellow card to use in the event of an outside sexual exposure and provided with condoms. They were invited to revisit the issues raised in the video and group discussion at home and to develop an agreement to remain HIV-free as a couple. They were scheduled for a counseling session one to two weekends later to finalize their agreement and take their vows.

Table 3
Inclusion/exclusion criteria.

Inclusion Criteria	Exclusion Criteria
1. Heterosexual, both partners HIV negative	1. Either partner has a condition, in opinion of investigator, that would prevent informed consent or affect reaching study objectives
2. Women aged 18–45 and men aged 18–65 years of age	2. Either partner HIV-positive or with indeterminate HIV rapid test results
3. Cohabiting 3 months or greater	3. May seek health care at a clinic randomized to the opposite arm of the clinic they would enroll in
4. Not taking any anti-retrovirals as Post or Pre-Exposure Prophylaxis	
5. Interested in participating	
6. Able and willing to provide informed consent	
7. Willing to answer questions on risk factors	
8. Available for duration of the study	
9. Willing and able to be reached by phone or home visit	
10. Willing and able to provide locator/contact information for retention and be contacted by study team	

2.8.5.2. Comparison arm: Good Health Package (GHP). Following the video and group discussion, couples were screened for hypertension via blood pressure cuff and diabetes (glucose) and schistosomiasis (blood) via urine dipstick. Individuals were provided with immediate treatment with praziquantel if blood was detected in the urine. Any participant with abnormal screening results, i.e., blood pressure greater than/equal to 140/90 mmHg and/or glucose on urine dipstick greater than/equal to 500 mg/dl was provided with additional lifestyle and dietary counseling, low sodium salt, and referral for further clinical assessments as indicated. Each couple received deworming tablets for the family, chlorine for water treatment, and hand soap. They were scheduled for a follow-up visit one to two weekends later to assess changes in knowledge and behavior.

2.8.6. Visit 2 (V2): follow-up visit

In the SOV arm at V2, each spouse was interviewed separately by a gender-matched counselor. The questionnaire covered knowledge of strategies which included recall of topics covered during intervention and questions related to the 30-day "window period" for HIV and the importance of abstaining or using condoms for this 30-day period if HIV exposed. Spouses responded to a series questions related to discussion of plans "Together HIV Free" and "Protecting My Spouse" with their spouses and whether they made their plan. These questions ranged from discussions at home in terms of the environment, length of discussion, agreement on the plan, discussion initiator, and comfort discussing these plans. The counselors read strategies for the "Together HIV Free" plan (monogamy, always using condoms with outside partners, testing with outside partners and/or knowing their HIV status) and "Protect My Spouse" plan (following an unprotected outside exposure, abstain from sex with spouse or use condoms for 1 month until HIV retest) and participants reported which components were a part of their agreement. Respondents reported whether they had challenges communicating their plans effectively and if there were any threats to their ability to remain HIV free in the union. After the interview, each partner was asked whether there was any information they had shared with the interviewer that they would NOT want discussed when the couple was brought together. Counselors for the two partners met separately to compare notes, brought the couple together, and reinforced and congratulated couples on successful negotiations while avoiding disclosure of confidential information. Spouses then recited the standardized SOV vows to each other, which include not exposing themselves to HIV outside the marriage and if potentially becoming exposed to HIV, keeping the spouse safe during the window period until repeat test was done. The citing the vows together gave the couple an opportunity to practice direct communication of their plans in a supportive environment with the counselor. This process further emphasized positive communication about keeping HIV out of the marriage from outside partnership through using the plans.

In the GHP arm, men and women were interviewed separately to assess change in knowledge and behavior related to components of the GHP intervention.

2.8.7. Visit 3-visit 5 (V3–V5): follow-up visits

Follow-up visits are scheduled 3 months (V3); 6 months (V4); and 60 months (V5) after intervention (V1). Each spouse is administered a questionnaire that includes sexual behavior questions that make up the HIV risk factor composite; these include reported sex with outside partners since participating in the intervention (for V2) or since the last visit (for V3, V4 and 5), HIV status (if known) of those outside partners, HIV testing with outside partners, condom use and alcohol use during outside exposures; and STIs including syphilis, genital ulcers, gonorrhea and genital discharge, which were diagnosed at or treated between study visits. Laboratory testing is done for HIV and STI using same tests outlined in enrollment procedures. Follow-up visits last between 1 and 4 h.

2.8.8. V5

At V5 after data collection regarding HIV risk behaviors and laboratory testing for HIV and STI, participants in each arm will receive the video-intervention from the other arm (i.e., SOV participants receive the GHP video intervention and GHP participants receive the SOV video intervention).

The construct of the questionnaires used to assess the impact on SOV was based on our 30 years of experience on sexual behavior in cohabiting Zambian heterosexual couples. These questionnaires were consistent with our previous work with regard to standard behavioral outcomes, such as outside partners, condom use, alcohol use, and self-reported STI treatment.

3. Retention

3.1. Retention strategies

3.1.1. Locator cards, appointment books, and late lists

Couple's locator information and phone numbers are updated throughout the trial. Phone numbers are verified by counselors during the visit. Appointments are recorded on couple's membership card and an internal appointment book. Couples with phones receive reminder texts prior to study visits and are called on the day of the visit if late for appointment. Appointments are rescheduled as needed. Late lists are generated to follow-up couples who miss appointments. Couples are contacted via SMS, phone call and/or home visit.

3.1.2. Couple identification

At enrollment and at each follow-up visit, right and left index and thumbprints of each spouse are taken manually using paper and fingerprint ink. Manual records are used real-time at the clinic for participant identification by comparing the ink fingerprints on the membership card issued at enrollment with the fingerprint obtained on the day of the follow-up visit.

We also captured electronic fingerprints [44] using tablet-based biometric software and a Lumidgm scanner. Tablets from participating clinics are brought to the research sites in Lusaka and Ndola for data upload as neither wifi nor adequate cellular reception are available at the clinics. Unique and anonymous numbers (not fingerprint images) are stored on a password secured website. This ensures that couples have not been enrolled in more than one clinic, and that the participants who return for follow-up are those who were enrolled with that identifier. Confirmation that the correct couple was interviewed at each follow-up visits is done post-hoc using this electronic database.

4. Sample size and power calculation

Power calculations were based on Hussey and Hughes [45] assuming enrollment of 1800 couples and a conservative 58% retention. Conservative retention estimates are based on our many years of experience with cohort studies in Zambia. Loss to follow-up is expected to be high due to high rates of relocation [46]. Expected outcomes are based on the literature. The calculations in Table 4 show risk in the intervention group and detectable risk ratio for 80% and 90% power with intraclass correlation value of 0.10.

Table 4
Power calculation.

Risk Control	Risk Intervention	Risk ratio detected	Power
15%	5%	0.53	80%
	6.5%	0.43	90%
20%	11%	0.55	80%
	12%	0.60	90%
25%	14%	0.56	80%
	15%	0.60	90%

5. Data management

Questionnaire data is managed using Microsoft Access and Research Electronic Data Capture (REDCap) electronic data capture tools hosted at Emory University [47] with IT support from Research and Woodruff Health IT Division grant support (UL1 TR000424). All laboratory data is managed in Microsoft Access. Data cleaning is conducted in REDCap as well as queries generated in Microsoft Excel and Microsoft Access. Data analysis is conducted using SAS 9.4 (SAS Institute, Cary, N.C.).

6. Baseline data analyses

6.1. Baseline sociodemographic, reproductive health characteristics, sexual history and behavioral characteristics by study arm

To assess the success of randomization and the resulting equivalency of participants in the two arms, baseline characteristics are compared between SOV and GHP for socio-demographic, contraceptive, reproductive and sexual behavioral characteristics including baseline HIV risk factors (Tables 5 and 6). A Couple HIV Risk Factor composite was created to indicate whether either or both partners self-reported any baseline HIV risk factors, defined as previous treatment for STI, outside partners since marriage, and condom and alcohol use with outside partners. Comparison of baseline characteristics by arm are done using *t*-test for continuous variables and Chi-Square for categorical variables. Each covariate in bivariate analysis is compared by study arm using generalized estimating equations (GEE) and presented as crude odds ratios (cOR) with 95% confidence intervals (CI). GEE is used to account for clustering. Any imbalances in baseline characteristics by trial arm will be considered as possible confounders in future analyses of the impact of the intervention on HIV/STI risk. To bolster the assumptions for the power calculations above, the composite Couple HIV Risk Factor is compared in the two arms.

7. Planned data analyses

7.1. Communication of plans to remain HIV free between SOV spouses post intervention

We will compare responses between spouses at V2 one to two weeks after the SOV intervention to assess knowledge retention. More importantly, we will compare responses from each spouse regarding their discussion of the two plans "Together HIV Free" and "Protecting My Spouse" at home. The questions will explore actions and communication, individually or jointly, as it relates to plan selection; disclosure of plan to spouse; identification of threats to remaining HIV free; protection of spouse in case of HIV exposure; barriers to using the plans; and the importance of remaining HIV free. Comparisons in responses between spouses will be assessed using logistic regression.

7.2. Knowledge uptake in Good Health Package health topics

We will compare baseline to V2 (one to two weeks post intervention), V3 (three months post intervention), and V4 (six months post intervention) and V5 (60 months post intervention) in the GHP arm to assess

Table 5
Baseline sociodemographic and reproductive health characteristics by study arm.

