HIV Prevention Counseling Intervention Delivered During Routine Clinical Care Reduces HIV Transmission Risk Behavior in HIV-Infected South Africans Receiving Antiretroviral Therapy: The Izindlela Zokuphila/Options for Health Randomized Trial

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The manuscript is 3484 words long
Abstract

Context. Sustainable interventions are needed to minimize HIV transmission risk behavior among people living with HIV (PLWH) in South Africa on antiretroviral therapy (ART), a significant proportion of whom do not achieve viral suppression.

Objective. To determine whether a brief lay counselor delivered intervention implemented during routine care can reduce sex without a condom among PLWH on ART.

Design. Cluster randomized 16 HIV clinical care sites in KwaZulu Natal, South Africa, to intervention or standard-of-care.

Setting. Publicly funded HIV clinical care sites.

Patients. 1891 PLWH on ART received the HIV prevention counseling intervention (n = 967) or standard-of-care counseling (n = 924).


Main Outcome Measures. Number of sexual events without a condom in the past four weeks with partners of any HIV status, and with partners perceived to be HIV-negative or status unknown, assessed at baseline, 6, 12, and 18 months.

Results. Intervention participants reported significantly greater reductions in HIV transmission risk behavior on both primary outcomes, compared to standard-of-care participants. Differences in STI incidence between arms were not observed.

Conclusion. Effective behavioral interventions, delivered by lay counselors within the clinical care setting, are consistent with the strategy of integrating HIV care and HIV prevention, integrating biomedical and behavioral approaches to stemming the HIV epidemic.
Trial Registration: Not applicable.

**Key words/Phrases:** South African HIV Epidemic, Prevention with Positives, HIV Transmission Risk Reduction
Introduction

The HIV/AIDS epidemic in South Africa has created enormous human suffering in all segments of society. Since the beginning of the South African epidemic, an estimated 2 million adults have died from HIV/AIDS \(^1\,^2\) and more than 2.1 million children have been orphaned by the disease \(^3\). Some 6.1 million South Africans are currently living with HIV \(^4\), the prevalence of HIV infection in the 15-49 year age range is 17.9\% \(^4\), and the incidence of HIV infection is 1.43\% per year among those aged 15-49 \(^3\). More than 370,000 HIV infections and 240,000 AIDS-related deaths occur in South Africa each year \(^4\).

South Africa’s national HIV Testing and Counseling campaign and rollout of antiretroviral therapy (ART) are well underway \(^5\). More South Africans are learning their HIV status and entering clinical care \(^6\), a setting that presents a unique opportunity to link HIV treatment with HIV prevention behavioral interventions for persons living with HIV (PLWH) on ART. PLWH on ART constitute a large and growing population of great significance for impacting South Africa’s HIV epidemic \(^7\). Specifically, South African PLWH, like PLWH everywhere, are variably adherent to ART \(^8\) and to safer sex practices \(^9\,^11\), despite clinic-based standard-of-care ART education and counseling and promotion of safer sex practices. Treatment failure with continuing detectable viremia among South African PLWH on ART is not uncommon \(^12\,^13\) and ART resistance has been found in a large proportion of South African PLWH who have been treated and have experienced therapeutic failure \(^14\,^16\). South African PLWH on ART who have experienced treatment failure may serve as relatively healthy but infectious vectors for transmission of both drug susceptible and drug resistant virus and may contribute to the maintenance or exacerbation of South Africa’s HIV epidemic. South African PLWH on ART
thus represent one potential leading edge of the country’s generalized HIV epidemic and merit priority for behavioral safer sex intervention efforts aimed at averting forward transmission of the virus. PLWH who engage in unprotected sexual behaviors also place themselves at risk for other sexually transmitted infections (STI), associated morbidity, and accelerated progression of HIV disease 17-19, as well as potential superinfection with drug resistant strains of HIV 20-23.

