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Promotion and integration of couples' HIV voluntary counseling and testing (CVCT) with other health services for HIV prevention

By

Kristin M. Wall

Doctor of Philosophy

Epidemiology

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Promotion and integration of couples' HIV voluntary counseling and testing (CVCT) with other health services for HIV prevention

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An abstract of

A dissertation submitted to the Faculty of the

James T. Laney School of Graduate Studies of Emory University

in partial fulfillment of the requirements for the degree of

Doctor of Philosophy

in Epidemiology

2012

Abstract

Promotion and integration of couples' HIV voluntary counseling and testing (CVCT)

with other health services for HIV prevention

By Kristin Wall

Couples' HIV voluntary counseling and testing (CVCT) is a high-impact testing strategy in which sexual partners jointly test for HIV, disclose results, and formulate counselor-mediated risk reduction plans. CVCT decreases HIV transmission and HIV risk behaviors. The WHO 2012 CVCT guidelines emphasize the need for increased CVCT access, as well as the synergistic impact of CVCT when integrated with other couple-focused health services on outcomes including increased family planning uptake and reduced intimate partner violence (IPV). This dissertation is comprised of three studies focusing on strategies for CVCT promotion and integration with family planning and IPV services, which remain operational challenges despite clear mandates.

In our first study, we identify predictors of CVCT uptake in Lusaka, Zambia to improve CVCT promotional strategies. Using multivariable logistic regression models with generalized estimating equation methods, we found recruiting CVCT promoters who had previously tested with partners, inviting acquaintances of CVCT promoters, inviting couples (versus individuals) in discreet locations, and utilizing non-government and health network (versus private) CVCT promoters increased CVCT uptake.

Our second study evaluated the impact of a family planning intervention on incident pregnancy among HIV positive couples receiving CVCT services in Lusaka, Zambia. This randomized controlled trial (RCT) of two video-based interventions showed that, among baseline contraceptive users, viewing a video focusing on longer-acting contraceptive methods was associated with a significantly lower pregnancy incidence.

Our final study identified factors associated with experiencing recent IPV or coercion within men who have sex with men (MSM) couples enrolled in a RCT of CVCT in the US. Using multilevel actor-partner interdependence models, factors associated with experiencing recent IPV were non-black/African American actor race, lower actor education, and lower partner education. Factors associated with experiencing coercion were younger actor age and lower partner education.

These findings will inform the design of promotional strategies, family planning interventions, and screening tools for IPV and coercion within the context of CVCT to further leverage the impact of CVCT and couple-focused health services. Our results can be extended as a framework to understanding CVCT promotions and integration with health services in other populations at high risk for HIV.

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Chapter 1: Introduction

Project summary

Couples' HIV voluntary counseling and testing (CVCT), in which both sexual partners test for HIV and mutually disclose their results, addresses issues with disclosure, enables serostatus-based formulation of risk-reduction plans, and has been shown to reduce high-risk behavior and HIV transmission [1-4]. CVCT was established in Africa over two decades ago and is a high-leverage HIV prevention intervention in that setting [5]. Roughly 60-94% of HIV transmissions in Africa occur within cohabiting couples [6], and CVCT can reduce HIV transmission by an estimated 50% in discordant couples [1, 7]. However, although CVCT has been shown to significantly reduce HIV incidence in the highest risk group in the world, and widespread CVCT access for at-risk couples has been recommended by the World Health Organization (WHO), operationalizing promotion of CVCT remains a critical research gap [4]. An improved understanding of country-specific and population-specific predictors of successful CVCT promotions is needed in order to improve promotional strategies.

Integrating CVCT with family planning services is another opportunity to decrease HIV risk and maximize the impact of CVCT. Integration of family planning and HIV prevention studies can potentially improve contraceptive method initiation, method continuation, decrease unintended pregnancy, and decrease vertical HIV transmission. However, significant gaps in the current evidence for integration remain, as most previous studies have insufficient follow-up time to evaluate long term effects such as incident pregnancy, and little focus being given to interventions targeting couples

[8, 9]. Currently, there are no published results of randomized controlled trials of family planning interventions in the context of CVCT.

Additionally, CVCT makes particular sense for men who have sex with men (MSM) given close parallels between the US MSM and African heterosexual epidemics: HIV prevalence among US MSM is around 20% [10], and roughly 68% of new transmissions occur between main partners [11]. CVCT is currently being scaled-up for MSM in the US and is particularly important given the reemergence of HIV among US MSM [12] and preliminary studies suggesting demand for this intervention in the US [13]. In the first randomized controlled trial of CVCT for MSM in the US, experiencing intimate partner violence (IPV) and coercion between study partners were screened for as a human subjects protection measure. MSM may be at increased risk for experiencing and perpetrating IPV and coercion relative to heterosexual females and non-MSM males [14-16], and these behaviors have been independently associated with negative health outcomes including increased HIV risk among MSM [17-19]. Therefore, coupling screening for experienced IPV and/or coercion and CVCT services is dually important for the successful, ethical scale-up of the CVCT intervention for MSM in the US, and as an intervention opportunity to decrease IPV-associated HIV risk. Investigation of the socio-demographic factors associated of these behaviors in this population will allow for the much needed development of improved screening tools [20].

Thus, understanding the successful promotion and integration of CVCT with other health services aiming to decrease HIV risk is critical to the sustained implementation and maximization of this evidence-based intervention targeting segments of the population where the burden of incident HIV infection is greatest or increasing.

The proposed work will study predictors of CVCT promotions in Lusaka, Zambia, a locale in which capacity has already been established, with the expected result of discovering novel predictors of successful CVCT promotion. This research will also represent initial steps to establish a broader programmatic experience for coupling CVCT and other HIV prevention services within new populations (IPV/coercion screening for MSM in the US) and existing health services (family planning services for sero-discordant heterosexual couples in sub-Saharan Africa).

Project narrative

Given strong evidence from several African countries supporting the ability of CVCT to decrease high-risk sexual behavior and reduce HIV transmission between couples, we believe the CVCT promotional model may be replicated and extended to other countries within and outside of Africa to educate, encourage, and incentivize couples to attend CVCT. Specifically, the results of the first research study will identify practical means to promote CVCT in Lusaka, Zambia that may be explored as potential predictors of CVCT uptake in different locations.

The integration of CVCT with a family planning intervention designed to increase long-acting contraceptive method uptake in Lusaka, Zambia will be explored. We expect the results of this study will mutually reinforce HIV prevention and unplanned pregnancy prevention to address obstacles at the client, provider, and policy levels. Successful integration of CVCT and family planning services, a key goal of the US Global Health Initiative and the WHO, could provide a paradigm for existing CVCT centers.

Finally, extending on the African model, the first steps toward scale-up of CVCT services for MSM in the US are underway, creating an opportunity to screen for IPV and

coercion, two behaviors associated with increased HIV risk, among MSM couples. Actor-partner factors and dyadic-characteristics associated with experiencing IPV or coercion within MSM couples enrolled in a randomized controlled trial of CVCT will be evaluated. The results of this study are expected to identify predictors of IPV and coercion to inform the design of better screening tools for these HIV-risk behaviors.

Specific aims

To study CVCT promotion and integration with other health services, the following Specific Aims will be addressed:

1. Evaluate the ability of community-based activities to identify predictors of CVCT uptake in Lusaka, Zambia
2. Evaluate the impact of a family planning intervention offered within the context of CVCT on pregnancy incidence in Lusaka, Zambia
3. Evaluate factors associated with IPV and coercion within MSM couples enrolled in a randomized controlled trial of CVCT in the US

Chapter 2: Promotion of couples' voluntary HIV counseling and testing in Lusaka, Zambia by influence network leaders and agents (*accepted, BMJ Open [21]*)

Promotion of couples' voluntary HIV counseling and testing in Lusaka, Zambia by influence network leaders and agents

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Running Head: Couples' voluntary HIV counseling and testing promotions

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Keywords: community workers, couples' voluntary counseling and testing, HIV, Zambia

Word Count:

Text: 3106 words

Abstract: 300 words

ABSTRACT

Objectives: Hypothesizing that couples' voluntary counseling and testing (CVCT) promotions can increase CVCT uptake, this study identified predictors of successful CVCT promotion in Lusaka, Zambia.

Design: Cohort study

Setting: Lusaka, Zambia

Participants: 68 influential network leaders [INLs] identified 320 agents [INAs] who delivered 29,119 CVCT invitations to heterosexual couples

Intervention: The CVCT promotional model used INLs who identified INAs who in turn conducted community-based promotion and distribution of CVCT invitations in two neighborhoods over 18 months, with a mobile unit in one neighborhood crossing over to the other mid-way through.

Primary outcome: The primary outcome of interest was couple testing (yes/no) after receipt of a CVCT invitation. INA, couple, and invitation characteristics predictive of couples' testing were evaluated accounting for two-level clustering.

Results: INAs delivered invitations resulting in 1727 couples testing (6% success rate). In multivariate analyses, INA characteristics significantly predictive of CVCT uptake included promoting in community-based (adjusted odds ratio [aOR]=1.3; 95%CI=1.0-

1.8) or health (aOR=1.5; 95%CI=1.2-2.0) networks versus private networks; being employed in the sales/service industry (aOR=1.5; 95%CI=1.0-2.1) versus unskilled manual labor; owning a home (aOR=0.7; 95%CI=0.6-0.9) versus not; and having tested for HIV with a partner (aOR=1.4; 95%CI=1.1-1.7) or alone (aOR=1.3; 95%CI=1.0-1.6) versus never having tested. Cohabiting couples were more likely to test (aOR=1.4; 95%CI=1.2-1.6) than non-cohabiting couples. Context characteristics predictive of CVCT uptake included inviting couples (aOR=1.2; 95%CI=1.0-1.4) versus individuals; the woman (aOR=1.6; 95%CI=1.2-2.2) or couple (aOR=1.4; 95%CI=1.0-1.8) initiating contact versus the INA; the couple being socially acquainted with the INA (aOR=1.6; 95%CI=1.4-1.9) versus having just met; home invitation delivery (aOR=1.3; 95%CI=1.1-1.5) versus elsewhere; and easy invitation delivery (aOR=1.8; 95%CI=1.4-2.2) versus difficult as reported by the INA.

Conclusions: This study demonstrated the ability of influential people to promote CVCT and identified agent, couple, and context-level factors associated with CVCT uptake in Lusaka, Zambia. We encourage the development of CVCT promotions in other sub-Saharan African countries to support sustained CVCT dissemination.

BACKGROUND

In 2009, 68% of the global HIV-positive population resided in sub-Saharan Africa, equating to roughly 22.5 million cases. Zambia has one of the largest HIV burdens, with roughly 980 000 prevalent and 76 000 incident cases in 2009,[22] and HIV prevalence roughly twice as high in urban (20%) versus rural (<10%) areas.[23]

Heterosexual transmission is the primary cause of incident HIV infections in sub-Saharan Africa where discordant couples (an HIV+ and HIV- partner) in long-term relationships represent the largest group at-risk for HIV.[6, 22] In urban Zambia, roughly 60% of new infections occurred between married/cohabiting heterosexual couples [6], and 17% of pregnant couples in Lusaka were discordant.[24]

Knowledge of HIV serostatus is critical for transmission prevention. According to the 2007 Zambia Demographic and Health Survey, although most adults know where to receive an HIV test, only 35% of women and 20% of men have ever tested and received results.[23] Voluntary HIV counseling and testing [VCT] is an evidence-based strategy to increase serostatus awareness, decrease high-risk behavior, and decrease transmission.[25] Couples' VCT [CVCT], in which both partners are tested and mutually disclose results, addresses issues with disclosure, allows for risk-reduction planning based on partner serostatus, and decreases high-risk behavior.[1, 3, 5] However, though CVCT effectively targets the highest at-risk group in sub-Saharan Africa, it has not been widely disseminated due to lack of demand and supply, and lack of funding. Lack of demand primarily results from insufficient knowledge about the possibility of couple serodiscordance and CVCT services.[5, 26-28]

The Zambia-Emory HIV Research Project [ZEHRP], based in Lusaka, provides CVCT services. ZEHRP and other groups have shown clinic and community-based CVCT promotions can increase CVCT awareness and demand.[24, 28-31] Social networks and community leaders are critical in changing perceptions towards HIV/AIDS and other health issues in sub-Saharan Africa. [32-35] At ZEHRP, CVCT promotional efforts are directed by influential network leaders [INLs] and agents [INAs], based on the Social Networks and Social Support Theory.[36] This study assessed the ability of INLs and INAs to promote CVCT and identified predictors of CVCT uptake in Lusaka.

METHODS

INL and INA recruitment and training

ZEHRP CVCT promotions maximize program impact by utilizing two existing social networks levels -- INLs and INAs. INL and INA recruitment and training methods are described elsewhere.[30, 37] Briefly, INLs were identified from CVCT consensus meetings and national/citywide umbrella referrals from four social networks (faith-based/religious, health, private, and community-based/non-governmental organizations [CBO/NGO]). INLs identified INA candidates from their respective networks, and final selection was made after interviewing with experienced ZEHRP counselors. INLs and INAs completed IRB-approved written informed consents, completed demographic questionnaires, and selected a network category that best described their role when promoting CVCT. Enrolled INAs received four-day training in HIV/AIDS health advocacy/outreach, social networking, CVCT promotions, and observation of successful

door-to-door ZEHRP promotional strategies. During training, INLs and INAs were offered CVCT or VCT.

CVCT promotions

CVCT promotional activities took place from July 2004-December 2005 in two randomly selected neighborhoods as described elsewhere.[38] Briefly, of eight neighborhoods assessed as potential sites, two were selected based on similar population size, infrastructure, and with consideration of geographic distance to minimize spillover effects. CVCT promotions and services were implemented in these neighborhoods, and a mobile unit operated in one neighborhood and crossed over to the other mid-way through the study. Given the catchment areas of these two neighborhoods (99,280 and 85,022 individuals), it was assumed that couples would rarely receive multiple invitations. INAs distributed invitations to couples or individuals within their neighborhoods that detailed CVCT facility directions and procedures. Couples could be cohabiting or non-cohabiting. Invitations included a unique ID, INA identifier, and a receipt portion that the INA retained and submitted bi-weekly. The receipt portion contained the invitation ID and space to record the date, time, place of invitation, relationship of the INA and recipient, recipient description (man, woman, or couple), recipients' age(s), residence, marital status, and INA's perception of the difficulty of invitation delivery.

Before March 18, 2005, INAs received $0.21/invitation issued and an additional $4.20/couple attending CVCT. Beginning March 19, 2005, payment/invitation was reduced to $0.11 and payment/couple attending CVCT was increased to $5.25 to deter fraudulent completion of invitation receipts. In addition to fixed CVCT sites, which could serve 30 couples/day, a mobile HIV testing unit, which could serve an additional

30 couples/day, was available for nine months in one neighborhood and then nine months in the other. Mobile testing sites were selected based on facility (churches, schools, and community centers) availability. For perspective, Purchasing Power Parity in Zambia, an adjusted measure of per-capita-income number, is $1500/year,[39] and the proportion of Zambians living on less than $1/day is 63.6%.[40]

CVCT procedures

CVCT procedures are described elsewhere.[30] Briefly, couples participate in group counseling, joint pre-test counseling, and, for those testing, confidential informed consent procedures, phlebotomy, rapid HIV testing,[41] and joint post-test counseling and test result delivery. CVCT services were free and transportation to testing sites was reimbursed. Invitation receipts were collected from INA-invited couples and the invitation ID was linked to the couple ID number. The study was approved by the Emory University IRB and the University of Zambia Research Ethics committee. Informed consent was obtained from all study participants.

Statistical analysis

Counts (percentages) for categorical variables and means (standard deviations) for continuous variables were calculated for INL, INA, couple, and invitation-level characteristics. Number of invitations distributed was tabulated by INA characteristic as were success rates (the number couples tested/number invitations distributed). Analyses were stratified by couple cohabitation status to identify differences in CVCT uptake and predictors of success. INAs not achieving ≥1.5% success were excluded from analyses to prevent inclusion of INAs systematically returning fraudulent receipts.

Crude odds ratios [ORs], 95%CIs, and p-values evaluated associations between INA-level characteristics predictive of successful invitations. Generalized estimating equation [GEE] methods evaluated the association between couple and invitation-level characteristics predictive of successful invitations. Since couple and invitation-level data are clustered at two-levels, within individual INAs and INLs, GEE methods accounted for non-independence of observations.

INA, couple, and invitation-level variables significant (Bonferroni corrected p-value=0.002) in univariate analyses were entered into a multivariate logistic regression model, and variables were examined for multi-collinearity. GEE methods accounted for clustering of couple and invitation-level characteristics within individual INAs and INLs. We fit the marginal multilevel logistic regression model using PROC GENMOD. GEE analysis methods with an exchangeable correlation structure accounted for two-level clustering of couple and invitation level characteristics within individual INAs and INLs. We hypothesized a priori that an exchangeable correlation structure would be appropriate since couples within a cluster should not be increasingly/decreasingly correlated. We also considered other correlation structures, such as unstructured. Data analysis was conducted with SASv9.2 (North Carolina, USA).

RESULTS

INL characteristics

Sixty-eight INLs were recruited from CBO/NGO, faith-based, health, and private sector networks. Average INL age was 45 (inter-quartile range [IQR]=36-52), and 68% were men. Average years living in Lusaka was 25 (IQR=15-34), and 72% were married.

Almost all INLs understood Nyanja and/or Bemba or English, roughly half owned their home, and most had previously tested for HIV (Table 1).

INA characteristics associated with couples' testing (Tables 1-2)

INLs recruited 320 INAs (excluding 70 INAs with <1.5% success), and overall, INAs distributed 29,119 invitations with 1727 couples tested for an average of 91 invites/INA and 5 couples tested/INA. INAs affiliated with CBO/NGOs distributed more than average invitations/INA and were more likely to successfully invite cohabiting couples relative to private network INAs. Health network INAs also distributed a high number of average invitations/INA and were more successful among all couples relative to private network INAs (Tables 1-2).