	Total (N = 1686)		Intervention Arm (N = 813)		Comparison Arm (N = 873)		p-value[a]	95% CI			
	Mean	SD	Mean	SD	Mean	SD		cOR	LL	UL	p-value
Man age (mean, years)[b]	31.9	7.8	32.1	7.8	31.7	7.8	0.39	1.01	0.99	1.02	0.39
Woman age (mean, years)[b]	26.2	6.7	26.4	6.8	26.0	6.5	0.21	1.01	0.99	1.02	0.21
	N	%	N	%	N	%					
Man's Income											
Yes	1662	99%	793	98%	869	100%	0.001				
No	24	1%	20	2%	4	0%					
Man's income (IQR, ZMW)[c]	800	800	700	800	900	1000	0.0001	0.99	0.98	0.99	0.002
Woman's Income											
Yes	1132	67%	492	61%	640	73%	<0.0001	Ref			
No	553	33%	320	39%	233	27%		1.79	1.45	2.19	<0.0001
Woman's income (IQR, ZMW)[c]	250	650	200	500	350	900	<0.0001	0.95	0.94	0.97	<0.0001
City of Residence											
Lusaka	334	20%	174	21%	160	18%	0.11	1.21	0.95	1.54	0.11
Ndola	1352	80%	639	79%	713	82%		Ref			
Man vernacular literacy (Bemba or Nyanja)											
Easily	1255	74%	556	68%	699	80%	<0.0001	Ref			
With Difficulty/Not at all	431	26%	257	32%	174	20%		1.86	1.49	2.32	<0.0001
Woman vernacular literacy (Bemba or Nyanja)											
Easily	927	55%	358	44%	569	65%	<0.0001	Ref			
With Difficulty/Not at all	758	45%	454	56%	304	35%		2.37	1.95	2.89	<0.0001
Man reads or understands English											
Easily	1070	63%	470	58%	600	69%	<0.0001	Ref			
With Difficulty/Not at all	616	37%	343	42%	273	31%		1.60	1.31	1.96	<0.0001
Woman reads or understands English											
Easily	716	42%	275	34%	441	51%	<0.0001	Ref			
With Difficulty/Not at all	969	58%	537	66%	432	49%		1.99	1.64	2.43	<0.0001
Couple: Years Cohabiting[b]	5.9	5.8	6.2	5.8	5.5	5.8	0.01	1.02	1.00	1.04	0.01
Couple: Number of people in household[d]	4.6	2.1	4.8	2.1	4.4	2.2	0.001	1.08	1.03	1.13	0.002
Couple: Number of children <16 years old in household[d]	2.1	1.7	2.3	1.6	1.9	1.6	<0.0001	1.15	1.09	1.23	<0.0001
Self-Reported Pregnancy											
Yes	450	27%	143	18%	307	35%	<0.0001	Ref			
No	1236	73%	670	82%	566	65%		2.54	2.02	3.19	<0.0001
If not pregnant, current contraceptive method											
IUD	12	1%	4	1%	8	1%	0.062				
Implant	198	16%	97	14%	101	18%					
Injectable	283	23%	159	24%	124	22%					
Pills	134	11%	64	10%	70	12%					
Tubal Ligation	1	0%	0	0%	1	0%					
None/Condom/Other	608	49%	346	52%	262	46%					

Ref indicates reference group.

[a] *Two-tailed t-test for continuous variables, chi-square test for categorical variables with cell counts >=5, Fisher's exact test for categorical variables with cell counts < 5.

[b] Per one year increase.

[c] Per 1 person or 1 child increase.

[d] Per one child increase.

knowledge and implementation of strategies for keeping their family healthy. Responses will be compared between men and women as it pertains to knowledge and application of strategies in water chlorination, handwashing, deworming, prevention of schistosomiasis, and prevention and management of diabetes and hypertension. In addition, barriers, roles in household as it relates to these areas, and the perceived importance of these strategies will be assessed. Comparisons in responses between spouses will be assessed using logistic regression.

7.3. Retention

We will present retention statistics of couples and indicate reasons for withdrawals and lost to follow-up. In addition, we will assess predictors of follow-up by comparing socio-demographic, reproductive and sexual history, and behavioral characteristics of couples completing baseline only versus couples with follow-up.

7.4. Impact of the intervention during 60 months of follow-up

At two weeks, three months and 6 months post-intervention, HIV/STI incidence and risk behaviors will be compared in the SOV and GHP arms. Given this short time frame of follow-up (for context, couples had been together for 6 years at the time they entered the study during which 24% had at least one partner reporting a risk factor as shown in Table 6) we do not anticipate very high levels of risk behavior. Thus, we will combine any reported risk behavior (outside partners, condom use with outside partners, alcohol use with outside partners, knowledge of outside partner HIV status, joint HIV testing with outside partners) or STI diagnosis (HIV, RPR, trichomonas diagnosed in the study or any STI treatment elsewhere) from either partner at V2, V3, and/or V4 into one composite outcome indicating one or more risk factors identified for the relationship, regardless of if it was from one or both partners..

The ongoing long-term follow-up is 60 months after the intervention and we do anticipate more reported risk behaviors and incident STI in this longer time frame. This will allow more detailed comparisons of individual risk factors between arms.

For outcomes assessed up to 6-months or 60 months, outcomes of interest will be described by study arm and compared using t-tests for continuous variables (e.g., number of outside partners) and Chi-Square tests for categorical variables (e.g., risk factor yes/no, composite

Table 6
Baseline sexual history and behavioral characteristics by study arm.

	Total (N = 1686)		Intervention Arm (N = 813)		Comparison Arm (N = 873)		p-value[a]		95% CI		
	Mean	SD	Mean	SD	Mean	SD		cOR	LL	UL	p-value
Man lifetime sex partners (mean)[b]	5.1	8.9	5.5	11.3	4.8	5.8	0.11	–			
Man lifetime sex partners (IQR)[b]	4.0	3.0	4.0	4.0	3.0	3.0	0.11	1.01	1.00	1.03	0.11
Woman lifetime sex partners (mean)[b]	1.9	1.5	2.0	1.4	1.9	1.6	0.18	–			
Woman lifetime sex partners (IQR)[b]	1.0	1.0	2.0	1.0	1.0	1.0	0.18	1.05	0.97	1.12	0.23
Man age at first sexual intercourse (mean, years)[c]	18.7	4.0	18.6	4.0	18.7	4.1	0.62	0.99	0.97	1.02	0.62
Woman age at first sexual intercourse (mean, years)[c]	17.7	2.6	17.3	2.5	18.0	2.6	<0.0001	0.88	0.85	0.92	<0.0001
Couple number of times sex with spouse in last 1 month[d]	12.5	10.1	10.2	7.8	14.5	11.5	<0.0001	0.95	0.94	0.96	<0.0001
	N	**%**	**N**	**%**	**N**	**%**					
Man Outside Partners Since Married											
Yes	200	12%	99	12%	101	12%	0.70				
No	1486	88%	714	88%	772	88%					
If yes, man's number of outside partners (mean)	2.0	2.2	2.3	2.8	1.7	1.3	0.07	1.06	0.79	1.42	0.70
Man Condom use with outside partners since married											
Yes without condoms	136	8%	76	9%	60	7%	0.03	1.37	0.96	1.95	0.08
Yes with condoms	64	4%	23	3%	41	5%		0.61	0.36	1.02	0.06
No	1486	94%	714	88%	772	88%		Ref			
Man alcohol use during sex with outside partners											
Yes with alcohol	93	6%	38	5%	55	6%	0.07				
Yes without alcohol	107	6%	61	8%	46	5%					
No	1486	88%	714	88%	772	88%					
Woman outside partners since married											
Yes	19	1%	7	1%	12	1%	0.32				
No	1666	99%	805	99%	861	99%					
If yes, woman's number of outside partners (mean)	1.5	0.8	1.7	1.1	1.3	0.5	0.31	0.62	0.24	1.59	0.32
Woman condom use with outside partners since married											
Yes without condoms	10	1%	4	0%	6	1%	0.63				
Yes with condoms	9	1%	3	0%	6	1%					
No	1666	99%	805	99%	861	99%					
Woman alcohol use during sex with outside partners											
Yes with alcohol	4	0%	1	0%	3	0%	0.59				
Yes without alcohol	15	1%	6	1%	9	1%					
No	1666	99%	805	99%	861	99%					
Man ever treated for STI											
Yes	209	12%	98	12%	111	13%	0.68				
No	1477	88%	715	88%	762	87%					
Woman ever treated for STI											
Yes	74	4%	31	4%	43	5%	0.27				
No	1611	96%	781	96%	830	95%					
HIV Risk Factor by spouse[e]											
No man and woman HIV risk	1285	76%	622	77%	663	76%	0.40				
Yes man only HIV risk	311	18%	154	19%	157	18%					

(continued on next page)

Table 6 (*continued*)

	Total (N = 1686)		Intervention Arm (N = 813)		Comparison Arm (N = 873)		p-value[a]		95% CI		
	Mean	SD	Mean	SD	Mean	SD		cOR	LL	UL	p-value
Yes woman only HIV risk	44	3%	16	2%	28	3%					
Yes man and woman HIV risk	45	3%	20	2%	25	3%					
Couple HIV Risk Factor ǀ											
Yes	400	24%	190	23%	210	24%	0.75	0.97	0.77	1.21	0.75
No	1285	76%	622	77%	663	76%		Ref			

Ref indicates reference group.
ǀHIV Risk Factor and Couple HIV Risk Factor includes man and woman's baseline self-reports of previous treatment for STI, outside partners since married, condom use with those outside partners, and alcohol use during sex with those outside partners.
[a] Two-tailed *t*-test for continuous variables, chi-square test for categorical variables with cell counts greater than or equal to 5, Fisher's exact test for categorical variables with cell counts less than 5.
[b] Per one person increase.
[c] Per one year increase.
[d] Per 1 sex act increase.

outcome). In our primary analysis, the effect of the intervention on outcomes of interest will be evaluated using crude logistic regression models and GEE methods. In sensitivity analyses, a multivariable model will estimate the impact of the intervention on outcomes of interest adjusting for any imbalances by study arm identified at baseline (described in the Results section and presented in Tables 5–6).

8. Results

We present trial flow from randomization to intervention participation in Fig. 1. We have enrolled 1686 couples (813 in SOV arm and 873 in GHP arm) in 10 clinics in Ndola and Lusaka. The average number of enrolled couples per clinic is 168.6 (range 112–224). We show baseline socio-demographics, reproductive and sexual history and behavioral characteristics by study arm in Tables 5 and 6 respectively.

9. Bivariate analysis

Baseline Sociodemographic and Reproductive Health Characteristics by Study Arm (Table 5): Significant differences in bivariate comparisons were found between the SOV and GHP arms in income, literacy, duration of cohabitation, number of people and children in the household, and current pregnancy. In summary, couples in the GHP comparison arm had higher men's and women's literacy in the vernacular and English, higher men's income, higher women's employment, fewer people and children living in the home and higher self-reported pregnancy. The two arms did not differ by residence (Lusaka vs. Ndola) or modern contraceptive use among non-pregnant women.