Despite the need for evidence-based safer sex behavioral interventions for PLWH on ART in South Africa and the potential efficacy and efficiency of such interventions when delivered in the clinical care setting, little to no rigorous large-scale research concerning such interventions has been reported 24-28. What has been published are largely pilot studies and descriptions of interventions which have not been rigorously evaluated, or interventions with a very limited follow-up period. There are also a limited number of randomized controlled trials in the United States and other resourced countries of HIV transmission risk reduction behavioral interventions designed specifically for PLWH and delivered in clinical care settings 29-31. We extensively modified the U.S. Options project—which resulted in a significant decrease in risky behavior among PLWH in an HIV clinical care setting 31 – for the South African cultural context, HIV risk dynamics, and health care setting. We conducted a successful pilot study 25 of this intervention and made modifications to bring it to scale. The current research widely implemented and rigorously evaluated this intervention in the South African clinical care setting to assist PLWH on ART to reduce HIV transmission risk behavior. We hypothesized that over an 18-month follow-up period, PLWH participating in the intervention compared to those receiving standard of care (SOC), would demonstrate significantly greater reductions in HIV transmission sexual risk behavior.
Methods

Randomization

Sixteen urban, peri-urban, and rural Primary Healthcare Clinics and Community Health Centers in the uMgungundlovu and uMkhanyakude health districts of KwaZulu-Natal, South Africa, paired on the basis of geography and clinic characteristics (e.g., catchment area, patient population, clinic resources), were cluster randomized to intervention (8 clinics) or SOC (8 clinics) study arms. These health districts report among the highest rates of HIV infection in South Africa, with prevalence among antenatal clinic attendees of 39.8% and 41.1%, respectively. See Figure 1 for the study design.

Participants

HIV-infected participants on ART (N = 1891) were recruited from participating clinical care sites between June 2008 and May 2010. Inclusion criteria were documented HIV infection, receiving HIV care at a participating clinic, prescribed ART, and minimum age 18 years. To maximize statistical power (≥ 80%) to detect changes in HIV transmission risk behavior, enrollment targets specified a minimum of 16 clinics with a minimum of 124 participants per site and used of a sampling strategy that oversampled those reporting recent HIV transmission risk behavior. Sampling targeted a 60:40 distribution of those reporting HIV transmission risk behavior during the past 4 weeks on a pre-enrollment screener vs. those not reporting risk. Similar numbers of HIV-infected women and men on ART were recruited to permit analysis of gender effects.
Procedures

Clinic staff referred eligible HIV-infected patients to a research assistant who described the study and screened interested patients for risky or non-risky sexual behavior in the past 4 weeks. Patients meeting criteria were invited to take part in the study and provide informed consent. Participation consisted of (1) completing audio computer-assisted self-interview (ACASI) and interviewer-administered questionnaires (in isiZulu or English) at four time points over an 18-month period (baseline, 6, 12, and 18 months), (2) providing biological samples to assess sexually transmitted infections (STIs) at three time points (baseline, 12, and 18 months), and (3) consenting to medical chart reviews for CD4 count, HIV viral load, STIs, and health status. As part of routine clinical care, participants in both the intervention (n = 967) and SOC (n = 924) arms received counseling provided by lay counselors concerning issues relevant to PLWH on ART (e.g., medication management; adherence education and counseling). Participants at the eight intervention clinics (n = 967) took part in brief (10-15-minute), theory and evidence-based, tailored one-on-one counseling sessions with trained lay counselors concerning sexual risk behavior reduction. SOC participants received standard of care safer sex promotion messages from counselors, which typically involved standard condom promotion messaging.

Intervention and SOC participants were compensated for completing study measures (R70 ~US $10 per assessment) but not for participation in one-on-one counseling. The study was approved by ethics committees at the University of Connecticut (USA), University of KwaZulu-Natal.
(South Africa), and Centre for Addiction and Mental Health (Canada). Approval for the study was obtained from the Research Committee for the KwaZulu-Natal Department of Health, and the uMgungundlovu and uMkhanyakude District Health Offices. The study was conducted according to the principles of the Helsinki Declaration.