Most INAs were women, and performance with respect to invitations delivered, success rates, and average number of couples tested was similar by gender (Table 1). Average INA age was 37 (IQR=29-44), and older INAs were significantly more successful among cohabiting, but less successful among non-cohabiting, couples relative to younger INAs (Table 2). The average number of years living in Lusaka was 21 (IQR=11-30) (data not shown), and years living in Lusaka significantly predicted successful invitation among cohabiting couples (Table 2).

Married INAs were significantly more successful among cohabiting couples relative to divorced, widowed, or single INAs (Table 2). Divorced INAs had very low success rates among non-cohabiting couples (Table 1). Among INAs with a partner, years of current relationship had a similar effect as age, with longer unions associated with significantly decreased success among non-cohabiting couples.

Seventy-four percent of INAs were sales/service industry employees, and these INAs were significantly more successful among cohabiting and non-cohabiting couples relative to unskilled manual laborers. Professional and agricultural sector employees were also more successful among non-cohabiting couples (Table 2). Eighty percent of INAs could read English (Table 1), and this was associated with successful invitations among non-cohabiting couples only.

Over half of INAs rented their home. The 38% who owned a home were less successful than those who rented or lived in housing provided by others; with stratification this remained significant only among cohabiting couples (Table 2). Two percent of INAs had housing provided by an employer and were substantially more successful among cohabiting couples (Table 1).

Only 57% of INAs had tested for HIV with a partner (22%) or alone (35%) (Table 1). INAs testing for HIV with a partner were more successful among all couples, and testing alone was associated with higher success among non-cohabiting couples relative to never testing (Table 2).

Seventy INAs did not achieve 1.5% success and were excluded from analyses as their invitation receipts were suspected to have been fraudulently completed. These INAs distributed 125 invitations/INA and were similar to INAs in the analysis by gender (χ^2 test of association=0.8, p=0.4), age (t-statistic=-1.9, p=0.06), and network ($\chi 2$=3.7, p=0.3). The average success of these 70 INAs was 0.57%, and when adding these INAs to those included in the analysis, overall INA success was 4.97%.

Couple and invitation characteristics associated with couples' testing (Table 3)

The mean age of men was 33 and of women was 27 years. Couples' testing were slightly older than those not testing ($p<0.001$). Most couples were cohabiting, and these were significantly more likely to test versus non-cohabiting couples. The mean duration of relationship was 6 years, and tested couples had been together on average one year longer than non-tested couples.

INAs initiated contact 93% of the time, though in the rare instances when the couple or the woman initiated contact with the INA, the couple was more likely to test. Inviting a couple together also resulted in increased testing. Couples who were family members or social acquaintances of the INA were more likely to test versus those previously unacquainted. Ease of invitation delivery (operationalized as not being time-consuming, requiring long explanations, challenging because of invitee resistance or scheduling conflicts) was also associated with couples' testing. Interestingly, though public endorsements were predictive of testing during a pilot study [30], they were not associated with increased uptake of testing in this larger study. Similarly, the presence of mobile units was not associated with increased testing.

Multivariate model of couples' testing predictors (Table 4)

Age of the man and woman were collinear and woman's age was excluded from the multivariate model. Couple cohabitation status was an effect measure modifier, and multivariate analyses were stratified by cohabitation status. All adjusted ORs [aORs] presented below were statistically significant in multivariate analyses accounting for two-level clustering.

Health sector INAs were most successful (aOR=1.5) followed by CBO/NGO INAs (aOR=1.3) relative to private sector INAs. Married INAs were more successful

versus others among cohabiting couples (aOR=1.3). Sales/service industry employees (aOR=1.5) versus unskilled manual laborers were more successful overall. Among non-cohabiting couples, INAs who could read English were more successful (aOR=2.0) whereas among cohabiting couples, INAs owning homes were less successful (aOR=0.7). INAs who had tested for HIV with a partner were more successful among all couples (aOR=1.4), while those who had tested for HIV alone were more successful among non-cohabiting couples (aOR=2.1), versus INAs who had never tested. Cohabiting couples were more likely to test (aOR=1.4) versus non-cohabiting couples.

Invitation-level predictors of testing among cohabiting couples included inviting the couple versus the woman alone (aOR=1.3); also couple (aOR=1.4) versus INA initiated contact was predictive. Being socially acquainted with the INA (aOR=1.6) versus having just met was predictive among all couples, while home CVCT invitation delivery (aOR=1.4) versus elsewhere, and easy invitation delivery (aOR=1.9) versus difficult were predictive among cohabiting couples.

DISCUSSION

In an African capital city where very few couples have jointly tested for HIV, a promotional program using INLs and INAs prompted approximately 100 couples/month to seek CVCT. INA network, occupation, marital status, and testing history, as well as couple cohabitation status and the INA-invitee relationship, influenced invitation success. Invitations delivered to the couple, in the home, and invitations initiated by the woman partner were also significant CVCT uptake predictors.

CBO/NGO and health network INAs were more successful than faith-based or private sector INAs. CBO/NGO networks included parent teacher, legal aid, skills

training, and health information organizations. Health networks included clinical officers, nurses, home healthcare visitors, community health workers, neighborhood health committee members, and traditional birth attendants. The private sector included individuals who were self-employed or those involved in providing the public with goods or services. Previous studies have similarly demonstrated the ability of influential people to effectively disseminate information and change attitudes and behaviors towards HIV in sub-Saharan Africa.[33-35] Unlike health and CBO/NGO INAs, private sector INAs may have been preoccupied with income generation and/or did not have similar opportunities to integrate CVCT promotions into their daily routine. The marginal performance of faith-based INAs was surprising given Zambia is strongly religious; however, though religious leaders have opportunities to promote from the pulpit, the stigma associated with sexually transmitted infections [STIs] may inhibit open discussion of CVCT.[34, 42]

Cohabiting couples were more likely than non-cohabiting couples to test, and married INAs delivered more successful invitations than unmarried INAs. Fear of stigma among married couples is common,[26, 43, 44] and perhaps married INAs were able to more successfully overcome this barrier with their fellow married couples. INAs who previously tested for HIV with a partner were also more successful than those who had not tested, likely due to their firsthand knowledge of CVCT procedures and ability to speak personally to perceived CVCT barriers.

INAs socially acquainted with the invitee were more successful versus those who were previously unacquainted. The strength of INA-invitee relationship may facilitate open discussion of CVCT and engender confidence. INAs inviting the couple together

versus either partner alone, potentially removing pressure for one partner to propose testing to the other, were also more successful. Previous studies support the effectiveness of couple-level targeted prevention strategies.[30, 45-48]

Though most invitations were initiated by INAs, when the woman partner initiated contact with the INA, CVCT uptake increased. This finding likely reflects pre-existing motivation to discuss or participate in CVCT.

Invitations delivered in the home versus community were more effective. Previous studies indicate that home and workplace HIV counseling and testing promotions are more successful in Zambia, Uganda, and Malawi relative to community locations.[49-52] These findings are likely due to increased discretion and comfort associated with home settings.

Results from a similar study using both INLs and INAs in Kigali, Rwanda highlight country-specific similarities and differences. Similar to Zambia, Rwandan health INAs were more successful relative to private network INAs. Married Rwandan INAs were more successful than single INAs, and cohabiting couples were more likely to test than non-cohabiting couples in univariate analyses. We similarly found that invitations delivered to couples socially acquainted with the INA, woman partner initiated contact, and invitations delivered in the home were more successful in multivariate analyses in Rwanda. In contrast to this study, Rwandan faith-based INAs were more successful in univariate analyses relative to private network INAs, and the overall INA success rate in Rwanda was higher (18%). Mobile units were also associated with increased testing in Rwanda.[37] We were surprised that the mobile unit was not predictive of testing in this analysis as in Rwanda, not because of mitigated transportation

costs, which were reimbursed, but because of the increased convenience and decreased time commitments engendered by mobile testing. More research is needed to determine why the mobile testing units did not increase uptake.

Kigali and Lusaka, though both capital cities, differ in several important ways: Kigali has a monolingual population of 800,000 with easy and inexpensive transportation. In contrast, Lusaka's 1.7 million inhabitants represent all 73 Zambian languages/dialects, the city is large, and transportation is expensive. Another study in the Bemba-speaking Copperbelt region of Zambia combined INA promotions with mass media strategies in two cities of 600,000 each and obtained success rates between those found in Lusaka and Kigali.[31] These linguistic and infrastructural differences highlight the importance of testing and adapting network-based promotional models to different environments.

Results from a pilot study of promotions in Lusaka with 33 INAs (no INLs) showed that, while invitation-level predictors were similar to those found in this larger study, the small sample size did not allow simultaneous detection of INA, couple, and invitation-level characteristics in hierarchical analysis.[30] Similarly, the Copperbelt study described previously did not examine INA, couple, or invitation-level predictors of success.[31]

The exclusion of the 70 INAs who did not achieve 1.5% success was considered necessary in order to determine the INA-level predictors of successful invitation delivery among INAs not returning fraudulent invitation receipts. We acknowledge that this exclusion may discount INAs who were poor performers in addition to INAs returning

fraudulent receipts thereby reducing the generalizability of our findings to more productive INAs..

Overall, this study demonstrated the feasibility of CVCT promotions in Lusaka, and we believe success rates could be considerably increased by utilizing the modifiable predictors of CVCT uptake identified: recruiting INAs who have tested with partners, focusing invitations on INA acquaintances, issuing invitations to couples and in a discreet location, and utilizing INAs from CBO/NGO and health networks. It should be noted that most of the statistically significant aORs are close to the null suggesting cautious interpretation of these associations. More research is especially needed to encourage faith-based leaders in Zambia to more effectively promote CVCT.

CONCLUSION

CVCT is an evidence-based testing strategy shown to reduce transmission of HIV and other STIs and to help prevent unintended pregnancies in sub-Saharan Africa. However, CVCT has yet to be widely implemented in this region.[1, 3, 24, 53-57] Here, we demonstrated not only the feasibility of CVCT promotions using INAs and INLs, but also identified practical INA, couple, and invitation-level factors which were marginally though significantly predictive of CVCT uptake in these analyses. These predictors can be used to enhance CVCT promotions in Zambia and may be extended as a framework to other locales, with adaptation based on location-specific predictors of CVCT promotions.

Contributorship statement

Kristin M Wall – made substantial contributions to the analysis and interpretation of data, drafting the article and revising it critically for important intellectual content, and gave final approval of the version to be published

William Kilembe - made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Azhar Nizam – made substantial contributions to the analysis and interpretation of data, revising the article critically for important intellectual content, and gave final approval of the version to be published

Cheswa Vwalika – made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Michelle Kautzman – made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Elwyn Chomba - made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Amanda Tichacek - made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Gurkiran Sardar - made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Deborah Casanova - made substantial contributions to data aquisition, revising the article critically for important intellectual content, and gave final approval of the version to be published

Faith Henderson - made substantial contributions to data aquisition, revising the article critically for important intellectual content, and gave final approval of the version to be published

Joseph Mulenga - made substantial contributions to data aquisition, revising the article critically for important intellectual content, and gave final approval of the version to be published

David Kleinbaum - made substantial contributions to the analysis and interpretation of data, revising the article critically for important intellectual content, and gave final approval of the version to be published

Susan Allen - made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published

Acknowledgements

We would like to acknowledge and thank the study participants, staff, interns, and Project Management Group members of the Zambia-Emory HIV Research Project in Lusaka,

Zambia. We would also like to thank Drs Joseph Telfair, David L Roth, Leslie Clark, and Alan Haworth for participating in the development of this intervention.

Competing interests

The authors have no competing interests, including relevant financial interests, activities, relationships, and affiliations.

Data sharing statement

There is no additional data available.

Funding

This work was supported by funding from the National Institute of Mental Health [R01 66767]; the AIDS International Training and Research Program Fogarty International Center [D43 TW001042]; the Emory Center for AIDS Research [P30 AI050409]; National Institutes of Health [R01s AI40951, AI51231, HD40125]; and the International AIDS Vaccine Initiative.

Table 1. INL and INA characteristics by invitations distributed, success rate, and couple cohabitation status

	INL (N=68)		INA (N=320)		Invitations Distributed	Couples Tested	Average invites/ INA
	N	%	N	%			
Total	**68**		**320**		**29119**	**1727**	**91**
Network							
Private	16	24%	73	23%	5592	302	77
Religious	19	28%	62	19%	5530	282	89
Health	12	18%	95	30%	9529	617	100
CBO/NGO	21	31%	90	28%	8468	526	94
Gender							
Man	46	68%	131	41%	11620	700	89
Woman	22	32%	189	59%	17499	1027	93
Relationship status							
Married	49	72%	208	65%	18814	1178	90
Divorced	5	7%	21	7%	2033	86	97
Single	7	10%	38	12%	2902	131	76
Widow	7	10%	45	14%	4212	303	94
Missing	0	0%	8	3%	1158	29	145
Occupation							

Professional/technical/ managerial	28	41%	68	21%	5605	330	82
Sales/service	22	32%	163	51%	11462	793	70
Agricultural	1	1%	6	2%	739	43	123
Unskilled manual labor	12	18%	42	13%	5352	278	127
Do not work for money	2	3%	33	10%	4912	253	149
Missing	3	4%	8	3%	1049	30	131
Read English							
Yes	64	94%	265	83%	23744	1439	90
No	4	6%	55	17%	5375	288	98
Housing							
Provided by employer (free)	5	7%	6	2%	372	38	62
Rental home	22	32%	166	52%	16341	985	98
Free housing by other means	10	15%	26	8%	1611	113	62
Own home	30	44%	120	38%	10583	585	88
Missing	1	1%	2	1%	212	6	106
Ever tested for							

HIV							
Yes with partner	41	60%	71	22%	6274	303	88
Yes alone	14	21%	113	35%	10424	608	92
No	13	19%	135	42%	12207	802	90
Missing	0	0%	1	0%	214	14	214

Table 1 (continued)

Average couples tested/INA	**Success Rate (%)**	**% invitations given to cohabiting couples**	**% couples tested who are cohabiting**	**Success Rate (%)**	
				Cohab Couples	**Non-Cohab Couples**
5	**6%**	**81%**	**87%**	**6%**	**4%**
4	5%	79%	82%	6%	3%
5	5%	85%	95%	6%	4%
6	6%	80%	86%	7%	5%
6	6%	82%	87%	7%	4%
5	6%	81%	85%	6%	5%
5	6%	82%	88%	6%	4%
6	6%	82%	88%	7%	4%
4	4%	82%	94%	5%	1%
3	5%	74%	83%	5%	3%
7	7%	83%	84%	7%	7%

4	3%	78%	79%	3%	2%
5	6%	80%	81%	6%	5%
5	7%	81%	88%	7%	5%
7	6%	75%	77%	6%	5%
7	5%	84%	90%	6%	3%
8	5%	82%	90%	6%	3%
4	3%	82%	100%	3%	0%
5	6%	81%	86%	6%	4%
5	5%	82%	92%	6%	2%
6	10%	83%	95%	12%	3%
6	6%	81%	86%	6%	4%
4	7%	80%	89%	8%	4%
5	6%	82%	87%	6%	4%
3	3%	62%	100%	5%	0%
4	5%	82%	93%	5%	2%
5	6%	81%	87%	6%	4%
6	7%	81%	85%	7%	5%
14	7%	86%	86%	7%	7%

INL: influential network leader

INA: influential network agent

Table 2. Bivariate association between INA characteristics and couples' testing by couples' cohabitation status

	All Couples			
INA characteristics	**Odds Ratio**	**95% CI**		**p-value**
Network				
Private	Ref			
CBO/NGO	1.23	1.06	1.43	0.01
Health	1.29	1.12	1.49	0.001
Religious	1.06	0.90	1.26	0.48
Gender				
Male	Ref			
Female	0.97	0.88	1.07	0.58
Age (per year increase)	1.01	1.00	1.01	0.07
Years living in Lusaka (per year increase)	1.01	1.00	1.01	<0.001
Relationship status				
Other (divorced, widowed, single)	Ref			
Married	1.19	1.07	1.32	0.001
Years of relationship (per year increase)*	1.00	0.99	1.01	0.97

Occupation				
Unskilled manual labor	Ref			
Professional	1.14	0.97	1.35	0.11
Sales/service	1.36	1.18	1.56	<0.001
Agricultural	1.13	0.81	1.57	0.48
Do not work for money	0.99	0.83	1.18	0.92
Read English				
No	Ref			
Yes	1.14	1.00	1.30	0.05
Housing				
Other housing (rental, free)	Ref			
Own home	0.89	0.80	0.98	0.02
Ever tested for HIV				
No	Ref			
Yes with partner	1.39	1.21	1.59	<0.001
Yes alone	1.22	1.06	1.41	0.01

*Among those with a partner

INL: influential network leader

INA: influential network agent

Table 2 (continued)

Cohabiting Couples				Non-cohabiting Couples			
Odds Ratio	**95% CI**		**p-value**	**Odds Ratio**	**95% CI**		**p-value**
Ref				Ref			
1.21	1.03	1.42	0.02	1.35	0.88	2.06	0.17
1.25	1.07	1.46	0.01	1.56	1.04	2.35	0.03
1.07	0.90	1.27	0.47	1.02	0.63	1.66	0.94
Ref				Ref			
1.01	0.91	1.12	0.84	0.79	0.60	1.03	0.09
1.01	1.00	1.01	0.002	0.98	0.96	0.99	0.001
1.01	1.01	1.01	<0.001	1.00	0.99	1.01	0.80
Ref				Ref			
1.22	1.09	1.36	0.001	0.96	0.73	1.26	0.75
1.01	1.00	1.01	0.09	0.95	0.93	0.97	<0.001
Ref				Ref			
1.02	0.86	1.22	0.82	2.25	1.42	3.57	0.001
1.31	1.13	1.52	<0.001	1.73	1.12	2.67	0.01

0.95	0.66	1.38	0.79	2.24	1.01	4.97	0.05
0.99	0.82	1.18	0.87	1.09	0.63	1.88	0.76
Ref				Ref			
1.06	0.92	1.21	0.44	2.12	1.35	3.33	0.001
Ref				Ref			
0.89	0.79	0.99	0.03	0.88	0.66	1.16	0.36
Ref				Ref			
1.26	1.09	1.45	0.002	2.97	1.85	4.78	<0.001
1.13	0.97	1.31	0.11	2.42	1.48	3.95	<0.001

Table 3. Bivariate association between couple and invitation characteristics and couples' testing accounting for clustering within INAs and INLs