Baseline Sexual History and Behavioral Characteristics by Study Arm (Table 6): There were few differences between SOV and GHP arms in sexual history, risk behaviors and STI histories. Variables not significant in bivariate analysis included number of lifetime sexual partners, man's age of sexual debut, alcohol use during sex with outside partners, and ever being treated for an STI. Women in the SOV arm had a younger age at first sexual intercourse and couples in the SOV arm reported fewer sexual contacts within the marriage in the last month. A composite score including history of STI, outside partners, condom use with outside partners, and alcohol use during sex with outside partners in either spouse showed no difference between the two groups. Twenty-four percent of couples had at least one risk factor including 18% with only the man having a risk factor, 3% with only the woman, and 3% with both partners reporting a risk factor since the union began.

10. Trial status

The trial started recruitment and enrollment in January 2016. Follow-up for the trial is ongoing.

11. Discussion

We describe a protocol for testing the impact of 'Strengthening Our Vows', an innovative behavioral intervention to reduce HIV risk among HIV concordant negative couples in Zambia through reduction in exposure from concurrent sexual partners. To our knowledge this is the first couple-based HIV prevention trial to look at the impact of sexual agreements in heterosexual African couples. Our study covers important gaps in the literature as it pertains to a health outcome in a high prevalence, resource limited setting, and addresses challenges associated with uptake and continued use of sexual agreements.

The majority of new HIV infections in sub Saharan Africa occur in cohabiting couples and CVCT has been recommended for HIV prevention by WHO since 2012. To date, only Rwanda has nationalized CVCT in antenatal clinics, where >80% of pregnant women have been tested with partners since 2013 [48] thus resulting in prevention of an estimated 70% of all new infections [1,2]. Research and implementation programs in several countries confirm that CVCT is feasible [5,49–59], recently summarized in a review of uptake of couples' testing [60]. Several clinical trials have provided CVCT in order to recruit discordant couples for biomedical prevention interventions [61,62] or concordant positive couples into treatment interventions [63] but prevention and treatment efforts to date have focused on HIV-infected couples.

A combination approach to HIV prevention has been adapted for specific risk groups such as female sex workers (FSW) and youth [64–69]. These targeted interventions ideally focus limited resources on those at highest risk. Examples in couples include treatment-as-prevention in the HIV + partner in discordant couples [70], PrEP in the HIV- partner if the HIV + partner does not have an undetectable viral load [61], and male circumcision in uninfected men married to HIV + women [71]. Given the low incidence of HIV in CNC after CVCT, cost-benefit analyses preclude PrEP in this group. Similarly, given limited access and low uptake in many areas [72–74] men in concordant HIV- unions would be a lower programmatic priority for male circumcision compared with single men or men with HIV + spouses.

Though unprotected sex with concurrent partners remains the primary mode of HIV acquisition in heterosexual CNC in Africa, couples lack evidence-based pragmatic, communication and action-focused strategies to aid in their decision-making to protect their marriages from HIV. Our 'Strengthening Our Vows' approach aims to incorporate this combinative strategy with CVCT, an already proven, cost-effective strategy and adapts strategies previously used to provide a platform for couples to discuss concurrent partnerships and HIV prevention [75,76].

In a review of 48 studies of HIV- MSM couples by LeBlanc et al., negotiated safety included the following components: joint HIV testing and counseling; explicit relationship boundaries with either monogamy allowing no condom use within the couple, or consistent condom use with outside partners; and a communication plan in the event the agreement was breached [77]. Though this review was published after our trial began, it describes an approach very similar to our intervention.

The literature on negotiated sexual agreements has grown since we began our trial and new findings will inform our analyses. Rogers et al. assessed measures of love, trust, and conflict style as they relate to agreement type, satisfaction with a breaking of agreements [78]. Mitchell et al. found that MSM cited rewards of sexual agreements included honesty, communication, clear expectations, intimacy and trust. Challenges included stigma about having an open agreement; awkwardness and jealousy [79]. Hoff et al. found positive relationship dynamics are associated with less risk with partners outside the relationship, but were associated with greater odds of condomless anal sex (CAS) with primary partners [80]. Feinstein also found that MSM who were seriously dating their partner and those with monogamous agreements were most likely to report condomless anal sex within the union (CAS) [81]. Hoff explored relationship quality and sex life enhancement motives and found the former associated with less CAS and the latter with more CAS outside the primary relationship [82]. Perry et al. found that decision-making power relative to one's partner was not associated with any agreement outcome, but that younger and lower earning MSM partners more frequently broke their agreements but the latter more often disclosed breaks [83]. Gusakova found that while monogamous couples had more positive attitudes toward communication about sexual agreements, the perceived impact of broken safety agreements in this group were less clear [84].

Young partnered US men who have sex with men ± women reported a need for skills training in negotiating sexual agreements [85]. To add to this complexity, dynamics change as relationships evolve: Mitchell et al. reported that desire for sexual exploration, events with other men, past relationships, other couples and duration of the union affect the context of agreements, highlighting the importance of maintaining open communication [86]. Given that outside exposures do happen even with monogamous agreements, prevention efforts should help couples mutually agree to integrate HIV testing into their sexual agreement [87]. A qualitative study of MSM in South Africa found sexual agreements permitting non-monogamy with female partners only, suggesting heteronormative societal pressures [88].

Responses describing the type of agreement a couple has do not always agree when partners are interviewed separately: Gamarel et al. found 45% of transgender women and their cisgender primary male partners had different perceptions of what their agreement was [89]. Studies in African heterosexuals have examined concordance in reporting sexual behaviors and risks. In Uganda, questions with high or substantial couple agreement included condom use at last sex and frequency of condom use while low or fair couple agreement was found in decision-making regarding condom use, wanting more biological children and deciding when to have sex [90]. This is similar to our own findings with Rwandan couples [91]. Other studies have focused on couples with one or both partners HIV+ [92–96] and have examined patterns of communication in couples and enhanced male involvement in HIV prevention with pregnant women [97–100], though without a specific focus on negotiated agreements [51,101–104].

Studies on sexual agreements with heterosexual couples are more limited and mostly assess feasibility of sexual agreements, self-reported monogamy agreements, or perceptions of western providers about agreements [105,106]. In a comprehensive scoping review of the primary literature on sexual agreements, including negotiated safety, Rios-Spicer and colleagues identified several knowledge gaps including the need to expand sexual agreements research beyond MSM populations and the need to better understand agreement breaks and break disclosure [75].

CVCT reduces incident HIV infections in Zambia CNC and during post-test counseling sexual agreements are often spontaneously developed by the couples that primarily focus on monogamy. Current counseling guidelines do not include structured support for negotiated agreements, how to protect individuals and their spouses from threats to monogamy or how to react to potential outside HIV exposures if they happen.

The addition of cost-effective, sustainable strategies to the existing HIV prevention toolkit are critical as funding for HIV continues to decline. This is especially true in resource limited settings. Though we have not performed cost analysis for this added component, we have shown that CVCT is feasible on a large scale [48], cost-effective [5], and able to be integrated into routine services [107]. In addition to feasibility and cost-effectiveness, we have shown that HIV and unplanned pregnancy prevention efforts can be mutually leveraged with integrated couples-focused programs [108]. Lastly, we have also shown that the addition of services such as hygiene, sanitation, and prevention of neglected and non-communicable diseases to CVCT is feasible [39]. Such an integrative, preventive public health package that not only encompasses multiple health topics (HIV/STIs, family planning, hygiene and sanitation, and prevention of neglected and non-communicable diseases) but also includes both spouses is ideal and captures the spirit of the UN Sustainable Development Goals [33].

Our intervention is novel, timely and integrative with minimum anticipated costs. An added strength of the study is that baseline couple HIV risk is not statistically significant between the two arms. This demonstrates that as it relates to the primary outcome of interest, the arms appear to be balanced. We acknowledge that the trial sample size being based on individuals and not clusters as well as sample size adjustments in early enrollment to increase couples instead of clinics may impact power. To account for potential loss of power, we have extended the follow-up period to 60 months. The number of clusters are limited due to budgetary constraints.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

Supplementary data related to this article can be found at https://doi.org/10.1016/j.conctc.2021.100850.

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ORIGINAL ARTICLE

Impact of a Group-Based Video and Interactive Group Session Addressing Diarrheal Disease, Helminthic and Schistosomiasis Infections, Hypertension and Diabetes on Short and Long-Term Improvement in Knowledge and Healthy Behaviors in Seroconcordant HIV-Negative Zambian Couples

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Abstract

Background: Non-communicable and neglected tropical diseases (NCD and NTD) contribute to high morbidity and mortality in Zambia. While the public health importance of NTD has long been recognized, prevalence of disease remains high. NCD are emerging as causes of morbidity and mortality. Knowledge of risk factors, diagnosis, management, and prevention of NCDs and NTDs in the general population is poor and as a result, low-cost commodities are insufficiently used.

Methods: Urban couples recruited in five government health centers (HC) participated in a video-based group intervention addressing hand washing, water treatment, routine deworming, and urinary schistosomiasis screening to prevent morbidity and mortality from NTD. Chlorine, soap, and deworming for the family were provided, along with schistosomiasis treatment. The intervention also promoted lifestyle changes to prevent and ameliorate hypertension and diabetes and emphasized the importance of medical management regardless of symptomatology. Blood pressure screening identified hypertensives that were given low-sodium salt and referrals. Those with glucose on urine dipstick were counseled and referred. Knowledge and observed and self-reported behaviors were measured 1-2 weeks and 6 months after the interventions. All activities took place in the HC and conducted by trained HC staff.

A comparison group recruited at five matched HC was assigned to an HIV prevention intervention and completed the same surveys as the intervention group at baseline and 6 months.