Outcome Measures

The primary outcome measures used in evaluation of the intervention were ACASI-reported number of sexual events without the use of condoms (penile-vaginal or penile-anal) over the past 4 weeks with partners, regardless of perceived partner serostatus, and number of sexual events without condoms over the past 4 weeks specifically with partners perceived to be HIV-negative or HIV status unknown. Additional outcome measures included interviewer assessment of participants’ number of unprotected sexual acts during the past 4 weeks, inconsistent condom use over the past 4 weeks and over the past 3 months (1 = “never” to 5 = “always”), and condom nonuse over the past 6 months (“When did you last have sex without a condom?”). These interviewer-delivered measures partially overlap with the primary outcome measures and were included to provide multiple and potentially convergent endpoints assessed via different methodologies (ACASI and interviewer). Data were cleaned prior to analyses; values entered on ACASI surveys judged to be due to touch screen over-sensitivity (e.g., the same number in duplicate [i.e., 88] or triplicate [i.e., 888]) were set to missing (affecting <1.7% of the data, unrelated to study arm).

Self-collected biological samples (vaginal tampons for women and urine samples for men) at baseline, 12, and 18 months were used to assess incident STIs that included *Neisseria gonorrhoeae* and *Chlamydia trachomatis* in males and females and *Trichomonas vaginalis* in
females. (The 12-month laboratory STI testing was abandoned midway through collection due to financial constraints). Specimens were transported to the laboratory within 48 hours of collection for detection of *Neisseria gonorrhoea, Chlamydia trachomatis*, and *Trichomonas vaginalis*.

Intervention

The *Izindlela Zokuphila/Options for Health* HIV transmission risk reduction counseling intervention for PLWH on ART was delivered by lay counselors on an ongoing basis during routine HIV clinical care visits and was based on the Information-Motivation-Behavioral Skills (IMB) model of health behavior change. The intervention consisted of brief, collaborative, patient-centered discussions between a trained lay counselor and a patient. Motivational Interviewing (MI) techniques were used to: (a) assess the patient’s sexual risk behavior, (b) identify informational, motivational, and behavioral skills barriers preventing the patient from engaging in safer sex, (c) explore strategies that the patient could use to address specific barriers, and (d) negotiate an achievable, individually-tailored behavior change (or maintenance of safer behavior) goal. This intervention demonstrated acceptability, feasibility, and fidelity in South African pilot projects and was adapted for the current study. At the end of each intervention session, lay counselors completed an “Options Record Form” (ORF) which served as a guide for continuing counseling at subsequent sessions and as a measure of intervention fidelity. The full *Izindlela Zokuphila/Options for Health* study protocol is available at

[www.chip.uconn.edu/southafricaoptions](http://www.chip.uconn.edu/southafricaoptions).

Lay Counselor Training and Support
Lay counselors from intervention sites (N = 48) participated in an intensive 5-day training to criterion in the intervention protocol. Telephone consultation, direct observation of intervention delivery, and booster trainings provided ongoing support to lay counselors. Lay counselors at intervention and control sites were already employed as clinic staff, but one additional study-supported lay counselor was hired at each intervention site to assist with intervention delivery, and one additional lay counselor was hired at each control site to provide resource parity.