	All couples		**Couples not tested**	
	N	**%**	**N**	**%**
Couple Characteristics				
Age of man (mean, SD)	33.25	9.03	33.16	8.99
Age of woman (mean, SD)	27.12	7.75	27.03	7.72
Relationship of couple				
Not cohabiting	5275	18%	5058	19%
Cohabiting	23664	82%	22161	81%
Years of relationship (mean, SD)	6.27	6.42	6.22	6.35
Number of children (mean, SD)	2.04	2.16	2.04	2.16
Invitation Characteristics				
Invitee (1st contact)				
Woman	8934	31%	8426	31%
Couple	8567	30%	7972	29%
Man	11467	40%	10851	40%
Who initiated contact?				
INA	26620	93%	25103	93%
Couple	527	2%	475	2%
Man	877	3%	811	3%
Woman	690	2%	624	2%

Relationship to INA				
Just met/unknown	19688	68%	18749	69%
Co-worker	287	1%	269	1%
Family	1697	6%	1525	6%
Social acquaintance (neighbor, friend, church member)	7186	25%	6601	24%
Place of invitation				
Community	9828	34%	9339	35%
Couple home	15460	54%	14532	54%
INA home	1636	6%	1461	5%
Couple or INA work	1812	6%	1702	6%
Public endorsement				
No	18148	63%	17080	63%
Yes	10715	37%	10066	37%
Delivering invitation				
Difficult/somewhat difficult	3030	10%	2912	65%
Easy	25860	89%	1599	35%
Mobile unit present at time of invitation				
No	14268	49%	13713	50%
Yes	14622	51%	13679	50%
Neighborhood of invitation				
Neighborhood 1	13705	47%	12911	47%

Neighborhood 2	15414	53%	14481	53%

Table 3 (continued)

Couples tested		**Odds Ratio**	**95% CI**		**p-value**
N	**%**				
34.61	9.43	1.01	1.01	1.02	<0.001
28.60	8.15	1.02	1.02	1.03	<0.001
217	13%	Ref			
1503	87%	1.58	1.38	1.81	<0.001
7.18	7.38	1.02	1.01	1.03	<0.001
2.06	2.12	1.01	0.99	1.03	0.29
508	30%	Ref			
595	35%	1.24	1.08	1.43	0.002
616	36%	0.91	0.81	1.03	0.13
1517	89%	Ref			
52	3%	1.71	1.34	2.18	<0.001
66	4%	1.18	0.88	1.58	0.26
66	4%	1.59	1.20	2.10	0.001

939	55%	Ref			
18	1%	1.35	0.89	2.06	0.16
172	10%	2.08	1.75	2.49	<0.001
585	34%	1.64	1.43	1.87	<0.001
489	29%	Ref			
928	55%	1.41	1.23	1.61	<0.001
175	10%	2.25	1.87	2.71	<0.001
110	6%	1.21	0.97	1.51	0.09
1068	62%	Ref			
649	38%	1.04	0.92	1.17	0.53
118	0.4%	Ref			
24261	99.5%	1.60	1.33	1.93	<0.001
909	53%	Ref			
818	47%	1.12	0.89	1.39	0.33

794	46%	Ref			
933	54%	0.97	0.79	1.18	0.74

Community: church/mosque, clinic, market, street/public place, social gathering

INL: influential network leader

INA: influential network agent

Table 4. Multivariate model of INA level, couple level, and invitation level characteristics associated with couples' testing

	All Couples			
	Odds Ratio	**95% CI**		**p-value**
INA characteristics				
Network				
Private	Ref			
Religious	1.01	0.71	1.43	0.95
Health	1.53	1.15	2.04	0.004
CBO/NGO	1.34	1.01	1.77	0.04
Years living in Lusaka	1.01	1.00	1.02	0.14
Age (per 1 year increase)	1.00	0.99	1.02	0.79
Marital status				
Other (divorced, widowed, single)	Ref			
Married	1.23	0.99	1.53	0.06
Occupation				
Unskilled manual labor	Ref			
Professional	1.19	0.77	1.84	0.45
Sales/service	1.45	1.01	2.10	0.05

Agricultural	1.14	0.65	2.01	0.64
Do not work for money	0.95	0.62	1.45	0.81
Reads English				
No	Ref			
Yes	1.18	0.90	1.55	0.22
Housing				
Other housing (rental, free)	Ref			
Own home	0.74	0.59	0.92	0.01
Ever tested for HIV				
No	Ref			
Yes with partner	1.36	1.07	1.72	0.01
Yes alone	1.28	1.00	1.64	0.05
Couple Characteristics				
Age of man (per 1 year increase)	1.00	1.00	1.01	0.30
Years of relationship (per 1 year increase)	1.01	0.99	1.02	0.35
Relationship of couple				
Not cohabiting	Ref			
Cohabiting	1.39	1.19	1.63	<0.001
Invitation Characteristics				
Invitee (1st contact)				

Individual (Woman/Man)	Ref			
Couple	1.20	1.04	1.39	0.01
Who initiated contact?				
INA	Ref			
Couple	1.35	1.03	1.78	0.03
Man	1.22	0.89	1.67	0.22
Woman	1.60	1.17	2.19	0.003
Relationship to INA				
Just met/unknown	Ref			
Co-worker	1.48	0.89	2.43	0.13
Social acquaintance (neighbor, friend, church member, family)	1.62	1.41	1.87	<0.001
Place of invitation				
Other (Community or couple/INA work)	Ref			
Couple or INA home	1.30	1.14	1.48	<0.001
Delivering invitation				
Difficult/somewhat difficult	Ref			
Easy	1.75	1.41	2.17	<0.001

Table 4 (continued)

Cohabiting Couples				**Non-cohabiting Couples**			
Odds Ratio	**95% CI**		**p-value**	**Odds Ratio**	**95% CI**		**p-value**
Ref				Ref			
1.01	0.73	1.40	0.94	1.16	0.49	2.77	0.74
1.48	1.11	1.97	0.01	1.80	0.96	3.35	0.07
1.31	0.98	1.76	0.07	1.53	0.84	2.79	0.16
1.01	1.00	1.02	0.07	1.01	0.99	1.04	0.24
1.00	0.99	1.02	0.53	0.99	0.97	1.01	0.35
Ref				Ref			
1.28	1.02	1.60	0.03	1.06	0.70	1.62	0.77
Ref				Ref			
1.06	0.69	1.64	0.79	1.98	0.92	4.27	0.08
1.37	0.94	1.99	0.11	1.67	0.88	3.19	0.12
0.97	0.55	1.72	0.93	1.68	0.60	4.67	0.32
0.95	0.62	1.45	0.80	0.69	0.26	1.82	0.45

Ref				Ref			
1.15	0.87	1.51	0.32	1.98	1.05	3.72	0.03
Ref				Ref			
0.73	0.58	0.91	0.01	0.93	0.62	1.38	0.71
Ref				Ref			
1.29	1.01	1.66	0.04	2.13	1.27	3.57	0.004
1.21	0.94	1.56	0.15	1.92	1.10	3.35	0.02
1.01	1.00	1.02	0.10	1.03	1.00	1.05	0.02
1.02	1.01	1.03	<0.001	0.45	0.37	0.55	<0.001
n/a				n/a			
Ref				Ref			
1.27	1.09	1.49	0.003	0.82	0.52	1.28	0.38
Ref				Ref			
1.43	1.05	1.94	0.02	0.94	0.27	3.20	0.92

1.26	0.90	1.75	0.18	1.00	0.47	2.12	1.00
1.53	1.10	2.12	0.01	1.54	0.73	3.27	0.26
Ref				Ref			
1.47	0.84	2.55	0.18	1.11	0.27	4.56	0.89
1.60	1.37	1.87	<0.001	1.60	1.15	2.24	0.01
Ref				Ref			
1.39	1.21	1.61	<0.001	0.93	0.68	1.27	0.65
Ref				Ref			
1.87	1.47	2.37	<0.001	1.15	0.67	1.99	0.61

INA: influential network agent

Chapter 3: Impact of long-term contraceptive promotion on incident pregnancy: a randomized controlled trial among HIV positive couples in Lusaka, Zambia (*submitted, JAIDS*)

Impact of long-term contraceptive promotion on incident pregnancy: a randomized controlled trial among HIV positive couples in Lusaka, Zambia

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Running Head: Family planning intervention among HIV positive couples

Conflicts of interest and source of funding: The authors have no conflicts of interest, including relevant financial interests, activities, relationships, and affiliations. This work was supported by funding from the National Institutes of Child Health and Development [NICHD RO1 HD40125]; National Institute of Mental Health [NIMH R01 66767]; the AIDS International Training and Research Program *Fogarty International Center* [D43 TW001042]; the Emory Center for AIDS Research [P30 AI050409]; National Institute of Allergy and Infectious Diseases [NIAID R01 AI51231]; and the International AIDS Vaccine Initiative.

Trial registration number: NCT00067522 (registered at clinicaltrials.gov)

Counts:

Text: 3,368

Abstract: 204

Tables: 2

Figures: 2

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Meetings at which parts of the data were presented:

Wall KM, Bellington V, Haddad L, Htee Khu N, Vwalika C, Kilembe W, Chomba E, Stephenson R, Kleinbaum D, Nizam A, Brill I, Tichacek A, Allen S. Effect of an intervention to promote contraceptive uptake on incident pregnancy: a randomized controlled trial among HIV positive couples in Zambia. Abstract submission number 247684. AIDS Vaccine 2012. Boston, MA, Sept 2012.

ABSTRACT

Objectives: To evaluate the impact of family planning promotion on incident pregnancy in a combined effort to address Prongs 1 and 2 of Prevention of Mother-to-Child Transmission of HIV.

Design: We conducted a factorial randomized controlled trial of two video-based interventions.

Methods: "Methods-focused" and "Motivational" messages promoted long-term contraceptive use among 1060 couples with HIV in Lusaka, Zambia.

Results: Among couples not using contraception prior to randomization (N=782), the video interventions had no impact on incident pregnancy. Among baseline contraceptive users, viewing the "Methods" video which focused on the IUD and contraceptive implant was associated with a significantly lower pregnancy incidence (HR=0.38; 95%CI:0.19-0.75) relative to those viewing control and/or motivational videos. The effect was strongest in concordant positive couples (HR=0.22; 95%CI:0.08-0.58) and couples with HIV+ women (HR=0.23; 95%CI:0.09-0.55).

Conclusions: The "Methods video" intervention was previously shown to increase uptake of longer-acting contraception and to prompt a shift from daily oral contraceptives to quarterly injectables and long-acting methods such as the IUD and implant. Follow-up confirms sustained intervention impact on pregnancy incidence among baseline contraceptive users, in particular couples with HIV positive women. Further work is needed to identify effective interventions to promote long-acting contraception among couples who have not yet adopted modern methods.

Key words: Couples' voluntary HIV counseling and testing, family planning, long-term contraception, randomized controlled trial, Zambia

INTRODUCTION

Total fertility rates (TFR) in Africa are among the world's highest, and though knowledge of modern contraception is increasing, women in many countries do not have access to these methods [58-60]. The United Nations has emphasized effective family planning as critical for economic recovery and development in Africa, and African countries are adopting family planning in order to advance maternal and child health, improve human rights, and moderate demographic trends. Some successes have been observed: the TFR in Rwanda decreased from 8.5 pre-genocide [61] to 5.0 in 2010 [62]. Until 2010, Zambia's fertility was declining, with a TFR of 7.2 in 1980, 6.7 in 1990, and 6.0 in 2000 [63]. A TFR of 5.2, the lowest observed in Zambia, was recorded from 2003-2009. However, the TFR has increased in recent years to 6.1 in 2010 and 6.0 in 2011 [64].

Barriers to family planning in sub-Saharan Africa include reduced contraception availability; lack of knowledge about available contraception methods (especially long-acting reversible methods such as the copper intrauterine device (IUD) and the contraceptive implant; fear of side-effects (especially among HIV positive women); and social, cultural and religious practices discouraging contraception use and encouraging childbearing [65-68]. Additionally, many women are not decision makers within the family, and African men often control sexual and familial economic decision-making [69-71].

Long-acting reversible user-independent contraceptive (LARC) methods, including the IUD and the contraceptive implant, are not subject to user error or re-supply like oral contraceptive pills (OCPs) and injectables, making them more effective at preventing pregnancy and more cost-efficient over the long term [72]. Barriers to IUD and implant use include client misconceptions about safety, lack of understanding about their mechanism of action, and lack of culturally-sensitive marketing to increase knowledge and allay concerns related to LARC methods [73, 74]. Few nurses in sub-Saharan Africa have the training to provide these contraception methods to patients [75]. This leads to poor knowledge of LARC methods among patients because nurses are not inclined to discuss what they are not comfortable or able to provide [76]. This cycle can be overcome by addressing supply-and-demand aspects concurrently by giving providers didactic training to improve knowledge and practical skills to ensure their comfort with insertions and removals, in tandem with medical education for clients [77, 78].

In Zambia, policies adopted in 1989 emphasized the goal of reducing population growth by controlling fertility [79] through increasing family planning services, raising the age of marriage, improving the status of women, providing family planning education, and incorporating economic incentives for reduced fertility [80]. The Zambian government endorses the complete range of contraceptive options with an emphasis on "method mix" and the capacity to provide all methods [81]. Today, user-dependent methods like daily OCPs and progesterone-based injectables like depot medroxyprogesterone acetate (DMPA), which must be administered every 13 weeks, are the most common methods in Zambia [82]. Overall contraceptive use is 23% among

women of reproductive age, and 17% use a modern form of contraception [83]. Less than 2% of women use a LARC method.

Despite social marketing efforts for family planning in Zambia and efforts by the Planned Parenthood Association of Zambia to include men in family planning services [84], spousal communication is often poor [85]. Findings from a community-based contraceptive distribution program suggest that involving both partners enhances service delivery and that involving men directly is more productive than asking women to discuss and negotiate family planning issues with their spouses [86-88].

In areas of high HIV prevalence and total fertility, it is critical to find family planning interventions that are effective and feasible in reducing unintended pregnancies. We present the results of a randomized controlled trial evaluating whether a video-based family planning intervention with a particular focus on LARC methods (addressing Prong 2 of PMTCT) influenced time to pregnancy among HIV sero-discordant and concordant positive couples obtaining couples' voluntary HIV counseling and testing (CVCT) services (Prong 1 of PMTCT) in Lusaka, Zambia.

METHODS

Study design

The study design and contraceptive uptake after two video interventions have been previously reported [89], as has the impact of the informed (IC) on knowledge of contraceptive methods and beliefs about efficacy and side effects [90]. Briefly, a factorial randomized controlled trial was designed to evaluate two interventions to promote contraceptive use among sero-discordant and concordant positive couples identified from CVCT clinics in Lusaka, Zambia. Consecutively numbered envelopes

were prepared in the US and shipped to Zambia, each containing a random assignment to "Methods", "Motivation", "Methods + Motivation", or "Control" videos in a 1:1:1:1 ratio. Couples viewed the designated videos followed by a counselor-facilitated discussion. The "Methods" video presented information about contraceptive methods starting with the LARC methods, specifically IUD and implant, followed by DMPA, OCP, emergency contraception, and permanent methods (tubal ligation and vasectomy). The "Motivational" video modeled future planning behaviors in a dramatized format; the impact of this intervention on will writing, financial planning, and appointing guardians has been previously published [90]. A "Control" video contained information on hand washing, bed-net use, and nutrition. Enrollment began in July 2002 and follow-up ended May 2006, prior to widespread availability of antiretrovirals in Lusaka. The study was approved by Office for Human Research Protections (OHRP)-registered Institutional Review Boards at Emory University and in Zambia. Written informed consent (IC) was obtained from all participating couples.

Outcome of interest

The outcome of interest was time to pregnancy, operationalized as clinically confirmed pregnancy or a positive pregnancy test at a follow-up visit (follow-up visits were scheduled every three months, with the possibility of client-initiated interim visits as needed). Participants were censored at death, loss to follow-up/dropout, exit interview, or the defined end-date of the study.

Exposures of interest

The exposure of interest was the arm of trial. Covariates of interest included socio-demographics, sexual behavior and health descriptors, and women's contraceptive

history. Socio-demographic and health and contraceptive history variables, including household income, English language ability, occupation, religion, and fertility intentions were collected at baseline prior to the intervention [91]. Time-varying variables, including contraceptive method uptake during follow-up, sero-conversion during follow-up, and method stopping/starting/switching, were collected at 3-month interval visits or at interim visits. The HIV stage variable was derived from laboratory staging (based on hematocrit and sedimentation rate) and clinical staging (based on variables from physical exam and past medical history) [92, 93].

Couple eligibility and recruitment

Participants were recruited from among couples referred after CVCT at the Zambia Emory HIV Research Project (ZEHRP) in Lusaka, Zambia [93]. Eligible participants were HIV sero-discordant or concordant positive couples cohabiting >12 months who had no indications of infertility or contraindications to contraception, were not pregnant at enrollment, and planned to stay in Lusaka at least one year post enrollment. Eligible women were 18-45 years of age, and eligible men were 18-65 years of age.

Data Analysis

Exclusionary criteria. Couples with no children and couples in which the man wanted more children in the next year were not considered to be at risk for avoiding pregnancy and were excluded from this analysis [89]. Analyses also excluded couples without at least one follow-up visit. Among randomized couples, the proportion analyzed was similar in the Methods (70%) and No Methods (71%) arms (Figure 1).

Descriptive analyses. Counts and percentages of categorical participant demographics and means and standard deviations of continuous variables were calculated by intervention arm. Chi-square (or Fisher's Exact) tests for categorical variables and t-tests for continuous variables evaluated significant differences between client demographics and intervention arm to explore potential failures of randomization. These differences were compared across study arms and stratified by baseline contraceptive use, which was determined to be an effect modifier.

Survival analyses. Predictors of contraceptive initiation or switching methods immediately following the intervention have been previously reported [89]. Potential effect modification by couple serostatus and contraceptive use at baseline (prior to the intervention) were evaluated in Cox Proportional Hazards models of time to pregnancy. Baseline covariates that were associated with trial arm, risk factors for the outcome, and which were not intermediates on the exposure-outcome pathway were evaluated as potential confounders. The proportional hazards assumption for intervention arm was evaluated for all Cox models via graphical methods and statistical tests. Log-rank tests evaluated significant differences in Kaplan-Meier survival curves by trial arm.