Results: One to two weeks after the intervention, reported use of chlorine treatment for drinking water increased from 24% to 96%, with knowledge of correct volume for dilution of 20 L and 5 L containers improving from 29%-35% to 96%-98%. Knowledge of household deworming increased from 62% to 99%. Observed handwashing technique improved including duration (20 seconds) and scrubbing of back, palms, wrists, between fingers and under fingernails. Knowledge that hypertension and diabetes could be asymptomatic increased from 63% to 82% and recall of potential sequelae also improved including heart disease/attack (14% to 41%), stroke (26% to 61%) and death (65%

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to 83%). Correct definition of hypertension (BP > = 140/90) increased from 6% to 54% and citing salt reduction as part of management increased from 31% to 85%. An increase in those reporting not adding salt (8% to 20%) corresponded with a decrease in those reporting > = 1/2 teaspoon (16% to 5%). Knowledge that diabetics should reduce sugar intake increased from 48% to 89% and the proportion reporting adding > = 3 tsp to their tea decreased from 42% to 26%. Taking prescribed medication and getting regular medical checks knowledge increased for both hypertension (38% to 73% and 28% to 66%, respectively) and diabetes (32% to 71% and 20% to 60%, respectively). These improvements were retained at 6-month follow-up and sharing-related household duties to prevent NTD and NCD improved. Comparison group surveys confirmed equivalency of NTD and NCD knowledge and behaviors between the two groups at baseline. Surveys at 6 months showed no improvement in the comparison group, confirming that secular trend did not play a role.

Conclusion: Video-based interventions are time and money-saving and ensure consistent messaging. Sustained improvements in knowledge and behavior were reported when low-cost commodities were provided.

Keywords

Non-communicable diseases, Neglected tropical diseases, Hygiene and sanitation, Helminthiasis, Handwashing, Healthy lifestyle, Video, Couples

Abbreviations

BP: Blood Pressure; CLTS: Community-Led Total Sanitation; CNC: Concordant HIV-negative Couples; CRT: Cluster Randomized Trial; CVCT: Couples' HIV Voluntary Counseling and Testing; ELISA: Enzyme-Linked Immunosorbent Assay; GHP: Good Health Package; HC: Health Center; NCD: Non Communicable Diseases; NTD: Neglected Tropical Diseases; SSA: Sub-Saharan Africa; WHO: World Health Organization

Introduction

Neglected tropical diseases (NTD) and non-communicable diseases (NCD) pose an important threat to health in Africa. In Zambia and many Sub-Saharan Africa (SSA) countries, the most prevalent NTDs are cholera, soil transmitted helminths and schistosomiasis. Among the leading causes of death in Zambia are lower respiratory infections (pneumonia) and diarrheal diseases at 4th and 5th respectively, with children most affected [1,2]. Various studies in SSA including Zambia have shown that handwashing can reduce prevalence of diarrheal diseases by 25% or more [3-8]. Cholera is also a frequent problem in two of the largest cities in Zambia, Lusaka and Ndola, with regular outbreaks occurring during the rainy season since the 1970s [9]. Previous cholera outbreaks have been linked to high fecal contamination of water sources and raw/prepared foods, inadequate safe water supply and sanitation, and insufficient drainage [9-15].

Hypertension and diabetes leading to heart disease and stroke are increasingly common due to urbanization, increase sedentary lifestyles and high salt and high fat diets. Stroke is now the 3rd leading cause of death having increased by almost 60% from 2009 to 2019 and ischemic and hypertensive heart disease are ranked at 7th and 10th position respectively [1]. Risk factors attributable to mortality and morbidity (disability) include water sanitation and hygiene (WaSH) in 4th position and high blood pressure (BP), high body mass index, and dietary risks at 6th-8th position respectively [1].

We previously offered basic NTD/NCD education with a flip chart and a selection of services (blood pressure screening, urine dipstick for blood (schistosomiasis) and sugar (diabetes) and commodities (hand soap, chlorine, deworming for the family, low sodium salt) to couples seeking joint HIV counseling and testing in Lusaka and Ndola, two of Zambia's largest cities [16], and these services were associated with increased follow-up for repeat HIV testing. However, health center (HC) staff reported that knowledge about NTD and NCD was poor, prompting us to develop a more intensive education program.

We present here knowledge and behaviors related to prevention, screening and treatment of common NTD and NCD in seroconcordant HIV-negative Zambian couples (CNC) who participated in a Good Health Package (GHP) comparator arm of a cluster randomized trial (CRT) described in detail elsewhere [17]. Baseline information is compared to survey responses two weeks and six months after a video-based educational session with practicums and provision of low-cost commodities. Outcomes at six months are compared with CNC in clinics randomized to a contemporaneous and unrelated HIV prevention, also described in more depth elsewhere [17]. Our findings will highlight successful couples-based prevention strategies to reduce the morbidity and mortality associated with NTD and NCD through education, practical training, low-cost commodity distribution and screening with treatment/referral.

Methods

Ethics

Approval has been granted by the OHRP-registered University of Zambia Biomedical Regulatory Ethics Committee and Emory University Institutional Review Board and retrospectively registered as NCT02744586 on ClinicalTrials.gov. Couples viewed a verbatim reading of the informed consent on a video, met with a counselor to discuss any questions or clarifications, and jointly signed consent [18-20]. A unique alphanumeric ID was implemented for all data gathering tools. Locator information was stored separately from data to maintain privacy and confidentiality.

Study design

Ten participating clinics (8 in Ndola and 2 in Lusaka) included 5 dyads with non-overlapping catchment areas matched by clinic volume and HIV prevalence. Each dyad was randomized such that one clinic was

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assigned to the GHP arm and the other to the control arm. An enrollment visit was followed by receipt of the intervention several days later. The short-term impact was measured 1-2 weeks after the intervention with intervention-specific questionnaires. Long-term impact was measured at six months with the same assessments in GHP and control groups, including knowledge and behaviors related to NTDs/NCDs. The trial is ongoing (clinicaltrials.govNCT02744586) with a 60-month follow-up visit to have more detailed comparisons of HIV risk factors between both arms and to assess longer-term knowledge and implementation of strategies in GHP arm. Hypotheses of the CRT are that the GHP arm will sustain improved knowledge and behaviors related to NTD/NCD prevention and treatment than the control arm. Conversely, the control arm will have a lower incidence of HIV risk factors, such as reported outside sexual contacts, incident HIV and STI than the GHP arm.

Objective

The purpose of this manuscript is to compare changes in NTD/NCD-related knowledge and behaviors in the GHP arm at baseline (pre-intervention) and post-intervention at two weeks and six months. This study will also compare knowledge and behaviors at six months post-intervention visit between GHP and a comparison group (control) that received an HIV intervention in order to assess potential secular trend due to other NTD/NCD programs.

Study population

At Couples HIV Voluntary Counseling and Testing (CVCT) offered in government health centers in Lusaka and Ndola, two of Zambia's largest cities, couples underwent pre-test counseling, HIV rapid testing per national guidelines adapted for couples [21] and post-test counseling. According to Center for Disease Control and Prevention and World Health Organization (WHO) guidelines, couples received HIV results together and were counseled per their couple HIV status [22,23].

In 2016, couples who received CVCT services and met pre-screening eligibility (both partners HIV-negative, women aged 18-45 and men aged 18-65, cohabiting for > = 3 months, interested, willing and capable of understanding and fulfilling study procedures and providing contact information) were invited the following weekend to return for screening and enrollment.

Study reimbursement

At each visit, couples received approximately 3 USD per person-visit as study reimbursement to cover time at clinic and transport, as described in the informed consent. An additional 2 USD per person was given as a lunch allowance for more extended study visits.

Enrollment visit

After joint informed consent, the couple was separated, and a baseline questionnaire was administered to women by female counselors and men by male counselors and included socio-demographic characteristics, knowledge of and behaviors related to NTDs and NCDs. The visit lasted 2-3 hours.

Intervention visit

The "Good Health Package" (GHP) video rationale and content was developed based on previous use of health education flip chart and a choice of provision of commodities (deworming tablets, chlorine and hand soap) and health screenings (blood pressure, diabetes and schistosomiasis) related to NCDs and NTDs to improve follow-up HIV testing in couples in which at least one partner was HIV-negative [16]. All materials were translated into the vernacular (Bemba and Nyanja) and content was equivalent to or below 8th grade level. During the visit, spouses watched a one-hour video that consisted of two-30-minute parts. Part one content covered risk groups; transmission and mechanism of action; signs and symptoms; key facts and statistics; and prevention strategies. In the first part of the video, spouses were separated into men and women's groups; male counselors led the men's groups, and female counselors led the women's groups. Pauses were incorporated throughout the video in key areas; during these pauses, the counselor actively facilitated discussion points to allow for questions, answers and further discussions/clarifications if needed. Hand washing with soap to prevent respiratory and diarrheal infections and intestinal helminths was emphasized, and during breaks in the video, participants practiced under supervision. Use of drinking water treatment with chlorine to prevent cholera and other causes of diarrhea was described and again participants practiced putting the correct amount of chlorine into 5-liter (one measure of the top of the chlorine bottle cap) and 20-liter (one measure of the bottom of the chlorine bottle cap) containers. Schistosomiasis education highlighted how freshwater areas within a city could be potential sources of infection based on a recent study showing active infection in 10% of healthy adults in Lusaka [24]. (Of note, we did not include discussions of malaria as we were not able to offer bed nets due to their high cost and the focus on pregnant women for available stock).

Modifiable lifestyle changes related to salt and sugar intake, weight maintenance and physical activity were emphasized for prevention of hypertension and diabetes, and salt and sugar measurements were used to illustrate portion control. All couples came back together in part two of video which had a quiz related to topics in the video in addition to discussion on the importance of equal responsibility in terms of household health and implementing strategies at home to improve the family's health. Couples were provided with a bottle of chlorine sufficient for one year of use in an average household, hand soap, and one round of de-worming

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medication sufficient for the household. Blood pressures were taken, and urine dipsticks were used for detection of urinary schistosomiasis (hematuria) and diabetes (glucosuria). All couples received low sodium salt and messaging for hypertension prevention. Participants with a blood pressure > = 140 mmHg systolic and/or > = 90 mmHg diastolic received added lifestyle and dietary counseling and were referred for medical evaluation. Participants with elevated glucose (> = 500 mg/dl (27.77 mmol/L) in urine were also referred for medical evaluation. Those with hematuria were provided with free treatment for schistosomiasis with praziquantel. The visit lasted 3-4 hours.

Follow-up visits 1-2 weeks and 6 months post-intervention visit

GHP spouses were separated and administered a questionnaire about knowledge, implementation of strategies, sharing of household roles, and behaviors related to their intervention content. At the 6-month follow-up visit, couples in both GHP and control arms responded to the same questions on hypertension, diabetes, diarrheal diseases, schistosomiasis, and helminths.