Analytic Approach
Pretest equivalence and attrition analyses were conducted to identify covariates (any variable at baseline that was non-equivalent between randomized groups or significantly associated with attrition or missing assessments). Sites were randomized to intervention or SOC control condition, and individuals within sites were assessed on 4 occasions (baseline, 6, 12 and 18 months) on the primary and additional risk-related outcomes. Intention to treat (ITT) analyses of risk behavior outcomes used generalized linear mixed effects modeling with non-normal outcome distributions (negative binomial) and AR(1) covariance structure to account for the correlated nature of longitudinal data, negative binomial distributions of outcome measures, and clustering of over time assessments within participants within research site. Analyses used ‘time’ as a continuous variable, with the interaction between time and condition used to determine effect of study condition on changes in risk behavior over time. We repeated analyses using ‘time’ in the class statement to evaluate effects by assessment interval. We found that negative binomial (versus Poisson) distribution on count-based outcomes and AR(1) as opposed to other structures were preferable. Outcomes were evaluated with SAS version 9.3.
using PROC GLIMMIX which accounts for repeated observations of the same individual over
time, nested within clinical care site, and which estimates missing observations via all available
pairs. Missing data were infrequent in our data set; analyses are expected to be robust and
consistent with outcomes that adopt multiple imputation strategies to recover larger gaps in data
coverage. All main analyses were repeated to determine robustness of effects while
controlling for identified covariates and gender. The potential impact of baseline rates of
unprotected sex was included in the models, as baseline risk set the intercept for each
individual’s slope for change over time, although we also compared study arms for potential
differences at baseline. Newly diagnosed STIs at 12 and 18 months relative to baseline were
evaluated for study arm differences using simple chi-square difference tests and logistic
regression.

Results

Patient Characteristics

A total of 1891 HIV+ patients on ART with mean age 37.3 years (range 18-78 years) were
enrolled. At study baseline, approximately two-thirds of the sample had been on ART less than
two years, 30% had CD4+ counts < 200 cells/μL, and approximately one in four participants
(26.1% of men, 22.2% of women) who had chart-based viral load data (N=961 of 1891 [51%])
at study baseline had a detectable viral load. Table 1 provides additional patient characteristic
data. Intervention and SOC arm participants had an equal number of clinical care visits (11, SD
= 4.68, range 1-24) over their study participation. A total of 903 (93.3%) intervention arm
participants were exposed to the intervention, receiving an average of five intervention visits
(range 0 to 15, SD = 2.86, normally distributed).
Baseline Equivalence and Attrition

Baseline levels of the primary and additional risk outcomes, CD4 count, and viral load variables did not differ significantly by condition. Five demographic variables were identified as potential covariates (Table 1) based on non-equivalence between the arms at baseline (cohabitating with sex partner, living in city or township, meeting with a counselor at least every 3 months, physical health, and drinking alcohol at least weekly) and were used as covariates in analyses of intervention outcomes.

Thirteen percent (246/1891) of participants discontinued research participation prior to 18-month assessment. This was evenly distributed between intervention (13.0%) and SOC (13.0%) arms and was not related to covariates identified in pre-test equivalence analyses or to categorical baseline risk variables. Gender was significantly related to attrition; stratified by study arm, men attrited more than women in the SOC condition (17% of men, 10% of women, p = 0.001), with a similar trend in the intervention condition (15% of men, 11% of women, p = 0.06). Gender was therefore included in covariate-controlled analyses of intervention effects. Missing any risk variable assessment at any point was experienced by 316 (16.7%) participants but was not related to condition ($X^2 = 0.09, p = 0.78$) or gender ($X^2 = 0.203, p = 0.65$), and differential measurement attrition by study arm did not occur. Study withdraws were not related to study arm and there were no adverse events due to intervention exposure.

Analyses of HIV Transmission Risk Behavior Outcomes

ITT analyses indicate that, compared to SOC participants, intervention arm participants showed
significantly greater reductions in HIV transmission risk behavior on the primary outcome variables. Specifically, intervention arm participants indicated significantly greater reductions in number of sex events (penile-vaginal or penile-anal) without a condom with any partner regardless of serostatus over the past 4 weeks, and in number of sex events without a condom with partners perceived to be HIV-negative or HIV-status unknown over the past 4 weeks (see Table 2 and Figures 2 and 3).