We also conducted a post hoc analysis evaluating the differences in the distribution of man's and woman's fertility intentions by couple serostatus via Chi-square tests. Data analysis was conducted with SAS 9.3 (Cary, North Carolina, US).

RESULTS

Participant flow. After exclusions for ineligibility (n=2975), 1502 couples were randomized to one of the four intervention arms. One hundred and forty-five couples were excluded from the analysis due to having no follow-up visits, 137 couples were

excluded due to the man's desire for more children in the next year, and 160 couples were excluded due to having no living children. The final analysis included 1060 couples (Figure 1).

Randomization. Couples in the "Method video" arms were less likely to be method users prior to the intervention relative to couples not receiving the "Methods video" intervention (23% vs. 29%, Chi-square p-value=0.015). We looked for other failures of randomization by trial arm (Methods video versus No Methods video arms) stratified by woman's use of a baseline contraceptive method, which was an effect measure modifier. Women who were not using a method at baseline in the "Methods video" arm were less likely to understand English relative to the "No Methods" arm (Table 1). Also among women not using a method at baseline, women in the "Methods video" arms were less likely to have knowledge about the IUD. Among women who were using a method at baseline, those in the "Methods video" arms were more likely to have knowledge of tubal ligation (Table 2). These variables were evaluated as potential confounders in multivariate models stratified by baseline method use.

Descriptive analyses. A total of 137 pregnancies occurred during follow-up, and average follow-up time was 506.6 days. Women were 29 (SD=6) years old on average, and men were on average 35 (SD=7) years of age. Couples had an average of 2 (SD=1) living children, and Nyanja literacy was high and similar among baseline method users and non-users. Most participants were of concordant positive serostatus (70% of baseline method non-users and 63% of baseline method users). Roughly two-thirds of women and 58% of men did not want more children, regardless of baseline contraceptive use. Men were more likely to want more children, but not in the next year relative to women for

both couples not using a contraceptive method at baseline (38% men vs. 26% women) and baseline method users (36% men vs. 29% women) (Table 1).

Roughly half of women reported that the couple decided together whether or not to have more children, and roughly 30% reported that the men decided, regardless of baseline method use. In contrast, the majority of men reported that the couple decided together (77% of baseline non-users and 78% for baseline method users) (Table 2).

Among women who were not using a method at baseline, most chose to uptake a modern contraceptive method immediately after receiving the intervention, with 43% selecting injectables, 35% selecting OCPs, 14% selecting Norplant implant, 4% choosing the IUD, and 1% choosing tubal ligation. The proportion who chose the IUD was higher in the Methods video arm (6%, N=24 vs 2%, N=8; Chi-square=7.76, p=0.005).

Among the 278 women using a modern contraceptive method prior to the intervention, the distribution of methods used was: 174 (63%) OCPs, 91 (33%) injectables, 5 (2%) IUD, 8 (3%) Norplant implant. This distribution did not differ by trial arm (Chi-square p-value=0.261, data not shown). After viewing their assigned intervention videos and being offered the full range of contraceptive methods, 193 (69%) continued their previous method and 85 switched to another method including 2 (1%) tubal ligation, 48 (17%) injectables, 5 (2%) IUD, 28 (10%) Norplant implant, and 2 (1%) OCP. The distribution of methods chosen was significantly different between those viewing the "Methods video" versus those not receiving the "Methods video" (p=0.018).

Among women who were using a method at baseline, the majority (69%) chose to continue with their contraceptive method, with 17% switching to injectables and 10%

switching to Norplant implant. All five of the baseline method users who switched to the IUD had viewed the "Methods" video (Table 2).

Knowledge of OCPs, injectables, and to a lesser extent, Norplant implant and IUD, was high among all women, as these methods were presented in the IC signed by all participating couples [90]. Relative to women using a method prior to the intervention, women who were not using a method had significantly less knowledge (either spontaneous or prompted) about Norplant implant (Chi-square p-value=0.0013), IUD and vasectomy (Chi-square p-value= 0.0246). Women who were not using a method prior to the intervention reported lower historical use of OCPs (Chi-square p-value < 0.0001) and injectables (Chi-square p-value < 0.0001) relative to women who were method users at entry into the study. Conversely, women using a method at baseline had significantly increased worries, concerns, or fears about OCPs (Chi-square p-value < 0.0001) and injectables (Chi-square p-value=0.0002) relative to women not using a method at baseline (Table 2).

Survival analyses. Effect measure modification by both couple serostatus and use of a contraceptive method at entry in the study (prior to the intervention) were observed (p-value <0.0001). No confounders (failures of randomization) were significant in multivariate Cox Proportional Hazards models among all couples, stratified by serostatus, or stratified by use of a contraceptive method at entry; therefore, unadjusted models are presented. The Proportional Hazards assumption was met for all models.

Results from the Cox Proportional Hazards Models showed that among couples in which the woman partner was not using a method at entry, there was no significant effect of the intervention on pregnancy incidence, even after stratifying by couple serostatus.

Among couples in which the woman was already using a contraceptive method at the time of the intervention, those who viewed the "Methods" video had a significantly increased time to pregnancy relative to those who did not (11/118 vs. 34/160; hazard ratio (HR)=0.38; 95% CI: 0.19-0.75). The effect size was highest in concordant positive couples (HR=0.22; 95%CI: 0.08-0.58), and couples in which the woman was HIV positive at baseline (HR=0.23; 95%CI: 0.09-0.55) (data not shown).

Log-rank tests from Kaplan-Meier survival curves were generated for each unadjusted model that also showed a significant intervention effect among couples who were using modern contraception at the time of study entry (Figure 2). Among couples of all serostatus combinations, pregnancy incidence was significantly lower in those who had viewed the "Methods" video (Figure 2A; Log Rank Chi-square=8.45, p-value=0.0036). Again, the association was strongest for concordant positive couples (Figure 2B; Log Rank Chi-square=11.38, p-value=0.0007) and for couples with HIV positive women (Figure 2C; Log Rank Chi-square=13.02 p-value=0.0003).

Post hoc analyses. Given that the intervention was successful among concordant positive couples, we evaluated the fertility intentions of concordant positive versus discordant couples in a post hoc analysis. Men in concordant positive relationships were more likely to not desire more children relative to men in discordant relationships (62% vs. 49%; Chi-square=17.77, p-value=0.0001). There was no significant difference in the distribution of women's fertility intentions between concordant positive couples and discordant couples (Chi-square=1.75, p-value=0.627), in which 68% and 67% of women did not desire more children, respectively (data not shown).

No harms or adverse events were associated with participation in this study.

DISCUSSION

This randomized controlled trial demonstrated the ability of the video-based "Methods video" intervention to decrease incident pregnancy among a cohort of HIV sero-discordant and concordant positive couples who had previously participated in CVCT and were offered the full range of contraceptive methods. Among couples who were using a contraceptive method prior to the intervention, viewing the Methods video was associated with a substantially reduced pregnancy incidence during followup. In this group, the Methods video intervention had its greatest impact among couples with HIV+ women. The lack of impact in couples who were not contracepting prior to the video-based intervention suggests that repetition and sustained messaging may be needed to increase comfort with all modern contraceptives, and with unfamiliar LARC methods in particular.

In our previous publication, a multivariate regression analysis showed that couples who viewed the "Methods" video were were more likely to adopt injectables (Risk Ratio (RR)=1.55, 95%CI: 1.03-2.34) relative to OCPs, and couples viewing both Methods and Motivational videos were more likely to adopt injectables RR=1.65, 95%CI: 1.07-2.55) and IUD, Norplant implant or tubal ligation (RR=2.06, 95%CI: 1.17-3.44) relative to OCPs. The "Motivational" video alone did not have a significant impact on contraceptive initiation [89], though it was associated with a substantially higher proportion of couples writing wills and naming guardians [89, 94].

Although virtually all participating couples initiated some type of modern contraception after entering the study, the "Methods video" intervention was not associated with lower pregnancy incidence among women using only condoms or no

contraception prior to the intervention, regardless of serostatus. More research is needed to determine the barriers women and couples face when deciding to adopt modern contraception, particularly LARC. In a longitudinal study in Rwanda among 684 cohabiting couples recruited to participate in an HIV testing and counseling program, the greatest increase in condom use occurred in couples where the men were being targeted with a specialized message after having received a generic message two years prior [26]. Similarly, the CDC Curriculum for Outreach Workers for use in training outreach workers and HIV educators highlights the importance of repetition when delivering HIV prevention messages using the "risk, recognition, response" framework [95].

The “Methods video” intervention was most successful among concordant positive couples and couples in which the woman was positive. Post-hoc analyses showed that fertility goals differed by gender and by couple HIV status: women were less likely than men to want more children, and men in concordant HIV+ unions were less likely to want more children than men in discordant couples. This reinforces the importance of involving men and women jointly in fertility decisions and highlights the importance of having these discussions in the context of known couple HIV status.

Potential limitations to our study include limited generalizability since those who participated may be different from the target population by having an increased desire/receptivity for CVCT and/or family planning (self-selection bias). We expect the results of this study to make inference to the target population of HIV concordant HIV-positive and discordant couples in urban Zambia, a group that will expand given the April 2012 release of WHO Guidelines strongly endorsing CVCT as an HIV prevention strategy. We have previously published that the IC explained all methods and thus

increased knowledge of all methods prior to the intervention [89]. The IC also clarified that all methods would be offered to all participants, and this may have attenuated the difference between control and intervention groups. For example, there was high uptake of contraceptive methods – including Norplant – even in the "Control" video arm: this highlights the importance of simply providing basic information about, and access to, the full range of contraceptive options. We acknowledge that provider bias may have also affected contraceptive method choice, despite training of project nurses in the provision of all contraceptives and in research methods.

Strengths of this study include its randomized design in which two educational interventions were evaluated concurrently, in comparison to most studies of family planning interventions which are observational or quasi-experimental.

In sub-Saharan Africa with high fertility and a high prevalence of HIV/STI in heterosexual populations, there is a simultaneous need to prevent unplanned pregnancy and HIV transmission. CVCT and family planning service target audiences overlap broadly and can benefit from, and in fact prefer, joint services [96-101]. Governments and funding agencies agree that HIV/STI and family planning services should be integrated [102, 103]. Preventing maternal-to-child transmission (PMTCT) of HIV through prevention of unplanned pregnancies is less expensive than PMTCT with antiretrovirals [104-107].

This study evaluated how a family planning intervention offered within the context of CVCT may reinforce HIV and unplanned pregnancy prevention and address client and provider-level obstacles. This successful integration of CVCT and family planning services,

a key goal of the US Global Health Initiative and the PEPFAR program, can provide a paradigm for other countries in Africa and beyond.

ACKNOWLEDGEMENTS

We would like to acknowledge and thank the study participants, staff, interns, and Project Management Group members of the Zambia-Emory HIV Research Project in Lusaka, Zambia. We also thank Michelle Kautzman MD MPH, Laurie Fuller RN MPH, Fong Liu MD MPH, Erin Shutes MPH, Lisa Jones RN MPH, and Tyronza Sharkey MPH for their contributions to study implementation.

Figure 1. Participant flow diagram (adapted from the CONSORT 2010 Flow Diagram)

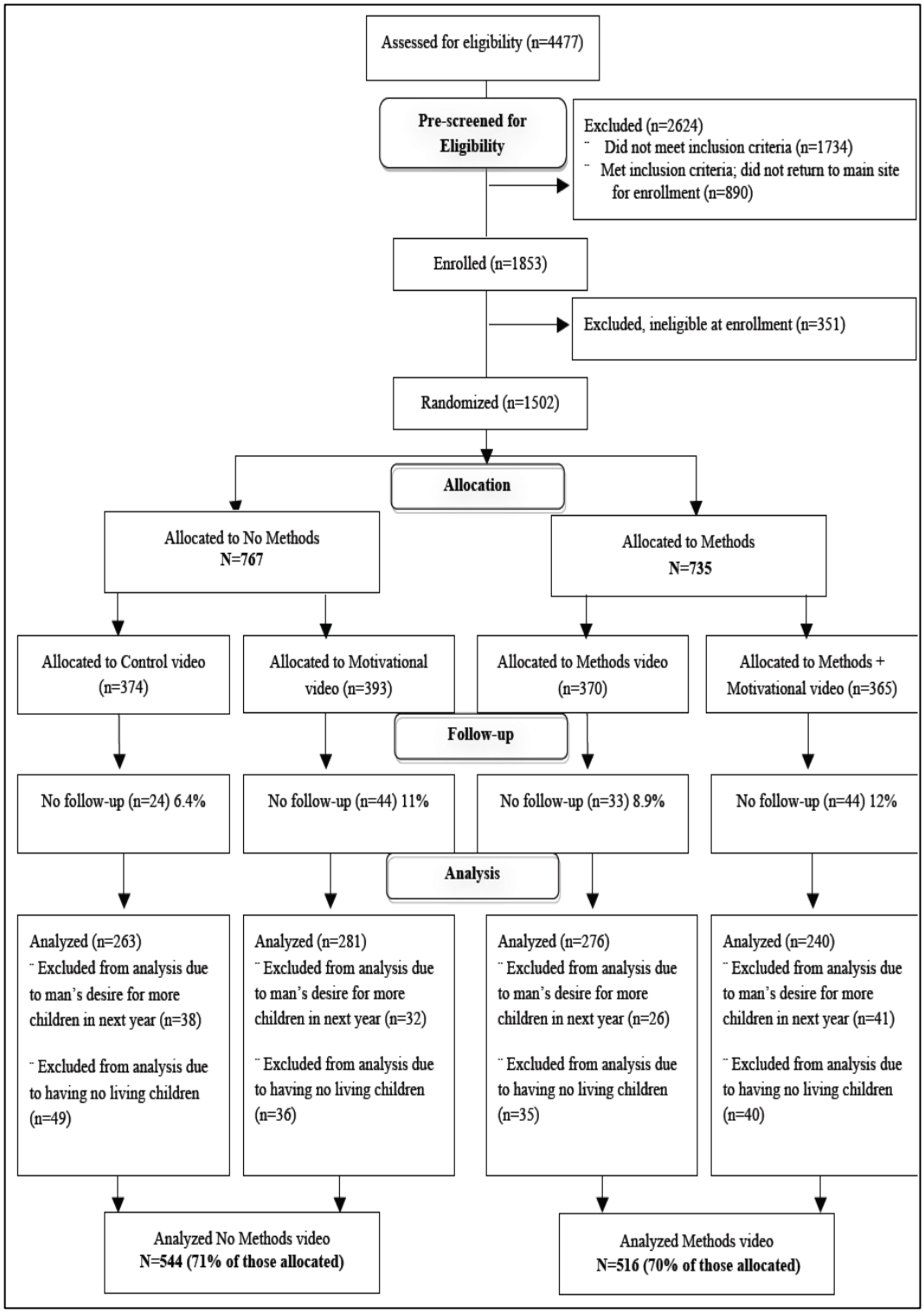


Table 1. Sociodemographic, health, and fertility characteristics stratified by arm of trial and use of contraception prior to the intervention

	Woman partner not using a method at baseline					
	Total (N = 782)		**No Method video (N = 384)**		**Method video (N = 398)**	
	n/mean	**%/SD**	**n/mean**	**%/SD**	**n/mean**	**%/SD**
Pregnant during follow-up	92	12%	42	11%	50	13%
Average follow-up time (days)*	501.7	320.2	496.1	309.3	507.2	330.6
Sociodemographic characteristics						
Age of Woman (years)*	28.8	5.6	28.9	5.6	28.7	5.6
Age of Man (years)*	35.0	6.5	35.2	6.3	34.9	6.7
Number of living children*	2.2	1.4	2.1	1.2	2.2	1.5
Household income (per 10,000 Kwacha)*	33.8	55.0	36.1	63.3	31.6	45.6
Years cohabitating*	7.7	5.1	7.7	4.9	7.8	5.3
Woman understands English						
Easily	201	26%	110	29%	91	23%

With difficulty/not at all	579	74%	274	71%	305	77%
Man understands English						
Easily	481	62%	239	62%	242	61%
With difficulty/not at all	300	38%	144	38%	156	39%
Woman understands Nyanja						
Easily	704	90%	344	90%	360	91%
With difficulty/not at all	76	10%	39	10%	37	9%
Man understands Nyanja						
Easily	674	86%	331	86%	343	86%
With difficulty/not at all	107	14%	52	14%	55	14%
Health and fertility characteristics						
HIV serostatus at baseline						
Serodiscordant (Woman is positive)	127	16%	54	14%	73	18%

Serodiscordant (Man is positive)	108	14%	54	14%	54	14%
Concordant positive	547	70%	276	72%	271	68%
Woman fertility intentions						
Wants more children in the next year	31	4%	15	4%	16	4%
Wants more children, but not in the next year	202	26%	94	24%	108	27%
Does not want more children	534	68%	268	70%	266	67%
Don't know	14	2%	7	2%	7	2%
Man fertility intentions						
Wants more children, but not in the next year	296	38%	139	36%	157	39%
Does not want more children	450	58%	225	59%	225	57%
Don't know	36	5%	20	5%	16	4%

Table 1 (continued)

Woman partner using a method at baseline					
Total (N = 278)		**No Method video (N = 160)**		**Method video (N = 118)**	
n/mean	**%/SD**	**n/mean**	**%/SD**	**n/mean**	**%/SD**
45	16%	34	21%#	11	9%#
520.2	314.1	494.2	305.2	555.5	323.8
28.6	5.4	28.1	5.4	29.4	5.5
34.9	6.8	34.7	6.7	35.2	6.8
2.3	1.5	2.3	1.6	2.4	1.5
35.2	43.7	35.3	48.0	35.0	37.5
8.5	5.3	8.1	5.0	9.1	5.7
68	25%	39	25%	29	25%
209	75%	120	75%	89	75%
174	63%	99	62%	75	64%
103	37%	60	38%	43	36%
246	89%	141	89%	105	89%
31	11%	18	11%	13	11%