Data management and analysis

Questionnaire data is managed using Microsoft Access and Research Electronic Data Capture (REDCap) electronic data capture tools hosted at Emory University [25] with IT support from Research and Woodruff Health IT Division grant support (UL1 TR000424). Responses to questionnaires are presented as frequencies. To establish significance, differences in responses between pre-and post-intervention and between men and women are assessed with chi-square tests. Because the number of participants is large, some statistically significant differences are not meaningful, and we thus only highlight in text significant differences of > 5%. Data analysis is conducted using SAS 9.4 (SAS Institute, Cary, N.C.).

Results

Demographic characteristics

In the 570 couples, who participated in the intervention and the first follow-up visit, the average age was 32 for men and 26 for women and the average duration of union was 5.9 years. The couple reported an average of 4.6 people in the household including an average of 2.1 children under 16. Literacy in the vernacular (Bemba or Nyanja) was good with 80% of men and 63% of women reporting reading easily. Most couples earned something with 99% of men and 71% of women reporting some income. Among men, 73% reported reading or understanding English easily compared with 55% of women.

A public tap was the most common source of water (33%) with outdoor tap piped into the yard (26%), a protected well (17%), and bore hole directly (15%) also common. Only 7% reported piped water in the home. Most could access water within a < 15 min walk (82%) or a 16 to 20-minute walk (9%). Two percent of respondents reported having high blood pressure and 36% knew of family members with high blood pressure. Only two respondents reported diabetes though 19% of respondents reported had affected family members.

In the presentation of data from Table 1, Table 2, Table 3 and Table 4 below, differences are significant unless specified and only significant differences of > 5% are mentioned in text.

Knowledge and behaviors prior to and 1-2 weeks post GHP intervention (Table 1)

At baseline, 46% of respondents (49% of men and 43% of women) did not treat their drinking water, 31% boiled water, and 24% added chlorine. This increased to 96% using chlorine and 15% boiling two weeks post-intervention. Knowledge of how much chlorine to use for 5-liter and 20-liter containers rose from 29-35% to 96-98%. Most respondents knew that handwashing after using the toilet and before cooking and eating were important before the intervention. Handwashing after handling animals, dirty diapers, or rubbish were reported more often though respondents citing after sneezing or coughing into your hands or before and after caring for the sick remained suboptimal at 36-40%. The techniques used during handwashing demonstration also improved with knowledge of scrubbing back of hands, palms, between fingers, and under fingernails, all increasing to > = 70%. For length of time for hand washing (20 seconds), an increase was seen between baseline and post-intervention for self-report (23% to 66%) as well as observed (5% to 43%).

Reported ways to get intestinal worms at baseline included eating dirt/soil (46%), not properly washing raw vegetables and fruits (43%), and undercooked meat (22%), all of which increased to > = 84% after the intervention. Less frequently reported ways to get intestinal worms at baseline, such as not washing hands after touching soil, using the toilet, and before handling food increased from < = 14% to > = 40% post-intervention. Prior to the video, 62% of respondents thought that deworming should include everyone in the home, and 26% thought it involved only the children. This increased to 99% volunteering that everyone in the home should be dewormed.

The knowledge that most hypertensive and/or diabetic patients did not have symptoms increased from 63% to 82%. Knowledge also increased that hypertension could lead to heart attacks (14% to 41%), stroke (26% to 61%) and death (65% to 83%). Only 6% of respondents correctly cited what value is considered high blood pressure (> = 140/90 mmHg) before the intervention; this increased to 54% (61% of men and 48% of women).

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Table 1: Knowledge and behaviors prior to and 1-2 weeks post GHP intervention.

	Baseline pre-intervention						Two weeks post-intervention					
	Total (N = 1140)		Men (N = 570)		Women (n = 570)		Total (N = 1140)		Men (N = 570)		Women (n = 570)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
How do you treat your drinking water?												
I do not treat my drinking water	523	46%	278	49%	245	43%	17	1%	9	2%	8	1%
Boil	351	31%	162	28%	189	33%	172	15%	80	14%	92	16%
Add chlorine	275	24%	127	22%	148	26%	1095	96%	544	95%	551	97%
Strain it through a cloth/Water filter/Other/Don't know	90	8%	43	8%	47	8%	20	2%	11	2%	9	2%
How much chlorine do you need for a 20 L container?												
Top of cap	115	10%	45	8%	70	12%	13	1%	9	2%	4	1%
Bottom of cap	404	35%	219	38%	185	32%	1115	98%	555	97%	560	98%
Other	76	7%	43	8%	33	6%	7	1%	4	1%	3	1%
Don't know	545	48%	263	46%	282	49%	5	0%	2	0%	3	1%
How much chlorine do you need for a 5 L container?												
Top of cap	287	29%	147	30%	140	29%	1100	96%	549	96%	551	97%
Bottom of cap	59	6%	31	6%	28	6%	18	2%	9	2%	9	2%
Other	78	8%	43	9%	35	7%	13	1%	8	1%	5	1%
Don't know	555	57%	267	55%	288	59%	9	1%	4	1%	5	1%
When do you wash your hands?												
After using the toilet	1064	93%	527	92%	537	94%	1124	99%	565	99%	559	98%
Before cooking and eating	1018	89%	519	91%	499	88%	1104	97%	551	97%	553	97%
After handling animals, dirty diapers, or rubbish	529	46%	273	48%	256	45%	915	80%	453	79%	462	81%
Before and after caring for the sick	100	9%	44	8%	56	10%	453	40%	233	41%	220	39%
After coughing or sneezing into your hands	68	6%	31	5%	37	6%	416	36%	209	37%	207	36%
Other/Don't know	160	14%	84	15%	76	13%	101	9%	55	10%	46	8%
How much time should you spend scrubbing your hands while washing them?												
20 seconds or as long as it takes to sing or hum the 'Happy Birthday Song' twice	260	23%	132	23%	128	22%	747	66%	398	70%	349	61%
Other/Don't know	880	77%	438	77%	442	78%	390	34%	171	30%	219	39%
Can you demonstrate how to properly wash your hands?												

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Wet hands with your hands with clean water	1055	93%	535	94%	520	91%	1137	100%	569	100%	568	100%
Apply soap to lather your entire hand	941	83%	442	78%	499	88%	1113	98%	548	96%	565	99%
Scrub back of hands	607	53%	333	58%	274	48%	985	86%	475	83%	510	89%
Scrub palms	587	51%	331	58%	256	45%	971	85%	475	83%	496	87%
Scrub between fingers	406	36%	231	41%	175	31%	982	86%	486	85%	496	87%
Scrub underneath fingernails	123	11%	71	12%	52	9%	799	70%	367	64%	432	76%
Scrub wrists	220	19%	123	22%	97	17%	774	68%	377	66%	397	70%
Rinse your hands with clean water and air dry	782	69%	386	68%	396	69%	935	82%	449	79%	486	85%
Scrub hands for 20 seconds or as long as it takes to sing or hum the Happy Birthday song twice	59	5%	42	7%	17	3%	493	43%	250	44%	243	43%
Did not demonstrate any of the steps	24	2%	7	1%	17	3%	0	0%	0	0%	0	0%
How can someone get worms?												
Eating dirt/soil	525	46%	202	35%	323	57%	963	84%	480	84%	483	85%
Not properly washed raw vegetables and fruits	486	43%	244	43%	242	42%	1035	91%	523	92%	512	90%
Undercooked meat	255	22%	148	26%	107	19%	1030	90%	522	92%	508	89%
Not washing your hands after touching soil	163	14%	82	14%	81	14%	574	50%	300	53%	274	48%
Not washing hands with soap after using toilet	54	5%	31	5%	23	4%	571	50%	311	55%	260	46%
Not washing hands before handling food	65	6%	42	7%	23	4%	460	40%	246	43%	214	38%
Other/Don't know	369	32%	217	38%	152	27%	37	3%	33	6%	4	1%
Who in your household should get dewormed?												
Myself	50	4%	9	2%	41	7%	0	0%	0	0%	0	0%
My spouse	37	3%	22	4%	15	3%	0	0%	0	0%	0	0%
My children	299	26%	145	25%	154	27%	12	1%	6	1%	6	1%
Everyone	708	62%	346	61%	362	64%	1126	99%	562	99%	564	99%
Other/Don't know	95	8%	58	10%	37	6%	1	0%	1	0%	0	0%
Do most people with high blood pressure (BP) or diabetes (sugar) have symptoms?												
Yes, people with one and/or both diseases usually have symptoms	418	37%	222	39%	196	34%	205	18%	94	17%	111	19%
No, most people with high BP and/or diabetes do not have symptoms	721	63%	347	61%	374	66%	934	82%	475	83%	459	81%
High blood pressure (BP) can lead to...?												
Heart disease or heart attack	157	14%	95	17%	62	11%	468	41%	232	41%	236	41%