Reported number of sex events without a condom with partners regardless of serostatus during the past 4 weeks decreased over time for each group (time effect -0.4462, p < .0001 for intervention; -0.2210, p < 0.0001 for SOC). However, membership in the intervention condition was associated with significantly greater reductions in risk compared to SOC (interaction effect -0.224, p < .002). Study arms significantly differed in favor of the intervention condition at each of the 6, 12 and 18 month assessments in relation to number of events without a condom with partners regardless of serostatus during the past four weeks (see Figure 2). Similar results were found with respect to the primary outcome variable of number of sexual events without a condom with partners perceived to be HIV-negative or HIV-status unknown, during the past 4-weeks. Events without a condom involving HIV-negative or HIV status unknown partners significantly decreased over time for intervention and control participants (time effect -0.7212, p <0.0001 in the intervention condition; -0.3124 in the control condition, p < 0.0001), with membership in the intervention condition associated with a significantly greater reduction in sex without a condom than the SOC condition (interaction effect -0.4088, p < 0.0001). The arms significantly differed in number of sexual events without a condom with HIV-negative and HIV-status unknown partners at 12 and 18-month assessment intervals (see Figure 3).
Repeating analyses controlling for covariates and gender produced similar results. Analysis of the additional interviewer-collected outcome data (interviewer administered measures of number of unprotected sexual acts during the past 4 weeks, consistency of condom use during the past 4 weeks and the past 3 months, and condom non-use during the past 6 months) produced similar patterns of results showing that intervention participants reported significantly greater reductions in all additional interviewer collected measures of HIV transmission risk behavior compared to control arm participants (data not shown).

STI findings

STI data were available for 1873 (99%) participants at baseline and 1571 (83%) at 18 months. Missing STI data at 18 months was associated with study arm (15.3% of those in the intervention arm vs. 18.6% of SOC participants were missing STI data at 18 months; $X^2 = 3.82$ (1, 1891), $p = 0.055$). With a total of 221 participants with a confirmed STI at baseline (111 in the intervention condition and 110 in the control condition) excluded, incident STIs were evaluated for those without STI at baseline who had an STI at month 18. A total of 53 (7.4% of valid cases) participants in the intervention arm and 44 (6.8% of valid cases) participants in the control arm had new STIs at month 18 ($X^2 (N=1366) = .168$, ns), which was not a statistically significant difference. Additionally, new STI cases were not significantly different by study arm when considered within gender or considered in terms of specific STI.

Discussion
The current findings support the efficacy of the Izindlela Zokuphila/Options for Health intervention for reduction of HIV transmission risk behavior among HIV-infected South Africans on ART. Intervention compared to SOC participants reported consistent, statistically significant, and meaningful reductions in each primary HIV transmission risk behavior endpoint and in all additional HIV transmission risk behavior endpoints. Findings indicated greater intervention compared to SOC arm reductions in unprotected sexual contacts with all sexual partners and with partners specifically perceived to be HIV-negative or HIV-status unknown. Similar reductions in HIV transmission risk behavior were observed in all additional outcome measures including unprotected sex overall and with HIV-negative and HIV-status unknown partners, across assessment intervals ranging from four weeks to six months, and as assessed by interviewer as well as ACASI methodologies. We note that the intervention was delivered during routine HIV clinical care visits, on an ongoing basis, by trained lay counselors, nearly all of whom were already employed at clinical care sites. This intervention approach provides effective and continuing intervention exposure that links HIV treatment with HIV prevention while deploying existing resources effectively.

The Izindlela Zokuphila/Options for Health intervention is highly compatible with an integrated behavioral and biomedical approach to HIV prevention that incorporates ART treatment and adherence to reduce HIV viral load and HIV transmission risk reduction to prevent forward transmission of HIV from PLWH who have not experienced viral suppression—some 25% of the current ART treated sample. As such, the current intervention represents an important addition to the integrated behavioral and biomedical HIV prevention armamentarium. We note as well that the intervention has considerable promise for widespread and sustainable dissemination at
low cost. The major costs of implementing it as a standard approach to integrated behavioral and biomedical HIV transmission risk reduction would involve training lay counselors already on staff in the intervention protocol and training an existing site mentor to provide ongoing intervention fidelity support, in the service of a substantial reduction in HIV transmission risk behavior.