249	90%	143	90%	106	90%
28	10%	16	10%	12	10%
45	16%	29	18%	16	14%
59	21%	38	24%	21	18%
174	63%	93	58%	81	69%
7	3%	5	3%	2	2%
80	29%	49	31%	31	26%
185	67%	102	64%	83	70%
5	2%	3	2%	2	2%
99	36%	63	40%	36	31%
160	58%	84	53%	76	64%
18	6%	12	8%	6	5%

*Data shown as means and SDs

Cells may not add up to totals due to missing values

#$p < 0.05$

Table 2. Family planning characteristics stratified by arm of trial and use of contraception prior to the intervention

	Woman partner not using a method at baseline					
	Total (N = 782)		**No Method video (N = 384)**		**Method video (N = 398)**	
	n	**%**	**n**	**%**	**n**	**%**
Who decides when/if you should have children (reported by woman)						
Woman respondent	28	4%	15	4%	13	3%
Man partner	224	29%	106	28%	118	30%
Couple decides together	370	47%	182	47%	188	47%
Extended family	0	0%	0	0%	0	0%
No one decides/plans	156	20%	78	20%	78	20%
No opinion	3	0%	3	1%	0	0%
Who decides when/if you should have children (reported by man)						

Man respondent	157	20%	76	20%	81	20%
Woman partner	14	2%	5	1%	9	2%
Couple decides together	603	77%	298	78%	305	77%
Extended family	2	0%	1	0%	1	0%
No one decides/plans	6	1%	4	1%	2	1%
No opinion	0	0%	0	0%	0	0%
Woman knowledge (spontaneous or prompted) about						
OCPs	782	100%	384	100%	398	100%
Injection	778	99%	383	100%	395	99%
Norplant implant	671	86%	336	88%	335	84%
IUD	681	87%	347	90%#	334	84%#
Emergency contraception	130	17%	64	17%	66	17%
Tubal ligation	618	79%	310	81%	308	77%
Vasectomy	263	34%	130	34%	133	33%

Contraception methods ever used (past or currently) by woman or partner						
OCPs	462	59%	228	59%	234	59%
Injection	217	28%	101	26%	116	29%
Norplant implant	5	1%	3	1%	2	1%
IUD	9	1%	5	1%	4	1%
Emergency contraception	3	0%	2	1%	1	0%
Woman has worries, concerns, or fears about (if applicable)						
OCPs	664	85%	326	85%	338	85%
Injection	529	68%	279	73%	263	66%
Norplant implant	282	36%	144	38%	138	35%
IUD	284	36%	150	39%	134	34%
Emergency contraception	47	6%	20	5%	27	7%

Tubal ligation	267	34%	140	36%	127	32%
Vasectomy	99	13%	45	12%	54	14%
FP method chosen immediately after intervention at baseline						
Tubal ligation	11	1%	7	2%	4	1%
Injectables	339	43%	161	42%	178	45%
IUD	32	4%	8	2%	24	6%
Norplant implant	111	14%	57	15%	54	14%
OCPs	274	35%	142	37%	132	33%
Continue current use	15	2%	9	2%	6	2%

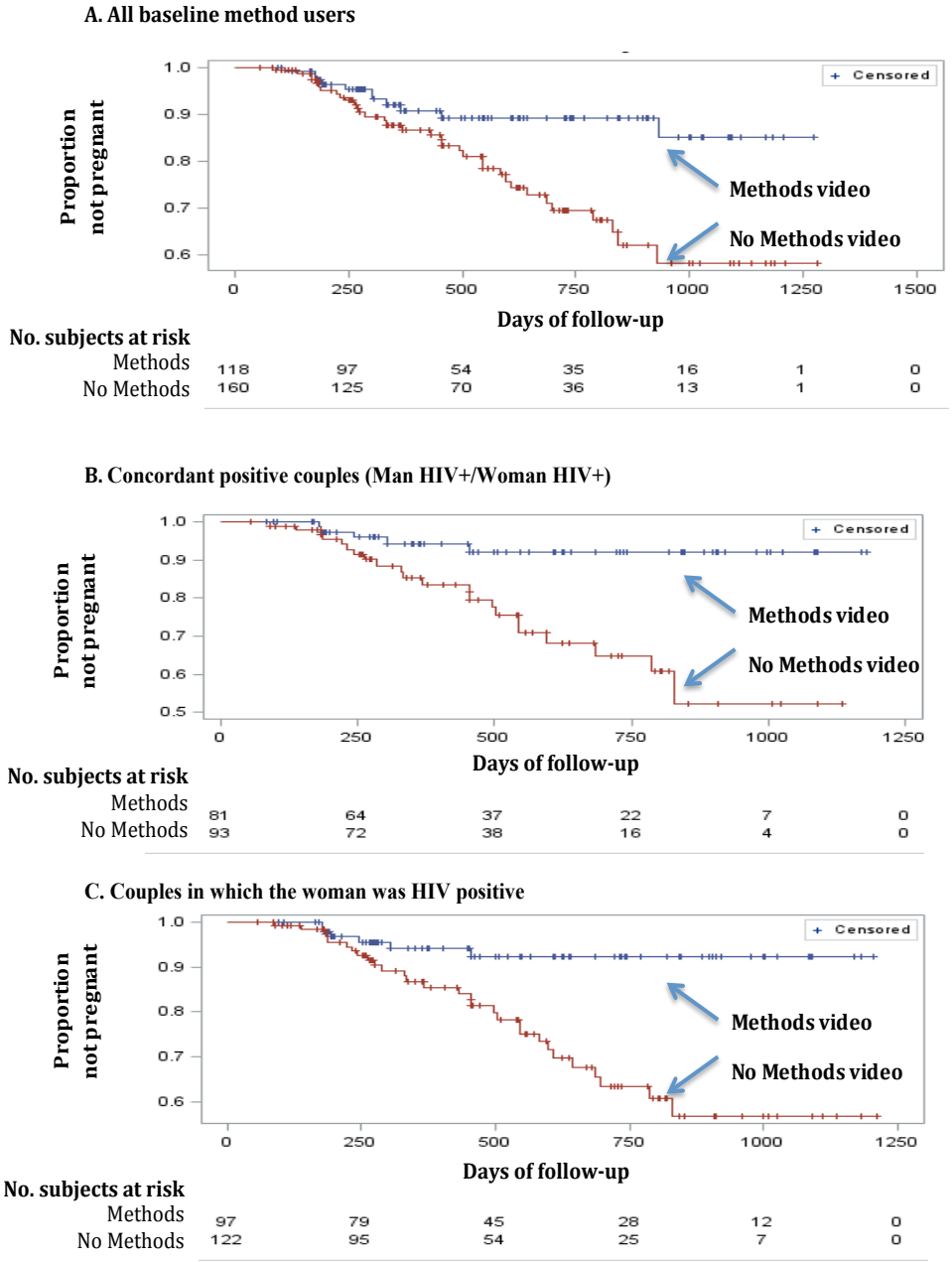
Table 2 (continued)

Woman partner using a method at baseline					
Total (N = 278)		**No Method video (N = 160)**		**Method video (N = 118)**	
n	**%**	**n**	**%**	**N**	**%**
9	3%	6	4%	3	3%
78	28%	45	28%	33	28%
144	52%	80	50%	64	54%
0	0%	0	0%	0	0%
46	17%	28	18%	18	15%
0	0%	0	0%	0	0%
58	21%	29	18%	29	25%
1	0%	1	1%	0	0%
215	78%	128	81%	87	74%
0	0%	0	0%	0	0%
3	1%	1	1%	2	2%
0	0%	0	0%	0	0%
278	100%	160	100%	118	100%
278	100%	160	100%	118	100%

259	93%	151	94%	108	92%
252	91%	145	91%	107	91%
38	14%	20	13%	18	15%
232	83%	125	78%#	107	91%#
114	41%	64	40%	50	42%
239	86%	138	86%	101	86%
144	52%	79	49%	65	55%
10	4%	3	2%	7	6%
10	4%	6	4%	4	3%
0	0%	0	0%	0	0%
264	95%	152	95%	112	95%
223	80%	131	82%	92	78%
106	38%	62	39%	44	37%
120	43%	69	43%	51	43%
15	5%	9	6%	6	5%
115	41%	63	39%	52	44%
43	15%	27	17%	16	14%
2	1%	2	1%#	0	0%#
48	17%	33	21%#	15	13%#

5	2%	0	0%#	5	4%#
28	10%	15	9%#	13	11%#
2	1%	0	0%#	2	2%#
193	69%	110	69%#	83	70%#

Figure 2. Product-limit survival estimates among couples in which the woman partner was using a method at baseline



Chapter 4: Actor-partner effects associated with experiencing intimate partner violence or coercion among male couples enrolled in an HIV prevention trial (*in progress*)

Actor-partner effects associated with experiencing intimate partner violence or coercion among male couples enrolled in an HIV prevention trial

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Running head: Experienced IPV and coercion among MSM couples

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Keywords: Actor-partner interdependence model, coercion, HIV, intimate partner violence, MSM

Counts:

Abstract: 271

Text: 3,362

Funding sources:

Conflicts of interest:

Acknowledgements: We would like to acknowledge Jason Mitchell for his insights on applying the APIM model to this dataset. We would also like to acknowledge The Emory Center for AIDS Research (CFAR P30 AI050409).

ABSTRACT

Objective: Intimate partner violence (IPV) and coercion have been associated with negative health outcomes, including increased HIV risk, among men who have sex with men (MSM). This is the first study to describe the prevalence and factors associated with experiencing IPV or coercion among US MSM dyads using the actor-partner interdependence model (APIM).

Methods: Among MSM couples enrolled as dyads in an HIV prevention randomized controlled trial (RCT), two outcomes are examined in this cross-sectional analysis: 1) the actor experiencing physical or sexual IPV from the study partner in the past 3-months and 2) the actor feeling coerced to participate in the RCT by the study partner. Two multilevel APIM logistic regression models evaluated the association between each outcome and actor, partner, and dyad-level factors.

Results: Of 190 individuals (95 MSM couples), 14 reported experiencing physical or sexual IPV from their study partner in the past 3 months (7.3%) and 12 reported feeling coerced to participate in the RCT by their study partner (6.3%). Results of multivariate APIM analyses indicated that reporting IPV was associated ($p<0.1$) with non-Black/African American actor race, lower actor education, and lower partner education. Reporting coercion was associated ($p<0.1$) with younger actor age and lower partner education.

Conclusions: These findings from an HIV prevention RCT for MSM show considerable levels of IPV experienced in the past 3-months and coercion to participate in the trial indicating the need for screening tools and support services for these behaviors. The identification of factors associated with IPV and coercion demonstrate the importance of

considering actor and partner effects, as well as dyadic-level effects, to improve development of screening tools and support services for these outcomes.

INTRODUCTION

Of the roughly 50,000 new HIV infections occurring annually in the United States (US), CDC estimates 61% occur among men who have sex with men (MSM), a group that accounts for 2% of the US population [23, 108]. Due to disproportionally high HIV incidence among US MSM and the significantly increasing incidence rates observed among subgroups of MSM, MSM are an important focus of CDCs High-Impact Prevention approach to HIV prevention [23, 109, 110]. Additionally, given that an estimated 68% of new transmissions among MSM occur in the context of main partnerships [11], more prevention efforts are focusing on male couples as a prevention point [111-115].

Recent studies have also shown MSM to be at increased risk of experiencing intimate partner violence (IPV) relative to non-MSM males and at rates similar to or higher than heterosexual females, though varying operational definitions of the numerous types of IPV and the different study recall periods make comparisons difficult [14-16]. The National Violence Against Women Survey (NVAWS) defines physical IPV as physical attacks or threats of attacks within a relationship. NVAWS defines sexual IPV as oral, anal, or vaginal penetration completed or attempted through force or threat of force [116]. A nationally representative probability sample of 14,182 participants of the NVAWS estimated that physical IPV experienced during any past or current relationship occurred among 25% of MSM, 8% of heterosexual males, and 21% of heterosexual females. This study estimated that experiences of sexual IPV occurred among 3% of MSM, 0.2% of heterosexual males, and 5% of heterosexual females [15]. These estimates are comparable with a probability-sample of 2,881 MSM from four US urban

centers which found 22% of men experienced physical IPV (defined as being hit, pushed, shoved, kicked, or having something thrown at him) in the past 5 years, and 5% experienced sexual IPV (defined as being forced to have sex) in the past 5 years [16].

Estimates of coercion, or attempts to control the thoughts/behavior of others, are scarcer and operational definitions more varied. Some studies include coercive control in the definition of IPV, and current research indicates coercion may be a precursor to IPV [117, 118]. The NVAWS defined controlling IPV as attempts to control the actions or thoughts of a partner and found estimates of lifetime experienced controlling IPV of 82% among MSM and 41% among both heterosexual men and women [15].

A limited number of cross-sectional studies have identified factors, primarily demographics and negative health correlates, associated with IPV experienced by MSM. A cross-sectional survey of 817 MSM in Chicago found lifetime experienced IPV (sexual, physical, or verbal) was associated with frequent (monthly or more often) alcohol intoxication, substance abuse, receptive or insertive unprotected anal intercourse (UAI) in the past 6 months, increased sero-discordant UAI, sexually transmitted infection (STI) diagnoses in the previous 2 years, depression, and lifetime mental health diagnoses [17]. A study among 521 South African MSM showed that experiencing physical IPV in the past year was associated with non-white race, higher levels of education, and reporting receptive or insertive UAI in the past year, while experiencing sexual IPV in the past year was associated with experiences of homophobia [19]. Another study among 2,881 US MSM reported physical IPV experienced in the past 5 years was associated with younger age, being HIV positive versus negative, and lower education, while sexual IPV experienced in the past 5 years was associated with younger age [16]. A

multinational study of 2,368 gay men from six countries found that, while demographic characteristics associated with IPV varied widely across countries, reporting homophobic discrimination was associated with experienced physical or sexual IPV in the past 12 months in all countries [119]. Finally, in one of the first studies to examine dyadic-level characteristics and IPV, data from an online survey of 528 US MSM couples showed men reporting non-white race and decreased relationship satisfaction were more likely to report physical IPV experienced with their study partner. Men reporting lower education, HIV positive serostatus, and decreased perceived stigma about having a male partner were more likely to report sexual IPV experienced with their study partner [115].

We aim to add to this body of literature by describing the prevalence of experienced IPV and coercion among MSM dyads enrolled in an HIV prevention randomized controlled trial (RCT) and evaluating the association between demographic factors and these outcomes using the actor-partner interdependence model (APIM). The APIM is an analytic framework to describe interdependent outcomes within dyads. In this model, an outcome for an individual within the dyad is measured in terms of their actor (self) characteristics, partner characteristics, and their dyadic-level (shared) characteristics [120, 121]. Actor-partner effects among MSM have been evaluated for various health outcomes related to HIV risk including UAI within and outside the relationship [122], agreements about sex outside the relationship [123], and main and casual partner selection related to sero-sorting [112]. However, the actor-partner characteristics associated with IPV and coercion have yet to be studied among MSM.

METHODS

Recruitment and eligibility. Male couples were recruited from the Atlanta area

into a randomized controlled trial of couples' voluntary HIV counseling and testing (CVCT) versus individual voluntary HIV counseling and testing as described elsewhere [124]. Briefly, eligible couples were at least 18 years old, had been in a partnership for at least 3 months, reported willingness to complete a 3 month follow-up survey, had never received a diagnosis of HIV, and could complete study assessments in English. Eligible participants provided informed consent and were given $50 for participation in the baseline survey and counseling session. This study was approved by Emory's Institutional Review Board.

Study procedures. Eligible and consenting participants separately answered a computer-administered baseline survey that collected demographic and couple characteristics, HIV testing history, sexual history, and several scales to measure aspects of couple functioning [111]. Two survey questions served as exclusionary criteria for randomization: history of experienced IPV (sexual or physical) in the past three months and feeling coercion by the study partner to test together. Couples in which either partner reported these exclusionary criteria were not randomized and were informed, without explanation, that they would receive individual testing.

Exposures. Exposures of interest in this analysis included individual (both actor and partner) level demographic variables (age, race/ethnicity, education, sexual orientation, serostatus, UAI with a man other than (and concurrent with) the main study partner in the past 3 months, and agreements about sex outside the relationship. Dyad-level relationship variables included duration of relationship (calculated as the average reported by both partners), UAI in past year with the main partner (reported by either partner), and dyadic differences in age, education, race, sexual orientation, and sexual

relationship agreements. The arms of the RCT were not of primary interest in this analysis, and for our purposes the data are cross-sectional.

Outcome variables. Two primary outcomes were considered: 1) reporting a 3-month history of IPV, either sexual or physical, from the study partner and 2) reporting feeling coerced to participate in the RCT by the study partner. History of IPV was measured using the following questions which were modified from the Conflict Tactics Scale: "*In the past 3 months, has ___ hit you, kicked you, or physically hurt you?*" and "*In the past 3 months has ___ ever used force (hitting, holding down, or using a weapon) to make you have oral or anal sex?*" Coercion by the study partner to participate in the RCT was measured using the following question: "*Do you feel like ___ forced you to participate in this research study?*"

Analyses. To describe individual-level and dyadic-level exposures, counts and percentages for categorical exposure variables and medians and interquartile ranges (IQRs) for continuous variables were tabulated separately for the outcomes of interest. Two-sided p-values from Chi-square tests (or Fisher's Exacts tests) for categorical variables or median two-sample tests for continuous variables evaluated differences in individual-level and dyadic-level exposures separately for IPV and coercion. These descriptive analyses did not consider actor-partner effects.

The hypothesized relationship between actor, partner, and dyadic-level effects and each outcome is depicted schematically in Figure 1, adapted from Cook and Kenny 2005 [125]. Though not explicitly depicted in this schematic, dyads in this analysis are considered indistinguishable, meaning there is no meaningful way to distinguish outcomes between individual members of the dyad [120, 121].

To determine the actor-partner and dyadic-level effects associated with each outcome, the dataset was structured in a pairwise format [120, 121]. Continuous variables were grand-mean centered and binary categorical variables were dummy coded. The pairwise intra-class correlation coefficient (PICC), a measure of the extent of dyadic interdependence, was calculated for each outcome. Multi-level APIM models were specified for this analysis as shown in Figure 2.