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Stroke	302	26%	141	25%	161	28%	698	61%	363	64%	335	59%
Death	737	65%	350	61%	387	68%	942	83%	496	87%	446	78%
Other/Don't know	265	23%	142	25%	123	22%	147	13%	77	14%	70	12%
What blood pressure is considered high?												
Greater than or equal to 140/90 mmHg	74	6%	33	6%	41	7%	617	54%	345	61%	272	48%
Other	76	7%	46	8%	30	5%	138	12%	56	10%	82	14%
Don't know	989	87%	491	86%	498	87%	384	34%	168	29%	216	38%
What should someone do if they have high BP?												
Reduce their salt intake	352	31%	182	32%	170	30%	969	85%	506	89%	463	81%
Take medicine prescribed by doctor	437	38%	216	38%	221	39%	828	73%	424	74%	404	71%
Get their BP checked regularly	319	28%	144	25%	175	31%	755	66%	383	67%	372	65%
Exercise	73	6%	43	8%	30	5%	483	42%	270	47%	213	37%
Lose weight if they are overweight	47	4%	17	3%	30	5%	375	33%	184	32%	191	34%
Get checked for diabetes (sugar)	44	4%	17	3%	27	5%	270	24%	132	23%	138	24%
Stop smoking	26	2%	14	2%	12	2%	250	22%	156	27%	94	16%
Other/Don't know	584	51%	294	52%	290	51%	244	21%	116	20%	128	22%
What should someone do if they have diabetes?												
Reduce their sugar intake	551	48%	290	51%	261	46%	1017	89%	529	93%	488	86%
Take medicine prescribed by doctor	363	32%	184	32%	179	31%	807	71%	399	70%	408	72%
Get their sugar checked regularly	228	20%	92	16%	136	24%	685	60%	336	59%	349	61%
Lose weight if they are overweight	41	4%	17	3%	24	4%	345	30%	157	28%	188	33%
Exercise	49	4%	29	5%	20	4%	411	36%	229	40%	182	32%
Get their BP checked	40	4%	16	3%	24	4%	280	25%	145	25%	135	24%
Other/Don't know	518	45%	251	44%	267	47%	170	15%	80	14%	90	16%
On average, how much salt do you add to your evening meal at the table?												
NONE	93	8%	35	6%	58	10%	232	20%	89	16%	143	25%
PINCH	728	64%	394	69%	334	59%	753	66%	397	70%	356	62%
¼ TSP	139	12%	80	14%	59	10%	101	9%	64	11%	37	6%
½ TSP	94	8%	34	6%	60	11%	42	4%	19	3%	23	4%
> = ¾ TSP	86	8%	27	5%	59	10%	12	1%	1	0%	11	2%
On average, how much sugar do you add to your cup of tea or coffee?												
NONE	9	1%	6	1%	3	1%	11	1%	9	2%	2	0%

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< 1 TSP	14	1%	10	2%	4	1%	23	2%	15	3%	8	1%
1 TSP	75	7%	33	6%	42	7%	109	10%	57	10%	52	9%
2 TSP	563	49%	274	48%	289	51%	697	61%	349	61%	348	61%
3 TSP	260	23%	144	25%	116	20%	185	16%	106	19%	79	14%
> = 4 TSP	219	19%	103	18%	116	20%	115	10%	34	6%	81	14%

Table 2: Adoption and maintenance of behavior change two weeks and six months post GHP intervention.

	Two weeks Total (N = 1140)		6 months Total (N = 961)	
	n/mean	%/SD	n/mean	%/SD
What strategies did you and your spouse began implementing?				
Chlorine for drinking water	1103	97%	933	97%
Soap (handwashing)	1085	95%	922	96%
Deworming the entire family	955	84%	779	81%
Reduce salt in cooking (use “Low Salt”)	862	76%	725	76%
Limiting exposure to areas with Bilharzia	525	46%	437	46%
Avoid eating foods with lots of salt (breads, crisps, processed meats such as polony, bacon, sausage)	559	49%	451	47%
Avoid adding a lot of sugar to drinks such as tea, coffee	468	41%	148	15%
Agree on food preparation together	448	39%	333	35%
Avoid or limit the number of drinks with a lot of sugar (soft drinks and alcohol)	435	38%	213	22%
Maintain healthy weight	337	30%	204	21%
Avoid stress	351	31%	192	20%
Eat plenty of fruits and vegetables, including greens	315	28%	110	11%
Increase physical activity (exercise)	309	27%	200	21%
Avoid/limit tobacco products like cigarettes	256	22%	119	12%
Limit alcohol intake	252	22%	76	8%
Drink at least 2 liters of clean water per day	223	20%	48	5%

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Table 3: Impact of the GHP intervention on sharing household duties.

	Baseline						6 months Post-Intervention					
	Total (N = 1140)		Men (N = 570)		Women (n = 570)		Total (N = 961)		Men (N = 481)		Women (n = 480)	
	N	%	N	%	N	%	N	%	N	%	N	%
In terms of your day to day activities in the household, who is primarily responsible for												
Collecting drinking water												
Myself	482	42%	31	5%	451	79%	354	37%	17	4%	337	71%
My spouse	407	36%	387	68%	20	4%	286	30%	277	58%	9	2%
Both of us	169	15%	116	20%	53	9%	284	30%	168	35%	116	24%
Other	75	7%	31	5%	44	8%	33	3%	17	4%	16	3%
NA	7	1%	5	1%	2	0%	1	0%	1	0%	0	0%
Treating drinking water with chlorine												
Myself	211	19%	27	5%	184	32%	280	29%	19	4%	261	54%
My spouse	121	11%	114	20%	7	1%	216	23%	209	44%	7	1%
Both of us	48	4%	35	6%	13	2%	450	47%	245	51%	205	43%
Other	7	1%	5	1%	2	0%	2	0%	1	0%	1	0%
NA	753	66%	389	68%	364	64%	11	1%	6	1%	5	1%
Purchasing food for the house												
Myself	323	28%	212	37%	111	19%	106	11%	61	13%	45	9%
My spouse	260	23%	81	14%	179	31%	99	10%	36	7%	63	13%
Both of us	551	48%	275	48%	276	48%	753	79%	384	80%	369	77%
Other	6	1%	2	0%	4	1%	1	0%	0	0%	1	0%
Preparing the food/ cooking												
Myself	540	47%	24	4%	516	91%	394	41%	14	3%	380	80%
My spouse	482	42%	470	82%	12	2%	375	39%	365	76%	10	2%
Both of us	101	9%	68	12%	33	6%	181	19%	98	20%	83	17%
Other	17	1%	8	1%	9	2%	8	1%	4	1%	4	1%
Taking care of sick persons in household												
Myself	206	18%	29	5%	177	20%	28	3%	3	1%	25	5%
My spouse	87	8%	80	14%	7	1%	21	2%	18	4%	3	1%
Both of us	832	73%	457	80%	375	78%	910	95%	459	95%	451	94%
NA	11	1%	3	1%	8	1%	1	0%	1	0%	0	0%

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Changing baby's nappy												
Myself	408	36%	17	3%	391	69%	364	38%	13	3%	351	73%
My spouse	380	33%	375	66%	5	1%	342	36%	335	70%	7	1%
Both of us	73	6%	51	9%	22	4%	95	10%	62	13%	33	7%
NA	278	24%	127	22%	151	26%	159	17%	71	15%	88	18%
Washing the dishes												
Myself	494	43%	21	4%	473	83%	420	44%	13	3%	407	85%
My spouse	444	39%	438	77%	6	1%	390	41%	383	80%	7	1%
Both of us	98	9%	68	12%	30	5%	96	10%	62	13%	34	7%
Other	103	9%	42	7%	61	11%	53	6%	23	5%	30	6%

NA: Not Applicable

Table 4: Comparison of knowledge uptake in GHP group with the control group that received a different intervention to assess potential contribution of secular trend due to other programs.

	GHP 6 months follow-up						SOV 6 months follow-up					
	Total (N = 961)		Men (N = 481)		Women (n = 480)		Total (N = 986)		Men (N = 493)		Women (n = 493)	
	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD	n/mean	%/SD
How do you treat your drinking water?												
Add chlorine	932	97%	463	96%	469	98%	347	35%	162	33%	185	38%
Boil	368	38%	181	38%	187	39%	294	30%	155	32%	139	28%
Strain it through a cloth	1	0%	1	0%	0	0%	6	1%	2	0%	4	1%
Use a water filter	13	1%	7	1%	6	1%	10	1%	4	1%	6	1%
Solar disinfection	2	0%	0	0%	2	0%	4	0%	2	0%	2	0%
I do not treat my drinking water	1	0%	1	0%	0	0%	396	40%	214	44%	182	37%
Other	2	0%	2	0%	0	0%	2	0%	2	0%	0	0%
Don't know	0	0%	0	0%	0	0%	9	1%	6	1%	3	1%
How much chlorine do you need for a 20 L container?												
Top of cap	18	2%	13	3%	5	1%	178	18%	76	15%	102	21%
Bottom of cap	931	97%	462	96%	469	98%	434	44%	223	45%	211	43%
Other	5	1%	3	1%	2	0%	22	2%	10	2%	12	2%
Don't know	6	1%	3	1%	3	1%	348	35%	182	37%	166	34%
How much chlorine do you need for a 5 L container?												
Top of cap	925	96%	463	96%	462	96%	361	37%	196	40%	165	34%
Bottom of cap	21	2%	12	2%	9	2%	116	12%	52	11%	64	13%

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Other	8	1%	4	1%	4	1%	54	5%	26	5%	28	6%
Don't know	6	1%	2	0%	4	1%	452	46%	217	44%	235	48%
When do you wash your hands?												
After using the toilet	949	99%	473	98%	476	99%	936	95%	471	96%	465	95%
Before cooking and eating	928	97%	460	96%	468	98%	883	90%	443	90%	440	89%
After handling animals, dirty diapers, or rubbish	785	82%	377	78%	408	85%	638	65%	293	60%	345	70%
Before and after caring for the sick	332	35%	179	37%	153	32%	213	22%	112	23%	101	21%
After coughing or sneezing into your hands	278	29%	115	24%	163	34%	154	16%	66	13%	88	18%
Other/Don't know	34	4%	18	4%	16	3%	46	5%	15	3%	31	6%
How much time should you spend scrubbing your hands while washing them?												
20 seconds or as long as it takes to sing or hum the 'Happy Birthday Song' twice	670	70%	330	69%	340	71%	483	49%	220	45%	263	54%
Other	257	27%	141	29%	116	24%	283	29%	170	35%	113	23%
Don't know	33	3%	10	2%	23	5%	213	22%	99	20%	114	23%
Can you demonstrate how to properly wash your hands?												
Wet hands with your hands with clean water	946	99%	474	99%	472	99%	898	91%	442	90%	456	93%
Apply soap to lather your entire hand	926	96%	462	96%	464	97%	868	88%	420	86%	448	91%
Scrub between fingers	808	84%	400	83%	408	85%	524	53%	285	58%	239	49%
Scrub back of hands	836	87%	401	83%	435	91%	618	63%	349	71%	269	55%
Scrub palms	815	85%	404	84%	411	86%	579	59%	326	66%	253	51%
Scrub underneath fingernails	625	65%	265	55%	360	75%	146	15%	70	14%	76	15%
Scrub wrists	659	69%	335	70%	324	68%	312	32%	148	30%	164	33%
Rinse your hands with clean water and allow to air dry	835	87%	393	82%	442	92%	781	79%	388	79%	393	80%
Scrub hands for 20 seconds or as long as it takes to sing or hum the Happy Birthday song twice!	310	32%	161	33%	149	31%	25	3%	11	2%	14	3%
How can someone get worms?												
Undercooked meat	877	91%	437	91%	440	92%	347	35%	215	44%	132	27%
Not properly washed raw vegetables and fruits	872	91%	433	90%	439	92%	466	47%	261	53%	205	42%
Eating dirt/soil	810	84%	392	81%	418	87%	731	74%	343	70%	388	79%
Not washing your hands after touching soil	417	43%	200	42%	217	45%	137	14%	65	13%	72	15%
Not washing hands with soap after using toilet	360	38%	197	41%	163	34%	106	11%	62	13%	44	9%