While this research has several strengths, limitations are also present. First, although the intervention achieved a significantly greater reduction in risk behavior than the SOC condition at nearly all assessment points, the SOC condition also exhibited a significant, albeit less impressive, reduction in risk behavior. Reduction of HIV risk behavior in control conditions of intervention research is commonly observed (e.g., see 45,48) and may be a result of systematic research-related attention and monitoring of risky sexual behavior. Second, we did not observe significant intervention impact on the STI outcome measure. While such an outcome would have been a desirable complement to self-reported outcomes that focus directly on unprotected sexual events, the STI measure was problematic, as we could not account for individuals with symptomatic STIs being diagnosed and treated in between assessment intervals. We note that complexities in the collection and interpretation of STI data as potential proxies for sexual risk behavior are present in a number of published behavioral intervention trials 48,49. With the profile of intervention effects replicating on diverse measures of risk behavior (collected on ACASI, on interview, asked as count data, asked as estimates of frequency of condom use), however, confidence can be placed in the integrity and accuracy of the behavioral risk data.

Conclusion
The current intervention approach provides effective, efficient, and continuing support for HIV transmission risk reduction among HIV-infected South Africans on ART. It is highly compatible with an integrated behavioral and biomedical approach to stemming HIV and holds promise for sustainable and widespread dissemination in intervention efforts linking treatment and prevention to curtail the South African HIV epidemic. Our intervention, situated within the clinical care setting and utilizing existing staff, represents an empirically-supported strategy to leverage existing resources and structures to promote HIV risk reduction among HIV-infected individuals on ART in generalized epidemic, resource-limited, sub-Saharan settings.
Author Contributions


Acquisition of data: S Christie, S MacDonald, N Ngcobo, S Pillay and P Shuper.


Drafting of the manuscript: KR Amico, S Christie, D Cornman, J Fisher, W Fisher, P Shuper.

Critical revision of the manuscript for important intellectual content: J Fisher, D Cornman, P Shuper, S Pillay, S Christie, S MacDonald, N Ngcobo, U Laloo, G Friedland, W Fisher.

Statistical analysis: KR Amico

Obtained funding: D Cornman, J Fisher, W Fisher, S Pillay, P Shuper, G Friedland

Administrative, technical, or material support: J Fisher, D Cornman, P Shuper, S Pillay, S Christie, S MacDonald, N Ngcobo.


P. Shuper and KR. Amico had full access to all of the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

SA Options Team

This study would not have been possible without the hard work and dedication of all members of the SA Options Team. For a full list of team members and their respective contributions, please visit the Center for Health, Intervention, and Prevention (CHIP) website (www.chip.uconn.edu/southafricaoptions).
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References


Table 1. Characteristics of Study Participants.