Next, actor, partner, and dyadic-level effects were estimated following the 3-step multilevel modeling procedures for binary outcomes using an APIM framework as specified by McMahon et al, 2006 [126]. Briefly, PROC GENMOD was used to obtain initial values for the intercept and slope parameters using a generalized estimating equations approach (Appendix A1), PROC MIXED was used to determine initial values for the between-dyad variance (Appendix A2), and PROC NLMIXED was used to evaluate the random intercept model using these initial values (Appendix A3) (modified from McMahon et al, 2006) [126].

The various analytical options used by McMahon et al, 2006 [126] were also utilized. The QPOINTS option defines the number of quadrature points needed for model convergence. The TECH=NEWRAP option stipulates that the Newton-Raphson algorithm is used as the parameter estimation optimization technique. The PARMS statement specifies the values of the beta parameters and the variance of the random effects obtained from PROC GENMOD and PROC MIXED. We also performed data analysis using an analogous 1-step PROC GLIMMIX procedure as described in Flom et al 2007 [127] for comparison (Appendix A4).

To build the multivariate APIM models of reported IPV and coercion, the above

procedures were first used to estimate the independent (crude bivariate) associations between actor, partner, and dyadic-level factors and the outcomes of interest. Multivariate models were then built using backward selection procedures (using a cutoff of $p<0.1$) to a model initially containing all exposures. Variables that were candidates for inclusion in the models were evaluated for multi-collinearity (cutoffs for multi-collinarity were taken as condition indices >30 and variance decomposition proportions >0.5). Odds ratios (OR) and 95% confidence intervals (95%CI) were calculated for all models. Data analysis was conducted with SAS v9.3 (Cary, NC).

RESULTS

Individual-level factors independently associated with IPV and coercion

In this study of 190 individuals (95 couples), 14 individuals reported experiencing physical or sexual IPV from their study partner in the past 3 months (7.3%). There were 12 individual reports of experienced physical IPV and 4 individual reports of experienced sexual IPV, with two individuals experiencing both behaviors. Twelve individuals reported experiencing coercion (6.3%). Individuals from two couples reported experiencing both IPV and coercion. Within one couple, both partners experienced coercion. The magnitude and direction of the associations between white/Caucasian race (n=30) and the outcomes, and other races (n=19) and the outcomes, were similar. These race categories were grouped (n=49) for analysis due to small numbers among the coercion outcome.

In bivariate analyses, individuals reporting IPV were older on median than individuals not reporting IPV (33.5 years versus 30.0 years, p=0.014). Individuals who reported having a high school/GED education or less were more likely to report IPV

relative to individuals with some post-high school education (13% versus 2%, p=0.004) (Table 1).

Dyad-level factors independently associated with IPV and coercion

In bivariate analyses, couples reporting coercion had a relatively larger dyadic-difference in median age (6.0 years versus 4.0 years, p=0.022) (Table 2).

Actor-partner and dyad-level factors associated with IPV

The estimates obtained from implementing the 3-step analysis method described (PROC GENMOD, MIXED, and NLMIXED) were very similar to those obtained using the 1-step PROC GLIMMIX procedure for all models. The 3-step method results are presented for all analyses as this method produces an approximation to the likelihood with a log-likelihood fit statistic and is thought to produce more valid results [127].

In multivariate analysis, non-black/African American actor race (p=0.024), actor high school/GED education or less (p=0.060), and partner high school/GED education or less (p=0.056) were associated with experiencing IPV (Table 3). No collinearity was detected between model variables and no significant interaction terms were discovered.

Actor-partner and dyad-level factors associated with coercion

In multivariate analysis, younger actor age (p=0.098) and partner high school/GED education or less (p=0.092) were associated were associated with experiencing coercion (Table 4). No collinearity was detected between model variables and no significant interaction terms were discovered.

DISCUSSION

In this analysis of MSM participating in an HIV prevention study as dyads, our estimates of physical or sexual IPV in the previous 3 months (7% prevalence) and

experienced coercion to participate in the study (6% prevalence) were similar to studies measuring more recent IPV among MSM. A study of MSM from 6 countries found 5.8% of US MSM reported experiencing physical IPV in the past year, and 4.5% reported experiencing sexual IPV in the past year [119]. To our knowledge, there are no large population-based estimates of coercion as defined here among MSM dyads.

There are currently no other published studies examining both the actor-partner effects in addition to the shared dyad-level characteristics associated with these outcomes among MSM. Evaluating actor-partner effects within the APIM framework is advantageous because it considers how one partner's exposures may influence the other partner's outcomes. These nuanced associations can be missed when looking at data at the individual-level only. For example, race was not significantly associated with experiencing IPV at the individual-level but was a significant actor effect in the multivariate actor-partner model.

Actor-partner effects associated with experienced IPV

The actor reporting non-black/African American race was associated with experiencing IPV in the past 3 months relative to the actor being black/African American. Since our sample was predominately black/African American, we were not able to evaluate race differences in more depth, and preliminary data suggest that different groups may define IPV differently. The existing literature regarding race and IPV among MSM is varied and conflicting – for example, in the previously described study of 528 US MSM, non-white race was found to be significantly associated with experiencing physical IPV [115], while the study of 2,881 US MSM indicated that race was not associated with reporting physical or sexual IPV [16]. These differences highlight a

recurring theme in the current literature, namely that demographic characteristics hypothesized to be associated with IPV do not translate to every MSM population, a finding especially notable in the multinational study by Finnernan et al [119]. For example, we did not find an association between age and experiences of recent IPV, and again results are varied in the current literature – some studies indicate younger age is associated with experienced physical or sexual IPV among MSM [16, 119], while other studies among MSM observed no association with age [19, 128]. Younger age is a classic risk factor for IPV experienced by heterosexual women, seemingly linked to the fact men tend to become less violent with age [129], but this association does not appear consistent across MSM populations.

Lower education was associated with reporting experienced IPV in the past 3 months in this study. Many investigations indicate a link between lower education and violence among MSM [16, 115, 128], as lower education may be associated with decreased access to economic, social, and health resources thereby increasing vulnerability. However, in the current study we further show that both actor and partner educational level have an effect.

Actor-partner effects associated with experienced coercion

The actor-partner and dyadic-level factors associated with experiencing coercion to participate in the study were younger actor age and lower partner education. While we are unaware of similar investigations of factors associated with coercion to participate in research studies between MSM couples for comparison, younger age and lower education have been associated with controlling IPV [15], and we hypothesize that the younger age of the actor creates a power dynamic making them more susceptible to experiencing

coercive control. A study by Greenwood et al (2002), which found a role for age in all forms of IPV, hypothesized that older persons may be better able to access resources and protection's than younger people, or that younger people may be easier to influence [16].

Screening for IPV and coercion in research and programmatic settings

IPV and coercion were screened for in this RCT in order to allocate couples reporting these behaviors to receive individual HIV testing, as the effect of the CVCT intervention on these behaviors is currently unclear. Additionally, in a research setting, coercion to participate in a study represents a threat to human subjects and bias study results, while in a programmatic setting, screening for coercion to participate in programs designed for male-male couples is important to ensure that services are delivered to clients who both desire and have independently chosen to receive the service.

More generally, in couples-focused research or programmatic settings, screening for IPV among MSM couples is an important opportunity for referrals for IPV support services. Importantly, evidence suggests coercive control may be an upstream behavior leading to IPV [117, 118] further motivating the rationale for screening for coercion in order to refer persons reporting this behavior for support services [118].

Screening tool and support service development

IPV screening tools do not currently have well-established psychometric soundness for use among MSM, the sensitivities and specificities between current screening tools vary greatly, few tease out coercion as a separate behavior, and the most common screening tools have been evaluated in relatively few studies among primarily heterosexuals [20, 117, 118]. IPV support services for MSM are also inadequate -- awareness of these issues among MSM is low, many US

domestic violence services do not serve men, and IPV victims from same-sex relationships are not provided civil protections in several states [15, 130]. This preliminary understanding actor-partner effects and dyadic differences related to IPV and coercion suggests that screening tools and support services can benefit from an understanding of both actor and partner effects, and that they may benefit from targeting younger, less educated MSM.

LIMITATIONS

Several limitations to this study warrant consideration. The small sample size did not allow for a deeper investigation of several associations, especially investigation of racial/ethnic differences and these outcomes, or the differences between physical and sexual IPV. Selection bias affecting who decided to participate in the study and who decided to answer the questions about IPV and coercion could limit the generalizability of these findings to MSM couples within the context of HIV prevention trial settings. Though measures were taken to ensure confidentiality in reporting IPV and coercion, prevarication in answering these sensitive relationship questions is common [131, 132] and may have affected the validity of our findings, likely underestimating the true prevalence of IPV and coercion. Additionally, given that these data are cross-sectional, we were only able to evaluate associations and not possible causal mechanisms. Longitudinal data exploring the causal relationships between couple characteristics and IPV and coercion among MSM are needed.

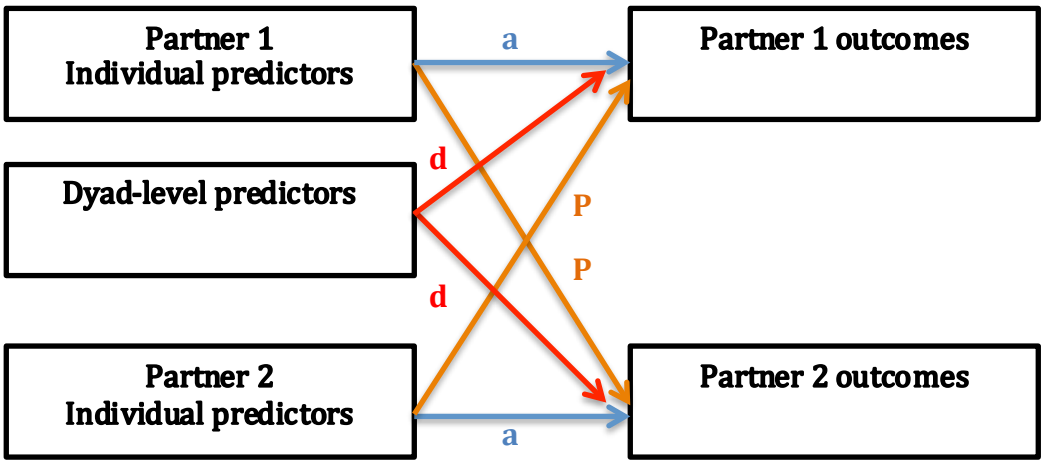
As this study was not designed or powered to detect differences in these outcomes, the analyses are exploratory and represent the first steps toward understanding the main actor-partner effects and dyadic characteristics related to IPV and coercion.

This novel use of the APIM employing systematic model building techniques would benefit from being applied to larger sample sizes and more diverse populations of MSM couples with consideration of the frequency and severity of IPV and coercion. Other exposures associated with IPV and coercion in previous studies also need to be considered in terms of actor and partner effects including substance abuse [17, 18], homophobic discrimination and internalized homophobia [19, 119, 128], experiences of homophobia [19, 119], history of violence [128], relationship concurrency, and perceived stigma [115].

CONCLUSIONS

Understanding the prevalence and factors associated with IPV and coercion among MSM increases awareness of these issues and the need for better screening tools and support services. Based on the results of this study and the current literature, we recommend future studies evaluate actor, partner, and dyadic-level predictors of IPV and coercion toward the goal of improving screening tools and support services for IPV and coercion among MSM couples.

Figure 1. Schematic of the actor-partner interdependence model (APIM) framework, adapted from Cook & Kenny, 2005



a, actor effects

p, partner effects

d, dyad-level effects

Within-dyad residual errors between outcomes and predictors are not shown

Individual-level predictors (actor and partner): Age, race/ethnicity, education, sexual orientation, serostatus, unprotected anal intercourse with a man other than main partner in past 3 months, and agreements about sex outside the relationship

Dyad-level predictors: Duration of relationship with main partner (average of partner responses); unprotected anal intercourse in last year with main partner (reported by either

partner); dyadic differences in age, education, race/ethnicity, sexual orientation, and agreements about sex outside the relationship

Outcomes: 1) IPV experienced from the study partner in the past three months, 2) coercion experienced from the study partner to participate in the study

Figure 2. Specification of the multi-level actor-partner interdependence model

Levels	Predictor labels	Predictors
Individual actor and individual partner (i)	X_actor, X_partner	Age, race/ethnicity, education, sexual orientation, serostatus, unprotected anal intercourse with a man other than main partner in past 3 months, agreements about sex outside the relationship
Dyad (j)	Z	Duration of relationship with main partner (average); unprotected anal intercourse in last year with main partner; dyadic differences in age, education, race/ethnicity, sexual orientation, and agreements about sex outside the relationship

1. Individual level model: $g^{-1}(m_{ij}) = \boldsymbol{\eta_{ij} = \beta_{0j} + \beta_{1j}(X\_actor)_{ij} + \beta_{2j}(X\_partner)_{ij}}$

Individual level residual term is omitted because its variance is assumed fixed

$\boldsymbol{\eta_{ij}}$ is the log odds of the outcome

$\boldsymbol{\beta_{0j}}$ is the within-dyad intercept in dyad j

$\boldsymbol{\beta_{1j}}$ is the slope of η_{ij} on x_{ij} in dyad j

2. Dyad level model: $\boldsymbol{\beta_{0j} = \gamma_{00} + \gamma_{01}(Z)_j + u_{oj},}$ $\boldsymbol{\beta_{1j} = \gamma_{10},}$ $\boldsymbol{\beta_{2j} = \gamma_{20}}$

Dyad level slopes are fixed

$\boldsymbol{u_{0j},}$ the random intercept, is the only random effect

$\boldsymbol{\gamma_{00}}$ is the average intercept across dyads

3. Final model: $\boldsymbol{\eta_{ij} = \gamma_{00} + \gamma_{01}(Z)_j + \gamma_{10}(X\_actor)_{ij} + \gamma_{20}(X\_partner)_{ij} + u_{oj},}$

This model contains one random intercept (no random slopes, no interaction terms)

Table 1. Individual-level demographic characteristics associated with experiencing IPV or coercion

	Total (N = 190)		**No experienced IPV (N = 176)**		**Experienced IPV (N = 14)**		**p-value***
	N	**col%**	**N**	**row%**	**N**	**row %**	
Age, median, IQR (years)	30.0	14.0	30.0	15.0	33.5	12.0	0.014
Race/ethnicity							0.203
Black/African American	137	74%	129	94%	8	6%	
Other	49	26%	43	88%	6	12%	
Education							0.004
Some education post-high school	98	52%	96	98%	2	2%	
High school, GED, or less	92	48%	80	87%	12	13%	
Sexual orientation							1.000

Homosexual/Gay	116	63%	108	93%	8	7%	
Bisexual/Other	68	37%	63	93%	5	7%	
Serostatus							1.000
HIV positive	20	11%	19	95%	1	5%	
HIV negative	170	89%	157	92%	13	8%	
UAI with an outside (and concurrent with main) partner in past 3 months							1.000
Yes	38	21%	36	95%	2	5%	
No	145	79%	135	93%	10	7%	
Agreements about sex outside the relationship							0.121
Monogamy	105	56%	100	95%	5	5%	
Other (Outside sex, no	84	44%	75	89%	9	11%	

agreement)							

Talbe 1 (continued)

No experienced coercion (N = 178)		**Experienced coercion (N = 12)**		**p-value***
N	**row%**	**N**	**row%**	
30.0	15.0	28.0	15.0	0.396
				0.070
126	92%	11	8%	
49	100%	0	0%	
				0.478
93	95%	5	5%	
85	92%	7	8%	
				0.364
110	95%	6	5%	
62	91%	6	9%	
				1.000
19	95%	1	5%	
159	94%	11	6%	
				0.464
37	97%	1	3%	
135	93%	10	7%	
				0.424
97	92%	8	8%	

80	95%	4	5%	

*Two-sided p-values from Chi-square tests or Fisher's Exacts tests (categorical variables) or Median two-sample tests (continuous variables)

Cells may not add to total due to missing values

GED: general educational development; IPV: intimate partner violence; IQR: interquartile range; UAI: unprotected anal intercourse

Table 2. Dyad-level demographic characteristics associated with experiencing IPV or coercion

	Total (N = 95)		No experienced IPV (N = 81)		Experienced IPV (N = 14)		p-value *
	N	col %	N	row %	N	row %	
Duration of relationship with main partner, median, IQR (months) (average reported by both partners)	14.0	17.3	13.4	16.0	22.1	21.7	0.084
UAI with main partner in past year (reported by either partner)							0.530
Yes	58	65%	48	83%	10	17%	
No	31	35%	28	90%	3	10%	
Difference in age, median, IQR (years)	4.0	6.0	4.0	6.0	4.5	4.0	0.966
Difference in education							0.337
Report same	69	73%	57	83%	12	17%	
Report different	26	27%	24	92%	2	8%	
Difference in race							1.000

Report same (both black, white, other)	76	84%	64	84%	12	16%	
Report different	15	16%	13	87%	2	13%	
Difference in orientation							0.349
Report same	56	63%	50	89%	6	11%	
Report different	33	37%	27	82%	6	18%	
Difference in agreements							0.795
Report same	50	53%	43	86%	7	14%	
Report different	44	47%	37	84%	7	16%	

Table 2 (continued)

No experienced coercion (N = 84)		**Experienced coercion (N = 11)**		**p-value***
N	**row %**	**N**	**row%**	
13.9	17.0	14.4	24.5	0.345
				0.734
52	90%	6	10%	
27	87%	4	13%	
4.0	5.5	6.0	6.0	0.022
				1.000
61	88%	8	12%	
23	88%	3	12%	
				0.668
68	89%	8	11%	
13	87%	2	13%	
				1.000
49	88%	7	13%	
29	88%	4	12%	

				0.460
43	86%	7	14%	
40	91%	4	9%	

* Two-sided p-values from Chi-square tests or Fisher's Exacts tests (categorical variables) or Median two-sample tests (continuous variables)

Cells may not add to total due to missing values

IPV: intimate partner violence; IQR: interquartile range; UAI: unprotected anal intercourse

Table 3. Actor-partner interdependence model of factors associated with experiencing IPV