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Not washing hands before handling food	232	24%	116	24%	116	24%	84	9%	52	11%	32	7%
Other/Don't know	32	3%	23	5%	9	2%	133	14%	76	15%	57	12%
Who in your household should get dewormed?												
Myself	0	0%	0	0%	0	0%	18	2%	8	2%	10	2%
My spouse	0	0%	0	0%	0	0%	20	2%	14	3%	6	1%
My children	12	1%	8	2%	4	1%	231	23%	120	24%	111	23%
Everyone	944	98%	471	98%	473	99%	722	73%	350	71%	372	76%
Other/Don't know	0	0%	0	0%	0	0%	29	3%	5	1%	6	1%
Bilharzia only affects children in rural areas												
True	10	1%	6	1%	4	1%	52	5%	23	5%	29	6%
False	949	99%	475	99%	474	99%	907	92%	450	92%	457	93%
Don't know	0	0%	0	0%	0	0%	23	2%	18	4%	5	1%
People in my household can get bilharzia from bathing, washing and playing in contaminated water where snails are present												
True	946	99%	475	99%	471	99%	922	94%	457	93%	465	95%
False	12	1%	6	1%	6	1%	35	4%	15	3%	20	4%
Don't know	1	0%	0	0%	1	0%	26	3%	19	4%	7	1%
Hypertension/Diabetes												
On average, how much salt do you add to your evening meal at the table?												
NONE	202	21%	82	17%	120	25%	125	13%	70	14%	55	11%
PINCH	570	59%	313	65%	257	54%	700	71%	346	70%	354	72%
¼ TSP	110	11%	65	14%	45	9%	84	9%	41	8%	43	9%
½ TSP	41	4%	10	2%	31	6%	62	6%	24	5%	38	8%
¾ TSP	0	0%	0	0%	0	0%	3	0%	2	0%	1	0%
> = 1 TSP	37	4%	11	2%	26	5%	9	1%	8	2%	1	0%
On average, how much sugar do you add to your cup of tea or coffee?												
NONE	14	1%	6	1%	8	2%	7	1%	4	1%	3	1%
< 1 TSP	6	1%	3	1%	3	1%	8	1%	6	1%	2	0%
1 TSP	78	8%	45	9%	33	7%	41	4%	21	4%	20	4%
2 TSP	652	68%	314	65%	338	71%	500	51%	215	44%	285	58%
3 TSP	155	16%	92	19%	63	13%	343	35%	205	42%	138	28%
> = 4 TSP	55	6%	21	4%	34	7%	82	8%	39	8%	43	9%
How many softies (Coca Cola, etc) do you drink per week? (mean)	2.8	3.2	3.3	3.7	2.3	2.5	2.7	2.7	3.3	3.2	2.1	2.0

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Do most people with high blood pressure (BP) or diabetes (sugar) have symptoms?												
Yes, people with both diseases usually have symptoms	194	20%	83	17%	111	23%	356	37%	197	41%	159	32%
People with either high BP or diabetes usually have symptoms	22	2%	12	3%	10	2%	56	6%	31	6%	25	5%
No, most people with high BP and/or diabetes do not have symptoms	743	77%	385	80%	358	75%	561	58%	254	53%	307	63%
High blood pressure (BP) can lead to...?												
Heart disease or heart attack	308	32%	174	36%	134	28%	146	15%	89	18%	57	12%
Stroke	570	59%	308	64%	262	55%	377	38%	193	39%	184	37%
Death	875	91%	442	92%	433	90%	793	81%	391	80%	402	82%
Other/Don't know	66	7%	36	7%	30	6%	72	7%	42	9%	30	6%
What blood pressure is considered high?												
Greater than or equal to 140/90 mmHg	508	53%	266	55%	242	51%	103	10%	46	9%	57	12%
Other	98	10%	48	10%	50	10%	27	3%	15	3%	12	2%
Don't know	354	37%	167	35%	187	39%	853	87%	430	88%	423	86%
What should someone do if they have high BP?												
Reduce their salt intake	850	89%	437	91%	413	86%	426	43%	187	38%	239	49%
Take medicine prescribed by doctor	708	74%	349	73%	359	75%	614	62%	313	64%	301	61%
Get their BP checked regularly	623	65%	294	61%	329	69%	444	45%	198	40%	246	50%
Exercise	436	45%	240	50%	196	41%	72	7%	48	10%	24	5%
Lose weight if they are overweight	280	29%	150	31%	130	27%	113	11%	46	9%	67	14%
Get checked for diabetes (sugar)	205	21%	98	20%	107	22%	59	6%	29	6%	30	6%
Stop smoking	179	19%	109	23%	70	15%	23	2%	15	3%	8	2%
Other/Don't know	198	21%	108	22%	90	19%	185	19%	85	17%	100	20%
What should someone do if they have diabetes?												
Reduce their sugar intake	862	90%	440	91%	422	88%	540	55%	275	56%	265	54%
Take medicine prescribed by doctor	707	74%	333	69%	374	78%	557	57%	296	60%	261	53%
Get their sugar checked regularly	516	54%	242	50%	274	57%	381	39%	176	36%	205	42%
Lose weight if they are overweight	281	29%	158	33%	123	26%	110	11%	52	11%	58	12%
Exercise	373	39%	198	41%	175	37%	41	4%	32	7%	9	2%
Get their BP checked	195	20%	101	21%	94	20%	52	5%	27	5%	25	5%
Other/Don't know	130	14%	68	14%	62	13%	167	17%	73	15%	94	19%

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Knowledge of lifestyle and dietary changes that people with hypertension should adopt improved for reducing salt intake (31% to 85%), taking prescribed medication (38% to 73%), and getting regular BP checks (28% to 66%). Interestingly, while knowledge of the importance of losing weight if overweight and exercising did improve, fewer than half of respondents mentioned those recommendations even after the intervention. Similar findings were noted with diabetes with reducing sugar intake (48% to 89%), taking prescribed medicine (32% to 71%), and getting sugar levels checked improving substantially (20% to 60%) but far less recall of diet and exercise recommendations.

Respondents did report behavior change after receiving GHP. Participants reporting adding none (or no salt) to their evening meal increased from 8% to 20% after the intervention visit. The percent increase in reporting no salt corresponded to a decrease in those reporting adding a ¼ tsp or more to their evening meal. Similarly, sugar added to a cup of tea of coffee shifted down with those reporting > = 3 tsp dropping from 42% to 26%.

Follow-up, retention and the comparison group (control)

Of the GHP 570 couples who completed baseline, the intervention and the two-week follow-up, 480 completed the 6-month follow-up. The control arm, interviewed at 6 months for comparison, included 489 couples.

Adoption and maintenance of behavior change two weeks and six months post GHP intervention

Table 2 presents strategies ordered by frequency mentioned two weeks post-intervention and compares analogous responses at 6 months. Implemented strategies mentioned at two weeks that were maintained at 6 months included chlorinating drinking water (97%), handwashing with soap (96%), deworming the family (81%) and reducing salt in cooking or using low sodium salt (76%). Some other behaviors adopted with lower frequency were also maintained, including avoiding areas with bilharzia (46%), avoiding salty foods (47% including 50% of men and 44% of women, not shown), and agreeing on food preparation together (35% including 39% of women and 31% of men, not shown).

Other reported health maintenance behaviors were less likely to be maintained over time including limiting sugary drinks, maintaining a healthy weight, avoiding stress, eating plenty of fruits and vegetables, exercising, avoiding tobacco products, limiting alcohol intake and drinking 2 liters of clean water/day.

Impact of the GHP intervention on sharing household duties (Table 3)

While men and women agreed that women usually collected water, the proportion reporting both partners collecting water increased from 15% before the intervention visit to 30% at 6 months, with men more likely to report sharing this duty (35% compared with 24% of women). Similarly, prior to the intervention visit, women assumed most of the responsibility for water chlorination in the 24% of households that used chlorine. After the intervention visit, sharing this responsibility increased to 47% in the 90% of households using chlorine, with the proportion of men reporting sharing 8-9% higher than their wives. Close to half (48%) of respondents at baseline reported sharing food purchasing duties, while a third reported the man took charge of this duty. Sharing food purchasing increased to 65% at two weeks and 79% at 6 months with similar reports from men and women. Food preparation was almost exclusively the woman's responsibility with a modest increase in shared responsibility (from 9% to 22% at two weeks) after the intervention visit. The proportion of couples sharing responsibility for taking care of sick persons in the household increased from 73% prior to the intervention visit to 95% at 6 months. Changing baby's nappy and doing dishes remained primarily a woman's job. Only 20% of households had animals, and handling animals was a shared duty before and after the intervention visit (not shown).

Comparison of knowledge uptake in GHP with the control group that received a different intervention to assess potential contribution of secular trend due to other programs (Table 4)

The control group that received an unrelated HIV intervention was interviewed at 6 months, contemporaneously with participants described in preceding tables, to assess the potential contribution of secular trend due to other water and sanitation, NTD and NCD programs. Knowledge of chlorine for water treatment (97% of GHP group vs. 35% of controls), and how to prepare potable water (96-97% vs. 37%-44%) were higher in the GHP group. When, how long, and the steps involved in hand washing including responses to questions and practical demonstrations were substantially better in the GHP group as was knowledge of how one could get worms and who in the house should be dewormed. The control group respondents reported adding more salt to food and sugar to tea/coffee. The control group was also less likely to know that hypertension and diabetes are usually asymptomatic and can result in heart attack or stroke. Lastly, knowledge of what blood pressure levels are considered high and actions to take if one has high blood pressure or diabetes were uniformly better in the GHP group.