<table>
<thead>
<tr>
<th>Characteristics</th>
<th>SOC* (n = 924)</th>
<th>Intervention (n = 967)</th>
<th>P value</th>
</tr>
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<tbody>
<tr>
<td>Female</td>
<td>514 (55.6%)</td>
<td>537 (55.5%)</td>
<td>0.967</td>
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<tr>
<td>Male</td>
<td>410 (44.4%)</td>
<td>430 (44.5%)</td>
<td>0.967</td>
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<tr>
<td>Age (M, SD)</td>
<td>37.3 (9.0)</td>
<td>37.3 (9.0)</td>
<td>0.828</td>
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<td>Race/ethnicity</td>
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<td></td>
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<td>Black-Zulu</td>
<td>882 (95.6%)</td>
<td>935 (97.3%)</td>
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<tr>
<td>Black-Xhosa</td>
<td>13 (1.4%)</td>
<td>13 (1.4%)</td>
<td></td>
</tr>
<tr>
<td>Black-Another race</td>
<td>23 (2.5%)</td>
<td>10 (1.0%)</td>
<td></td>
</tr>
<tr>
<td>Indian</td>
<td>2 (0.2%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Coloured</td>
<td>1 (0.1%)</td>
<td>3 (0.3%)</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>2 (0.2%)</td>
<td>0 (0.0%)</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td></td>
<td></td>
<td>0.646</td>
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<tr>
<td>No schooling</td>
<td>134 (14.5%)</td>
<td>133 (13.8%)</td>
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<tr>
<td>Class1/GR1 - STD7/GR9</td>
<td>405 (43.9%)</td>
<td>440 (45.8%)</td>
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<tr>
<td>STD8/GR10 - STD10/Matric/N3/GR12</td>
<td>373 (40.4%)</td>
<td>381 (39.6%)</td>
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<tr>
<td>Post-secondary</td>
<td>11 (1.2%)</td>
<td>7 (0.7%)</td>
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<tr>
<td>Employment and Income</td>
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<tr>
<td>Currently unemployed</td>
<td>657 (71.2%)</td>
<td>698 (72.2%)</td>
<td>0.629</td>
</tr>
<tr>
<td>Household income ~R1500/Month (~US $200)</td>
<td>394 (70.7%)</td>
<td>538 (72.6%)</td>
<td>0.354</td>
</tr>
<tr>
<td>Relationship and Family</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Married/living with a partner</td>
<td>213 (23.1%)</td>
<td>203 (21.1%)</td>
<td>0.279</td>
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<tr>
<td>Cohabitating with sex partner</td>
<td>475 (51.4%)</td>
<td>449 (46.4%)</td>
<td>0.031</td>
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<tr>
<td>Have one or more children</td>
<td>809 (88.4%)</td>
<td>861 (89.4%)</td>
<td>0.493</td>
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<tr>
<td>Currently trying to have a baby</td>
<td>227 (24.6%)</td>
<td>272 (28.1%)</td>
<td>0.086</td>
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<tr>
<td>Housing</td>
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### OPTIONS FOR HEALTH RANDOMIZED TRIAL

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1</th>
<th>Group 2</th>
<th>p-value</th>
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</thead>
<tbody>
<tr>
<td>Housing location = Rural</td>
<td>617 (66.9%)</td>
<td>653 (67.5%)</td>
<td>0.778</td>
</tr>
<tr>
<td>Dwelling Type = Informal</td>
<td>509 (55.1%)</td>
<td>532 (55.1%)</td>
<td>0.974</td>
</tr>
<tr>
<td>Lives in City or Township</td>
<td>149 (16.1%)</td>
<td>204 (21.1%)</td>
<td>0.006</td>
</tr>
</tbody>
</table>

### HIV Diagnosis and Treatment at Study Baseline (Clinical chart extraction)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1</th>
<th>Group 2</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>HIV positive for 2 or more years</td>
<td>415 (57.6%)</td>
<td>372 (56.8%)</td>
<td>0.752</td>
</tr>
<tr>
<td>On ARTs for 2 or more years</td>
<td>304 (35.9%)</td>
<td>277 (33.2%)</td>
<td>0.241</td>
</tr>
<tr>
<td>CD4 Count &lt;200</td>
<td>233 (29.9%)</td>
<td>230 (29.7%)</td>
<td>0.920</td>
</tr>
<tr>
<td>HIV viral load &lt;=50 copies/mL= Undetectable (±90 days from Baseline†)</td>
<td>367 (78.3%)</td>
<td>364 (74.0%)</td>
<td>0.121</td>
</tr>
</tbody>
</table>

### Self-Reported Physical and Mental Health

<table>
<thead>
<tr>
<th>Variable</th>
<th>Group 1</th>
<th>Group 2</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Meets with a counselor at clinic at least every 3 months</td>
<td>774 (83.8%)</td>
<td>770 (79.6%)</td>
<td>0.020</td>
</tr>
<tr>
<td>FAHI - Physical Health (possible range=0-40) (M, SD)</td>
<td>28.2 (8.0)</td>
<td>26.9 (8.2)</td>
<td>0.001</td>
</tr>
<tr>
<td>Depressed (Modified CESD using 15 as cutoff)</td>
<td>197 (21.3%)</td>
<td>239 (24.7%)</td>
<td>0.080</td>
</tr>
<tr>
<td>Reported drinking alcohol weekly or more frequently</td>
<td>48 (5.2%)</td>
<td>16 (1.7%)</td>
<td>0.0001</td>
</tr>
</tbody>
</table>

* Standard-of-care

Percentages are based on the number of participants who indicated a specific response divided by the number of participants who responded to the item in question.