	Crude OR	**(90% CI)**		**p-value**	**Adjusted OR**	**(90% CI)**		**p-value**
ACTOR VARIABLES								
Age, per year increase	1.05	1.00	1.09	0.090				
Race/ethnicity								
Black/African American	ref							
Other	2.25	0.88	5.77	0.156	4.25	1.49	12.12	0.024
Education								
Some education post-high school	ref							
High school, GED, or less	7.20	1.98	26.18	0.013	5.01	1.23	20.45	0.060
Sexual orientation								
	ref							

Homosexual/Gay								
Bisexual/Other	1.07	0.40	2.86	0.907				
erostatus								
HIV positive	ref							
HIV negative	1.57	0.27	9.21	0.672				
UAI with a man other than (and concurrent with) main partner in past 3 months								
Yes	ref							
No	1.33	0.36	5.00	0.719				
Agreements about sex outside the relationship								
Monogamy	ref							
Other (Outside sex, no agreements)	2.40	0.92	6.26	0.133				

PARTNER VARIABLES								
Age, per year increase	1.05	1.01	1.10	0.054				
Race/ethnicity								
Black/African American	ref							
Other	1.13	0.41	3.14	0.845				
Education								
Some education post-high school	ref							
High school, GED, or less	7.20	1.98	26.18	0.013	5.14	1.26	20.92	0.056
Sexual orientation								
Homosexual/Gay	ref							
Bisexual/Other	1.51	0.58	3.93	0.480				
Serostatus								
HIV positive	ref							
HIV negative	1.57	0.27	9.21	0.672				

UAI with a man other than (and concurrent with) main partner in past 3 months								
Yes	1.78	0.62	5.06	0.364				
No	ref							
Agreements about sex outside the relationship								
Monogamy	ref							
Other (Outside sex, no agreements)	1.74	0.68	4.40	0.327				
DYAD-LEVEL VARIABLES								
Duration of relationship with main partner	1.01	1.00	1.03	0.154				

(average reported by both partners, per year increase)								
UAI with main partner in past year (reported by either partner)								
Yes	1.86	0.60	5.71	0.364				
No	ref							
Difference in age (per year decrease)	1.02	0.93	1.13	0.689				
Difference in education								
Report same	2.36	0.65	8.70	0.275				
Report different	ref							
Difference in race								
Report same	1.20	0.32	4.46	0.818				

(both black, white, other)								
Report different	ref							
Difference in orientation								
Report same	ref							
Report different	1.77	0.65	4.78	0.345				
Difference in agreements								
Report same	ref							
Report different	1.15	0.46	2.89	0.804				

GED: general educational development; IPV: intimate partner violence; UAI: unprotected anal intercourse

Table 4. Actor-partner interdependence model of factors associated with experiencing coercion

	Crude OR	**(90% CI)**		**p-value**	**Adjusted OR**	**(90% CI)**		**p-value**
ACTOR VARIABLES								
Age, per year decrease	1.05	0.99	1.11	0.205	1.06	1.00	1.13	0.098
Race/ethnicity								
Black/African American	n/a							
Other								
Education								
Some education post-high school	ref							
High school, GED, or less	1.53	0.56	4.18	0.483				
Sexual orientation								
Homosexual/Gay	ref							
Bisexual/Other	1.77	0.66	4.79	0.340				
Serostatus								

HIV positive	ref							
HIV negative	1.31	0.22	7.78	0.799				
UAI with a man other than (and concurrent with) main partner in past 3 months								
Yes	2.74	0.47	16.05	0.346				
No	ref							
Agreements about sex outside the relationship								
Monogamy	1.65	0.58	4.70	0.429				
Other (Outside sex, no agreements)	ref							
PARTNER VARIABLES								
Age, per year decrease	1.02	0.97	1.07	0.569				
Race/ethnicity								
Black/African American	1.85	0.50	6.90	0.439				

Other	ref							
Education								
Some education post-high school	ref							
High school, GED, or less	2.24	0.79	6.37	0.205	3.04	1.03	9.00	0.092
Sexual orientation								
Homosexual/Gay	ref							
Bisexual/Other	1.77	0.66	4.79	0.340				
Serostatus								
HIV positive	1.78	0.46	6.86	0.481				
HIV negative	ref							
UAI with a man other than (and concurrent with) main partner in past 3 months								
Yes	1.19	0.31	4.52	0.828				
No	ref							
Agreements about sex outside the relationship								
Monogamy	1.13	0.41	3.08	0.842				

Other (Outside sex, no agreements)	ref							
DYAD-LEVEL VARIABLES								
Duration of relationship with main partner (average reported by both partners, per year increase)	1.01	1.00	1.03	0.459				
UAI with main partner in past year (reported by either partner)								
Yes	ref							
No	1.61	0.57	4.56	0.450				
Difference in age (per year increase)	1.01	0.92	1.11	0.872				
Difference in education								
Report same	1.13	0.36	3.56	0.861				
Report different	ref							

Difference in race								
Report same (both black, white, other)	ref							
Report different	1.14	0.30	4.34	0.876				
Difference in orientation								
Report same	1.19	0.42	3.41	0.782				
Report different	ref							
Difference in agreements								
Report same	1.25	0.46	3.41	0.713				
Report different	ref							

GED: general educational development; UAI: unprotected anal intercourse

Appendix

A1. Obtain initial values for the intercept and slope parameters:

```
proc genmod data = dataset descending;
        class dyad;
        model outcome = X_partner X_actor Z / dist = bin link = logit;
        repeated subject = dyad/type = un;
run;
```

A2. Determine initial values for the between-dyad variance:

```
proc mixed data = dataset method = reml;
        class dyad;
        model outcome = X_partner  X_actor  Z/solution;
        random intercept/subject = dyad;
run;
```

A3. Evaluate the random intercept model using the initial values from steps A1 and A2:

```
proc nlmixed data = dataset qpoints = 20 tech = newrap;
        parms   beta0=x0  beta1=x1  beta2=x2  beta3=x3   s2u = x4;
        eta=beta0 + beta1*X_actor + beta2*X_partner+ beta3*Z+ u;
        mu = exp(eta) / (1+exp (eta));
        model outcome ~ binary (mu);
        random u ~ normal(0, s2u) subject = dyad
run;
```

A4. One step procedure to obtain beta estimates:

```
proc glimmix data = dataset;
        class  dyad;
        model outcome = X_actor X_parnter Z
                / solution link = logit dist = binomial;
        random  intercept /subject = dyad type = un gcorr ;
run;
```

Chapter 5: Discussion and conclusions

Study 1 – Promotion of CVCT

In this cross sectional analysis, we demonstrated the feasibility of promoting CVCT using community-based promotions, and identified predictors of CVCT uptake in Lusaka, Zambia. Using multi-level, multivariable logistic regression models, results showed that recruiting CVCT promoters who had previously tested with partners, inviting acquaintances of CVCT promoters, inviting couples (versus individuals) and in discreet locations like the home, and utilizing CVCT promoters from non-governmental and health networks (versus private networks) all significantly increased CVCT uptake.

A potential limitation is the possibility of fraudulent invitation receipts being returned by INAs for compensation. This would represent misclassification of the exposure, which could be differential by the outcome (hypothesizing that less successful INAs, i.e., INAs with fewer invited couples who tested, were more likely to return fraudulent receipts). Return of fraudulent receipts would make the intervention appear less successful, affecting internal study validity by biasing our results toward the null. We addressed this issue by conducting a sensitivity analysis excluding INAs with less than 0.5% to 2.5% success rates and evaluating the effect of these exclusions on our results. We found that excluding INAs with 1.5% success rates or less gave the most stable results.

Additionally, selection bias could affect our results if the selected INLs and INAs are different from the target population (external validity issue), and/or if selection is related to both the exposure and the outcome (internal validity issue). The selection of INLs and INAs were made via referrals from those known to or associated with the

CVCT centers, and while not representing the general population of influential leaders in urban Zambia, this source population should represent the target population of community leaders in urban Zambia who have some association with HIV testing. Selection of INLs and INAs is considered to be independent of exposure and outcome.

The main strength of this study was in demonstrating the feasibility of promoting CVCT in a large, ethnically-diverse urban center where HIV prevalence is high, and in identifying modifiable predictors of successful CVCT uptake in Lusaka, Zambia. We believe that the invitation uptake success rate in Zambia was relatively low (6%) because of sociocultural and infrastructure barriers to CVCT, and because, though INAs who have HIV tested were more successful, 42% had never tested; though promoting to acquaintances was more successful, only 32% of invitations were delivered to acquaintances; and though inviting couple was more successful, 70% invites were to an individual.

In order to design better promotions in Lusaka, we will need to recruit more INAs who are: from health networks, married, have tested for HIV; promote invitation delivery to INA acquaintances, to the couple, and in discrete locations; encourage invitation delivery to couples who are demographically similar to themselves (evidence for age mates, education mates); and continue to address sociocultural, knowledge, and infrastructure barriers through community-outreach and health staff education.

We expect that these predictors can be used to design improved CVCT promotional efforts in Lusaka, Zambia and to encourage stakeholders toward sponsorship of CVCT programs. It will be critical to further identify and garner support from stakeholders, health care providers, political leaders, and influential community leaders to

continue promoting CVCT within the community in Lusaka, Zambia. Based on these and other similar analyses, CVCT could also opportunistically be extended to other venues, as in home-based testing, or integrated within existing HIV services in Lusaka. Studies of the barriers to scaling-up CVCT in these venues in Zambia would be informative. Investigations of cost and cost-effectiveness will also be necessary to promote sustained support for CVCT promotions and continued scale-up.

Finally, outside of Zambia, we would like to use the knowledge gained from this study to encourage funding sources to sponsor CVCT programs, government and community leaders to endorse CVCT, and researchers to investigate the most effective ways to promote and provide CVCT services to the couples in their locales. Given these study results and the results from our similar study in Kigali, Rwanda, we recommend that this study design be used as a framework to identify predictors of CVCT uptake in other sub-Saharan African countries.

Study 2 – Integration of CVCT and family planning

We showed in an RCT of a video-based family planning intervention, conducted in the context of CVCT in Lusaka, Zambia, increased uptake of modern contraception from 26.2% to 98.6%. Importantly, we showed that sero-discordant couples educated on long-acting reversible contraceptive methods, in addition to all modern methods, had significantly reduced incidence of pregnancy. Specifically, among baseline contraceptive users, viewing this educational video was significantly associated with lower pregnancy incidence, and this effect in couples in which the woman was positive (either concordant positive couples, or sero-discordant couples in which the woman was positive). Condom use remained high during the study: any sex without a condom in past three months was reported for 32% of follow-up visits, while any sex with a condom in past three months was reported at 69% of follow-up visits.

A potential limitation to our study is the restricted generalizability (external validity) of our results since those who participated in the trial may be different from the target population by having an increased desire/receptivity for family planning (self-selection bias).

It is possible the outcome could be misclassified in the case of an undetected pregnancy/spontaneous abortion. However, undiagnosed spontaneous abortion should not be differential with respect to the exposure, and if any bias occurred, we expect it to be toward the null. As previously reported [89], the informed consent, which explained all methods prior to the intervention, likely increased knowledge of these methods and thereby attenuated the effect of the intervention.

Loss to follow-up may limit internal study validity if loss to follow up is associated with the intervention arm and/or the outcome (i.e., informative censoring). If those who are lost to follow-up were less likely to become pregnant (assuming pregnancy is a driving factor for a woman to attend a follow-up visit), then the effect of our intervention may be biased if the losses are also associated with the exposure. Sensitivity analyses testing the affect of various scenarios on estimates of effect will be considered.

Competing risks including infertility or a woman becoming no longer sexually active would prevent a woman from being at risk of the outcome. If one of such event occurs and is unknown to the study team, this person would be contributing immortal person time to the denominator of our estimates of effect. Since we are not accounting for the possibility of such competing risks, we are calculating unconditional measures of effect.

Strengths of this study include its randomized design in which two educational interventions were evaluated concurrently, in comparison to most studies of family planning interventions that are observational or quasi-experimental. The Methods video was successful among baseline users because IUD use increased 3% to 7% (for the No Methods Video, IUD use stayed at 1%), and Norplant use increased 5% to 14% (for the No Methods Video, Norplant use increased 2% to 11%). We hypothesize that baseline users may be more comfortable with modern contraceptives, and baseline users exposed to contraception education may have decreased barriers to continuation or uptake of a longer-acting method

The intervention was especially successful among concordant positive and HIV+ women couples who were baseline users because couples with positive women were

more likely to switch to LARC methods. Uptake in IUD use was the same as for all baseline method users, but Norplant use increased from 5% to 17.5% (for the No Methods Video, uptake increased from 2.5% to 11%). This may be explained by findings from a post-hoc analysis which showed that men in M+F+ relationships were more likely to not desire more children relative to men in discordant relationships (62% vs. 49%; p = 0.0001).

The intervention not successful among baseline non-users because most switched from no method/condoms to OCPs or injectables. We hypothesize that baseline non-method users may not yet be comfortable with modern contraception and may need repeated, sustained messaging to increase comfort with using modern contraceptives

In future analyses, we need to further explore baseline non-users to determine why they tend to chose less effective methods initially, to determine their predictors of initial method chosen and subsequent stopping/switching, and to test the hypothesis that they would benefit from repeated education on LARC methods. Additionally, we know that HIV positive women behave differently and a more in depth analysis of couple serostatus by initial contraceptive method, methods chosen at baseline, method discontinuation (stopping/switching) over the course of follow-up, and pregnancy incidence is warranted.

This dataset could also be used to analyze time to method discontinuation (stopping and switching), method choice (including an analysis of dual method use) by pregnancy outcomes, dual method use, and the currently controversial association between hormonal contraception and HIV risk. We note that the WHO Technical Statement on hormonal contraception and HIV [133] states that dual protection is always

recommended, and CVCT is an important point of contact to discuss hormonal contraception in the context of condom use among women at high risk for HIV.

Additionally, the 2012 Cochrane Review "Integration of HIV/AIDS services with maternal, neonatal and child health, nutrition, and family planning services" points out several gaps in the current literature that we could address using data from our study sites. For example, there is a current dearth in cost-effectiveness data for effective models of family planning integration, lack of information regarding how integration impacts current services, and few studies evaluate the outcomes of HIV incidence and STI incidence.

We expect these results to serve as a paradigm for transfer to other CVCT centers in Africa, and recommend that other CVCT centers, or ANC HIV testing centers, conduct preliminary feasibility studies evaluating the potential to scale-up this intervention within their study sites. This would allow for the development of integration of this family planning intervention outside of clinical trial settings, where research has been limited.

Study 3 – Integration of CVCT and IPV/coercion screening

We showed the prevalence of experiencing IPV or coercion among MSM couples enrolled in a RCT of CVCT in the US, and we used a multilevel actor-partner interdependence model (APIM) framework to identify correlates of experiencing IPV or coercion. To our knowledge, there are no large population-based estimates of coercion as defined here among MSM dyads, and there are no published studies examine the actor-partner characteristics associated with these outcomes. Factors associated with experiencing IPV were non-black/African American actor race, lower actor education, and lower partner education. Factors associated with experiencing coercion were younger actor age and lower partner education.

Selection bias possibly influenced which couples chose to participate in the trial, which could limit the generalizability of our findings to MSM couples in HIV prevention trial research settings. Information bias may have affected our results, namely regarding the potential for prevarication bias in accurately reporting experiences of the outcomes, IPV or coercion, which may be differential by the potential exposures (i.e., actor, partner, and dyadic demographic factors). Though measures were taken to ensure confidentiality in answering the study questions, we expect that this potential information would lead to an underestimate in the true prevalence of IPV and coercion. Since our data are cross-sectional, we cannot evaluate causal associations. Finally, this study was not designed or powered to detect differences in reported experiences of IPV and coercion, and these analyses are considered exploratory.

These analyses are exploratory and our results represent the initial steps in investigating the actor, partner, and dyadic-level characteristics associated with

experiences of IPV and coercion in the context of a RCT of CVCT for MSM in the US. Our findings suggest screening tools and interventions for IPV and coercion may benefit by directing efforts toward younger and less educated MSM.

Further exploration of this data set, comprised of MSM couples enrolled in a HIV prevention trial, using the APIM model to evaluate socio-demographic factors correlated with UAI and agreements about sex outside the relationship would further inform our understanding of HIV risk behaviors in this study sample.

Longitudinal data collected from larger and more diverse study populations (i.e., MSM couples outside of an HIV prevention trial research context) investigating the causal relationships between actor, partner, and dyadic-characteristics and physical IPV, sexual IPV, and coercion, both experienced and perpetrated, are needed. Additionally, further consideration of various covariates associated with IPV in other studies, including substance abuse [134], homophobic discrimination and internalized homophobia [19, 119, 128], experiences of homophobia [19, 119], relationship concurrency, and perceived stigma [115], should be evaluated with longitudinal data.

We believe that the novel application of the APIM demonstrated in this study can be used to inform other investigations of outcomes associated with HIV risk among MSM couples, including additional studies of IPV and coercion and also studies investigating predictors of UAI and agreements about sex outside the relationship by collecting actor, partner, and dyadic-level data.

Abbreviations

CBO/NGO - Community-based/non-governmental organization

CDC - Centers for Disease Control and Prevention

CHCT - Couples' Voluntary HIV Counseling and Testing

CVCT - Couples' Voluntary HIV Counseling and Testing

DAG – Directed acyclic graph

DMPA - Depo-Provera

GEE - Generalized estimating equation

HR – Hazard Ratio

INA - Influential network agent

INL - Influential network leader

IPV – Intimate partner violence

IUD - Intrauterine device

LARC - Long-acting reversible user-independent contraceptive

MSM - Men who have sex with men

OCP - Oral contraceptive

OR - Odds Ratio

PEPFAR - US President's Emergency Plan for AIDS Relief

PSF - Project San Francisco

RR - Risk Ratio

RZHRG - The Rwanda Zambia HIV Research Group

STI - Sexually transmitted infection

TFR - Total fertility rate

US - United States

VCT - Individual Voluntary HIV Counseling and Testing

WHO - World Health Organization

ZEHRP - Zambia Emory HIV Research Project

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Appendix: Wall, K.M., et al., Promotion of couples' voluntary HIV counselling and testing in Lusaka, Zambia by influence network leaders and agents. BMJ Open, 2012. 2(5).