Discussion

Neglected tropical diseases (NTDs) and non-communicable diseases (NCDs) are prominent causes of morbidity and mortality in Zambia. This study confirms

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the urgent need for information and practical training in basic hygiene and sanitation, deworming and dietary and lifestyle changes to prevent respiratory and diarrheal disease, helminthic infection, hypertension and diabetes. Video-based group discussions with practical training in preparation of chlorinated potable water and proper hand washing, combined with provision of chlorine and hand soap, prompted substantial improvements in knowledge and reported behavior. Education about transmission, prevention and treatment of helminths, along with distribution of mebendazole or albendazole for household de-worming, reinforced the importance of chlorine and handwashing. Screening with free treatment for schistosomiasis further heightened awareness of this prevalent but often asymptomatic NTD. Misconceptions about the clinical symptoms, sequelae, and management of hypertension and diabetes were reduced, and participants reported adding less salt to their food and sugar to their tea/ coffee. These benefits were sustained over time, and a contemporaneous comparison with a group who received an unrelated HIV intervention confirmed that other health promotion programs had not resulted in a secular trend that might confound the interpretation of our findings.

Urban sanitation in Zambia is a challenge due to high population density, unplanned growth, and limited resources for conventional sanitation [26]. In Lusaka and Ndola, pit-latrines combined with leaking sewerage discharge untreated human sewage directly into the aquifers which residents rely on for drinking water [27-31]. Cholera outbreaks occur when potable water is unavailable and basic hygiene is poor. In total, 34,950 cases of cholera were reported in Zambia between 2008 and 2017, and the country is considered endemic for cholera with crowded urban areas at highest risk [13,32,33]. Respiratory and diarrheal diseases, among the leading causes of death in Zambia, particularly in children, along with common parasitic infections of the gut [34], can be prevented with handwashing, water chlorination, and periodic household anti-helminthic treatment [35-43]. WHO and UNICEF Joint Monitoring Programme indicators for Water Supply, Sanitation and Hygiene Models using Demographic and Health Surveys and other studies have predicted safely managed drinking water also reduces stunting and diarrhea in children [44,45], thus averting negative health outcomes which may increase risk of NCD later in life [46-49].

Zambia has attempted to address these problems through community-led total sanitation (CLTS), which has emerged as the most widely implemented policy intervention for improving rural sanitation in low-income countries [50]. The Sanitation and Hygiene Applied Research for Equity Programme funded by the UK Department for International Development has also sponsored human resource strengthening in research capacity in Zambia [51]. In November 2011, CTLS was featured as part of the Zambia Sanitation and Hygiene Program (ZSHP) in order to increase the use of improved sanitation facilities and adopt positive hygiene practices [52]. In a pre- and post-assessment of national-scale CLTS programming in Zambia conducted from 2013 to 2016, the authors measured a 16% increase in access to improved sanitation facilities and modest increases in hand washing behavior and dedicated hand hygiene spaces [50]. Our GHP intervention focused on improving knowledge and skills combined with provision of chlorine, hand soap, and deworming medication. As several CLTS survey areas overlapped with our study area [52], we compared our GHP group with our comparison (control) group that received an HIV intervention to assess the role of secular trend in hygiene and sanitation knowledge and behaviors. Our findings confirm that knowledge and use of chlorine remained poor in our comparison group (35% use compared with 97% in the GHP group), as did knowledge of when and how to effectively hand wash and prepare food to reduce transmission and who in the household should be regularly dewormed. These findings reinforce the importance of ongoing and repeated education and commodity provision efforts.

We have recently shown that schistosomiasis is associated with HIV-1 transmission and death in Lusaka, possibly related to enhanced inflammatory responses caused by egg deposition in the lower genital tract [24,53]. A recent assessment based on literature review estimates nationwide prevalence of schistosome infection exceeding 30% with an adult prevalence of 54% [54]. While our program used urine dipstick to assess prevalence of microhematuria suggestive of *Schistosoma haematobium*, hepatosplenic schistosomiasis due to *Schistosoma mansoni* is also a neglected problem in Zambia. On questioning, 68% (75/110) of Zambian patients with portal hypertension (88% of whom were ELISA positive for schistosoma antibodies) knew nothing about schistosomiasis transmission [55]. Although this NTD is generally considered to be concentrated in rural areas or near bodies of water [56], our previous work has shown that 59% of Lusaka residents had positive ELISA titers [24]. Further work is needed to improve knowledge, prevention, screening and treatment for schistosomiasis.

While NTDs, hygiene, and sanitation have long been a focus of concern in Africa, hypertension and diabetes have recently been identified as emerging public health problems. Several studies in Zambia have shown a high prevalence of hypertension in both urban and rural areas [57,58]. In Lusaka, 1,928 individuals participated in the survey, of which 33% were males. 21% of males and 49% of females were overweight or obese. The prevalence for hypertension was 35% (38% of men and 33% of women). Risk factors have been similar to those identified in western countries: older age, male sex, high body mass index, increased alcohol consumption,

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sedentary lifestyle, higher education and smoking [59-61]. One study showed mean total weight of salt added to food was nearly double the WHO recommendation, with women adding significantly more salt to food than men [62]. As in other studies in Africa, lack of and limited knowledge is a barrier to effective prevention, diagnosis, and management of NCDs in the region [63-68]. Most individuals do not know that they have high BP and others do not take any medication [57]. In focus groups, participants cited westernized diets, lack of physical activity, stress, psychological factors and urbanization as causative factors for hypertension. Participants lacked understanding of BP medications, healthy lifestyles, adherence to treatment and ongoing monitoring [62]. Our study confirmed poor knowledge of the manifestations, sequelae, prevention and management of NCD and demonstrated sustained improvement in this knowledge after the intervention. Reported salt intake declined after the GHP intervention, with the proportion no longer adding salt rising from 8% to 20% and the proportion adding > = 1/2 tsp declining from 16% to 5%. We provided low sodium salt (half potassium and half sodium chloride) which is available in Zambian stores and should be more closely studied. Future efforts to improve hypertension control should focus on population preventive care and primary healthcare provider education on individual management [69].

Surveys including measures in blood sugar have found a 15% prevalence of diabetes mellitus in Ndola bank employees [70]. In a household survey in Lusaka adults, the prevalence for impaired glucose level or diabetes was 4% [71]. As in the west, risk factors included obesity, physical inactivity, older age and mild hypertension. The authors conclude that interventions targeting the younger 25-34 age group should be put in place now to curtail the development of diabetes. Our survey confirmed the need for more education: The knowledge that diabetics should reduce sugar intake was only 48% before the intervention visit, rising to 89% afterwards, with corresponding increases in respondents citing taking prescribed medication and getting sugar levels tested regularly. This knowledge translated into reported behaviors with the proportion of respondents adding > = 3 tsp to their cup of tea or coffee decreased from 42% before to 26% after receiving GHP.

In one qualitative study in Zambia, knowledge of cardiovascular disease risk factors was good but "risk factors were difficult to avoid due to ingrained taste preferences for high salt and sugar, increasingly busy lives that force them to use cooking oil to reduce preparation time, cultural preference for big body size or fatness, especially for women, stigmatized body image attached to HIV, stressful life or life events related to poverty, and financial barriers to affording quality foods and healthcare services" [72]. We make a similar observation in our study: While use of salt and sugar declined and knowledge of manifestations and management increased, a minority of participants cited increasing physical activity, maintaining a healthy weight or eating plenty of vegetables and fruit as important strategies. Government clinic nurses who received training in delivering our intervention underwent screening. A number were found to be hypertensive, which was not surprising as they were generally women aged 40-50 age, and many were overweight by international standards. Their views echoed those mentioned above and reinforce the need to include perceptions of health care providers to better inform NCD policy [73].

Other studies have highlighted male involvement in traditionally women-oriented household roles in the context of maternal and child health [74-78]. We have worked extensively with Zambian couples on HIV and unplanned pregnancy prevention, and collaboration between spouses is strongly associated with success in those domains [18,79,80]. We noted an increase in shared household responsibilities relating to collecting and treating water, food purchasing and preparation and taking care of sick persons. This highlights opportunities to engage men in traditionally women-oriented household roles for the betterment of their family's health. This not only can improve family health but also gender equity within the couple.

Limitations

Our study was not without limitations. We acknowledge that a limitation was measuring the impact of knowledge uptake on disease outcomes. Given the increased burden of NTD and NCD in SSA, more studies linking biological markers with knowledge uptake are needed. Additionally, there were limitations in our methods of testing and treatment: our schistosomiasis screening did not include detection of *S. mansoni* as we used urine dipsticks; urine dipstick screening for glucose is less expensive but also less sensitive for diabetes screening than glucometers or HbA1c testing [81-83]; and though we provided albendazole and mebendazole for deworming we understand that this may not adequately treat other helminth infections such as Taenia and protozoa including cryptosporidium, giardia and amoeba [34].

Conclusion

This study shows the feasibility of delivering multiple health education topics without compromising areas. Our study highlights that a video-based intervention focusing on NCDs and NTDs can lead to substantial and sustained knowledge uptake in Zambian couples. As we utilized a simplified flipchart-only version of this tool integrated with CVCT, we would propose expansion of this with CVCT and family planning which is shown to be effective.

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Statement of Equal Authors' Contribution: Author Contributions

T.S. contributed to Conceptualization; Data curation; Formal analysis; Investigation; Methodology; Project administration; Validation; Visualization; Roles/ Writing - original draft; Writing - review & editing. K.W. contributed to Formal analysis; Methodology; Writing - review & editing. Ra. P. contributed to Formal analysis; Methodology; Writing - review & editing. W.K contributed to Conceptualization; Supervision. M.I. contributed to Conceptualization; Supervision. A.T. contributed to Formal analysis; Methodology. K.M. contributed to Data curation; Supervision; Validation; Writing-review & editing. C.K. contributed to Writing - review & editing; N.A. contributed to Writing - review & editing; R.B. contributed to Writing - review & editing; Ro. P. contributed to Supervision; Writing - review & editing; S.A. contributed to Conceptualization; Funding acquisition; Writing - review & editing.

Trial Registration

Retrospectively registered on ClinicalTrials.gov #: NCT02744586.

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