Significant differences presented as adjusted scores using mean substitution for missing values to allow for use of variable in main analyses (2 missing values for living in city or township; 3 missing values for cohabitation; 3 missing values for seeing counselor at least every 3 months; 16 missing values for drinking weekly; and 1 missing value for depression scores). Missingness was unrelated to condition.
Table 2. ITT generalized linear mixed effects modeling with non-normal outcome distributions (negative binomial) and AR(1) covariance structure comparing intervention to control.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Estimate</th>
<th>Standard Error</th>
<th>df</th>
<th>t</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of events without condom</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with any partner</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.6239</td>
<td>0.1891</td>
<td>6</td>
<td>3.30</td>
<td>0.0164</td>
</tr>
<tr>
<td>Condition (Intervention)</td>
<td>0.08902</td>
<td>0.2646</td>
<td>6</td>
<td>0.34</td>
<td>0.7480</td>
</tr>
<tr>
<td>Time effect in Intervention Arm</td>
<td>-0.4462</td>
<td>0.05162</td>
<td>6628</td>
<td>-8.64</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Time effect in Control Arma</td>
<td>-0.2210</td>
<td>0.05098</td>
<td>6628</td>
<td>-4.33</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Time by condition (Intervention)</td>
<td>-0.2241</td>
<td>0.07351</td>
<td>6628</td>
<td>-3.05</td>
<td>0.0023</td>
</tr>
<tr>
<td><strong>Number of events without condom</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>with partners perceived to be HIV negative or HIV status unknown partners</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>0.01043</td>
<td>0.1353</td>
<td>6</td>
<td>0.08</td>
<td>0.9411</td>
</tr>
<tr>
<td>Condition (Intervention)</td>
<td>0.2293</td>
<td>0.1895</td>
<td>6</td>
<td>1.21</td>
<td>0.2717</td>
</tr>
<tr>
<td>Time effect in Intervention Arm</td>
<td>-0.7212</td>
<td>0.05328</td>
<td>6628</td>
<td>-13.54</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Time effect in Control Arma</td>
<td>-0.3124</td>
<td>0.04604</td>
<td>6628</td>
<td>-6.79</td>
<td>&lt;.0001</td>
</tr>
<tr>
<td>Time by condition (Intervention)</td>
<td>-0.4088</td>
<td>0.07042</td>
<td>6628</td>
<td>-5.81</td>
<td>&lt;.0001</td>
</tr>
</tbody>
</table>

* Derived by model where intervention arm served as referent group. Intervention condition=1; Control condition=0.
*Follow-up is defined as completing the ACASI and the Interviewer measure, or completing either the ACASI measure or the Interviewer measure.

†GEE analyses required two of more assessment periods with a valid score on the specified risk behavior variable to be included in the ITT. 94% of randomized participants met this criteria in the intervention arm and in the control arm.
**Figure 2.** Model Estimated Mean Number of Events without a condom with any Partner During the Past Four weeks.

Results indicate a statistically significant decrease favoring the intervention arm at each follow-up time point with a 72% total reduction in events without a condom from baseline by 18-months in the intervention group versus a 45% reduction in the control arm.

Error bars represent +/- 1 standard error with non-overlap in errors between group estimates reflecting significant group differences, also designated with * p < .05.
Figure 3. Model Estimated Mean Number of Events without a Condom with Partners Perceived to be HIV-negative or HIV-status unknown During the Past Four weeks.

Results indicate a statistically significant decrease favoring the intervention group with an 86% total reduction in events without a condom from baseline by 18-months in the intervention group versus a 59% reduction in the control arm.

Error bars represent +/- 1 standard error with non-overlap in errors between group estimates reflecting significant group differences, also designated with * p < .05 and ** p < .01 on over time axis.