Open Access Research

BMJ open

Promotion of couples' voluntary HIV counselling and testing in Lusaka, Zambia by influence network leaders and agents

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To cite: Wall KM, Kilembe W, Nizam A, *et al*. Promotion of couples' voluntary HIV counselling and testing in Lusaka, Zambia by influence network leaders and agents. *BMJ Open* 2012;2:e001171. doi:10.1136/bmjopen-2012-001171

► Prepublication history for this paper are available online. To view these files please visit the journal online (http://dx.doi.org/10.1136/bmjopen-2012-001171).

Received 20 March 2012
Accepted 20 July 2012

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ABSTRACT

Objectives: Hypothesising that couples' voluntary counselling and testing (CVCT) promotions can increase CVCT uptake, this study identified predictors of successful CVCT promotion in Lusaka, Zambia.

Design: Cohort study.

Setting: Lusaka, Zambia.

Participants: 68 influential network leaders (INLs) identified 320 agents (INAs) who delivered 29 119 CVCT invitations to heterosexual couples.

Intervention: The CVCT promotional model used INLs who identified INAs, who in turn conducted community-based promotion and distribution of CVCT invitations in two neighbourhoods over 18 months, with a mobile unit in one neighbourhood crossing over to the other mid-way through.

Primary outcome: The primary outcome of interest was couple testing (yes/no) after receipt of a CVCT invitation. INA, couple and invitation characteristics predictive of couples' testing were evaluated accounting for two-level clustering.

Results: INAs delivered invitations resulting in 1727 couples testing (6% success rate). In multivariate analyses, INA characteristics significantly predictive of CVCT uptake included promoting in community-based (adjusted OR (aOR)=1.3; 95% CI 1.0 to 1.8) or health (aOR=1.5; 95% CI 1.2 to 2.0) networks versus private networks; being employed in the sales/service industry (aOR=1.5; 95% CI 1.0 to 2.1) versus unskilled manual labour; owning a home (aOR=0.7; 95% CI 0.6 to 0.9) versus not; and having tested for HIV with a partner (aOR=1.4; 95% CI 1.1 to 1.7) or alone (aOR=1.3; 95% CI 1.0 to 1.6) versus never having tested. Cohabiting couples were more likely to test (aOR=1.4; 95% CI 1.2 to 1.6) than non-cohabiting couples. Context characteristics predictive of CVCT uptake included inviting couples (aOR=1.2; 95% CI 1.0 to 1.4) versus individuals; the woman (aOR=1.6; 95% CI 1.2 to 2.2) or couple (aOR=1.4; 95% CI 1.0 to 1.8) initiating contact versus the INA; the couple being socially acquainted with the INA (aOR=1.6; 95% CI 1.4 to 1.9) versus having just met; home invitation delivery (aOR=1.3; 95% CI 1.1 to 1.5) versus elsewhere; and easy invitation delivery (aOR=1.8; 95% CI 1.4 to 2.2) versus difficult as reported by the INA.

Conclusions: This study demonstrated the ability of influential people to promote CVCT and identified agent, couple and context-level factors associated with CVCT uptake in Lusaka, Zambia. We encourage the

ARTICLE SUMMARY

Article focus

- Given preliminary findings from Zambia and Rwanda suggesting community-based promotion of couples' voluntary counselling and testing (CVCT) is effective, we hypothesise that predictors of successful promotions can be identified to increase CVCT uptake in Lusaka, Zambia.
- This study evaluated the ability of community-based activities to promote CVCT and identified predictors of CVCT uptake in Lusaka, Zambia.

Key messages

- Here, we not only demonstrated the feasibility of CVCT promotions using influential network agents and leaders (INAs and INLs) to promote CVCT, but also identified INA-level, couple-level and invitation-level predictors of CVCT uptake.
- The predictors of CVCT uptake included: recruiting INAs who have tested with partners, focusing invitations on INA acquaintances, issuing invitations to couples and in a discreet location, and utilising INAs from non-governmental and health networks.

Strengths and limitations of this study

- These predictors can be used to enhance CVCT promotions in Zambia and may be extended as a framework to other locales, with adaptation based on location-specific predictors of CVCT promotions.
- Country-specific differences in CVCT promotions indicate that more research into site-specific predictors of CVCT may be necessary for successful CVCT promotions in other locales.

development of CVCT promotions in other sub-Saharan African countries to support sustained CVCT dissemination.

BACKGROUND

In 2009, 68% of the global HIV-positive population resided in sub-Saharan Africa, equating to roughly 22.5 million cases. Zambia has one of the largest HIV burdens, with roughly 980 000 prevalent and 76 000 incident cases in 2009,[1] and HIV prevalence roughly twice as high in urban (20%) versus rural (<10%) areas.[2]

Heterosexual transmission is the primary cause of incident HIV infections in sub-Saharan Africa where discordant couples (an HIV+ and HIV− partner) in long-term relationships represent the largest group at-risk for HIV.[1 3] In urban Zambia, roughly 60% of new infections occurred between married/cohabiting heterosexual couples,[3] and 17% of pregnant couples in Lusaka were discordant.[4]

Knowledge of HIV serostatus is critical for prevention of transmission. According to the 2007 Zambia Demographic and Health Survey, although most adults know where to receive an HIV test, only 35% of women and 20% of men have ever tested and received results.[2] Voluntary HIV counselling and testing (VCT) is an evidence-based strategy to increase serostatus awareness, decrease high-risk behaviour and decrease transmission.[5] Couples' VCT (CVCT), in which both partners are tested and mutually disclose results, addresses issues with disclosure, allows for risk-reduction planning based on partner serostatus, and decreases high-risk behaviour.[6–9] However, though CVCT effectively targets the highest at-risk group in sub-Saharan Africa, it has not been widely disseminated due to lack of demand and supply, and lack of funding. Lack of demand primarily results from insufficient knowledge about the possibility of couple serodiscordance and CVCT services.[8–11]

The Zambia-Emory HIV Research Project (ZEHRP), based in Lusaka, provides CVCT services. ZEHRP and other groups have shown that clinic and community-based CVCT promotions can increase CVCT awareness and demand.[4 11–14] Social networks and community leaders are critical in changing perceptions towards HIV/AIDS and other health issues in sub-Saharan Africa.[15–18] At ZEHRP, CVCT promotional efforts are directed by influential network leaders (INLs) and agents (INAs), based on the Social Networks and Social Support Theory.[19] This study assessed the ability of INLs and INAs to promote CVCT and identified predictors of CVCT uptake in Lusaka.

METHODS

INL and INA recruitment and training

ZEHRP CVCT promotions maximise programme impact by utilising two existing social networks levels—INLs and INAs. INL and INA recruitment and training methods are described elsewhere.[15 20] Briefly, INLs were identified from CVCT consensus meetings and national/city-wide umbrella referrals from four social networks (faith-based/religious, health, private and community-based/non-governmental organisations (CBOs/NGOs)). INLs identified INA candidates from their respective networks, and final selection was made after interviewing with experienced ZEHRP counsellors. INLs and INAs completed IRB-approved written informed consents, completed demographic questionnaires and selected a network category that best described their role when promoting CVCT. Enrolled INAs received 4-day training in HIV/AIDS health advocacy/outreach, social networking, CVCT promotions and observation of successful door-to-door ZEHRP promotional strategies. During training, INLs and INAs were offered CVCT or VCT.

CVCT promotions

CVCT promotional activities took place from July 2004 to December 2005 in two randomly selected neighbourhoods as described elsewhere.[21] Briefly, of eight neighbourhoods assessed as potential sites, two were selected based on similar population size, infrastructure and with consideration of geographic distance to minimise spill-over effects. CVCT promotions and services were implemented in these neighbourhoods, and a mobile unit operated in one neighbourhood and crossed over to the other mid-way through the study. Given the catchment areas of these two neighbourhoods (99 280 and 85 022 individuals), it was assumed that couples would rarely receive multiple invitations. INAs distributed invitations to couples or individuals within their neighbourhoods that detailed CVCT facility directions and procedures. Couples could be cohabiting or non-cohabiting. Invitations included a unique ID, INA identifier and a receipt portion that the INA retained and submitted bi-weekly. The receipt portion contained the invitation ID and space to record the date, time, place of invitation, relationship of the INA and recipient, recipient description (man, woman or couple), recipients' age(s), residence, marital status and INA's perception of the difficulty of invitation delivery.

Before 18 March 2005, INAs received $0.21/invitation issued and an additional $4.20/couple attending CVCT. Beginning 19 March 2005, payment/invitation was reduced to $0.11 and payment/couple attending CVCT was increased to $5.25 to deter fraudulent completion of invitation receipts. For perspective, Purchasing Power Parity in Zambia, an adjusted measure of per-capita-income number, is $1500/year,[22] and the proportion of Zambians living on less than $1/day is 68.6%.[23] In addition to fixed CVCT sites, which could serve 30 couples/day, a mobile HIV testing unit, which could serve an additional 30 couples/day, was available for 9 months in one neighbourhood and then 9 months in the other. Mobile testing sites were selected based on facility (churches, schools and community centres) availability.

CVCT procedures

CVCT procedures are described elsewhere.[18] Briefly, couples participate in group counselling, joint pretest counselling and, for those testing, confidential informed consent procedures, phlebotomy, rapid HIV testing,[24] and joint post-test counselling and test result delivery. CVCT services were free and transportation to testing sites was reimbursed. Invitation receipts were collected from INA-invited couples and the invitation ID was linked to the couple ID number. The study was approved by the Emory University IRB and the University of Zambia Research Ethics committee. Informed consent was obtained from all study participants.

Statistical analysis

Counts (percentages) for categorical variables and means (SD) for continuous variables were calculated for INL-level, INA-level, couple-level and invitation-level characteristics. Number of invitations distributed was tabulated by INA characteristics as were success rates (the number couples tested/number invitations distributed). Analyses were stratified by couple cohabitation status to identify differences in CVCT uptake and predictors of success. INAs not achieving ≥1.5% success were excluded from analyses to prevent the inclusion of INAs systematically returning fraudulent receipts.

Crude ORs, 95% CIs and p values evaluated associations between INA-level characteristics predictive of successful invitations. Generalised estimating equation (GEE) methods evaluated the association between couple-level and invitation-level characteristics predictive of successful invitations. Since couple-level and invitation-level data are clustered at two levels, within-individual INAs and INLs, GEE methods accounted for non-independence of observations.

INA-level, couple-level and invitation-level variables significant (Bonferroni corrected p value=0.002) in univariate analyses were entered into a multivariate logistic regression model, and the variables were examined for multi-collinearity. GEE methods accounted for clustering of couple-level and invitation-level characteristics within individual INAs and INLs. We fit the marginal multilevel logistic regression model using PROC GENMOD. GEE analysis methods with an exchangeable correlation structure accounted for two-level clustering of couple-level and invitation-level characteristics within individual INAs and INLs. We hypothesised a priori that an exchangeable correlation structure would be appropriate since couples within a cluster should not be increasingly/decreasingly correlated. We also considered other correlation structures, such as unstructured. Data analysis was conducted with SAS V.9.2 (North Carolina, USA).

RESULTS

INL characteristics

Sixty-eight INLs were recruited from CBOs/NGOs, faith-based, health and private sector networks. Average INL age was 45 (IQR=36–52), and 68% were men. Average years living in Lusaka was 25 (IQR=15–34), and 72% were married. Almost all INLs understood Nyanja and/or Bemba or English, roughly half owned their home and most had previously tested for HIV (table 1).

INA characteristics associated with couples' testing

INLs recruited 520 INAs (excluding 70 INAs with <1.5% success), and overall INAs distributed 29 119 invitations with 1727 couples tested for an average of 91 invites/INA and five couples tested/INA. INAs affiliated to CBOs/NGOs distributed more than average invitations/INA and were more likely to successfully invite cohabiting couples relative to private network INAs. Health network INAs also distributed a high number of average invitations/INA and were more successful among all couples relative to private network INAs (tables 1 and 2).

Most INAs were women, and performance with respect to invitations delivered, success rates and average number of couples tested was similar by gender (table 1). The average INA age was 37 (IQR=29–44), and older INAs were significantly more successful among cohabiting, but less successful among non-cohabiting, couples relative to younger INAs (table 2). The average number of years living in Lusaka was 21 (IQR=11–30), and years living in Lusaka significantly predicted successful invitation among cohabiting couples (table 2).

Married INAs were significantly more successful among cohabiting couples relative to divorced, widowed or single INAs (table 2). Divorced INAs had very low success rates among non-cohabiting couples (table 1). Among INAs with a partner, years of current relationship had a similar effect as age, with longer unions associated with significantly decreased success among non-cohabiting couples.

Fifty one per cent of INAs were sales/service industry employees, and these INAs were significantly more successful among cohabiting and non-cohabiting couples relative to unskilled manual labourers. Professional and agricultural sector employees were also more successful among non-cohabiting couples (table 2). Eighty per cent of INAs could read English (table 1), and this was associated with successful invitations among non-cohabiting couples only.

Over half of INAs rented their home. The 38% who owned a home were less successful than those who rented or lived in housing provided by others; with stratification this remained significant only among cohabiting couples (table 2). Two per cent of INAs had housing provided by an employer and were substantially more successful among cohabiting couples (table 1).

Only 57% of INAs had tested for HIV with a partner (22%) or alone (35%) (table 1). INAs testing for HIV with a partner were more successful among all couples, and testing alone was associated with higher success among non-cohabiting couples relative to never testing (table 2).

Table 1 INL and INA characteristics by invitations distributed, success rate and couple cohabitation status

	INL (N=68)		INA (N=320)		Invitations distributed	Couples tested	Average invites/INA	Average couples tested/INA	Success rate (%)	% Invitations given to cohabiting couples	% couples tested who are cohabiting	Success rate (%)	
	N	%	N	%								Cohab couples	Non-cohab couples
Total	68		320		29119	1727	91	5	6	81	87	6	4
Network													
Private	16	24	73	23	5592	302	77	4	5	79	82	6	3
Religious	19	28	62	19	5530	282	89	5	5	85	95	6	4
Health	12	18	95	30	9529	617	100	6	6	80	86	7	5
CBOs/NGOs	21	31	90	28	8468	526	94	6	6	82	87	7	4
Gender													
Man	46	68	131	41	11620	700	89	5	6	81	85	6	5
Woman	22	32	189	59	17499	1027	93	5	6	82	88	6	4
Relationship status													
Married	49	72	208	65	18814	1178	90	6	6	82	88	7	4
Divorced	5	7	21	7	2033	86	97	4	4	82	94	5	1
Single	7	10	38	12	2902	131	76	3	5	74	83	5	3
Widow	7	10	45	14	4212	303	94	7	7	83	84	7	7
Missing	0	0	8	3	1158	29	145	4	3	78	79	3	2
Occupation													
Professional/technical/managerial	28	41	68	21	5605	330	82	5	6	80	81	6	5
Sales/service	22	32	163	51	11462	793	70	5	7	81	88	7	5
Agricultural	1	1	6	2	739	43	123	7	6	75	77	6	5
Unskilled manual labor	12	18	42	13	5352	278	127	7	5	84	90	6	3
Do not work for money	2	3	33	10	4912	253	149	8	5	82	90	6	3
Missing	3	4	8	3	1049	30	131	4	3	82	100	3	0
Read English													
Yes	64	94	265	83	23744	1439	90	5	6	81	86	6	4
No	4	6	55	17	5375	288	98	5	5	82	92	6	2
Housing													
Provided by employer (free)	5	7	6	2	372	38	62	6	10	83	95	12	3
Rental home	22	32	166	52	16341	985	98	6	6	81	86	6	4
Free housing by other means	10	15	26	8	1611	113	62	4	7	80	89	8	4

Continued

Table 1 Continued

	INL (N=68)		INA (N=320)		Invitations distributed	Couples tested	Average invited/ INA	Average couples tested/INA	Success rate (%)	% Invitations given to cohabiting couples	% couples tested who are cohabiting	Success rate (%)	
	N	%	N	%								Cohab couples	Non-cohab couples
Own home	30	44	120	38	10583	585	88	5	6	82	87	6	4
Missing	1	1	2	1	212	6	106	3	3	62	100	5	0
Ever tested for HIV													
Yes with partner	41	60	71	22	6274	303	88	4	5	82	93	5	2
Yes alone	14	21	113	35	10424	608	92	5	6	81	87	6	4
No	13	19	135	42	12207	802	90	6	7	81	86	7	5
Missing	0	0	1	0	214	14	214	14	7	86	86	7	7

INA, influential network agent; INL, influential network leader.

Seventy INAs did not achieve 1.5% success and were excluded from analyses as their invitation receipts were suspected to have been fraudulently completed. These INAs distributed 125 invitations/INA and were similar to INAs in the analysis by gender (χ^2 test of association=0.8, p=0.4), age (t-statistic=−1.9, p=0.06) and network (χ^2=3.7, p=0.3). The average success of these 70 INAs was 0.57%, and when adding these INAs to those included in the analysis, the overall INA success was 4.97%.

Couple and invitation characteristics associated with couples' testing

The mean age of men was 33 years and of women was 27 years (table 3). The couples tested were slightly older than those not tested (p <0.001). Most couples were cohabiting, and these were significantly more likely to test versus non-cohabiting couples. The mean duration of a relationship was 6 years, and tested couples had been together on average 1 year longer than non-tested couples.

INAs initiated contact 95% of the time, although in the rare instances when the couple or the woman initiated contact with the INA, the couple was more likely to test. Inviting a couple together also resulted in increased testing. Couples who were family members or social acquaintances of the INA were more likely to test versus those previously unacquainted. Ease of invitation delivery (operationalised as not being time consuming, requiring long explanations, challenging because of invitee resistance or scheduling conflicts) was also associated with couples' testing. Interestingly, though public endorsements were predictive of testing during a pilot study,[15] they were not associated with increased uptake of testing in this larger study. Similarly, the presence of mobile units was not associated with increased testing (table 3).

Multivariate model of couples' testing predictors

Age of the man and woman was collinear and woman's age was excluded from the multivariate model (table 4). Couple cohabitation status was an effect measure modifier, and multivariate analyses were stratified by cohabitation status. All adjusted ORs (aORs) presented below were statistically significant in multivariate analyses accounting for two-level clustering.

Health sector INAs were most successful (aOR=1.5) followed by CBO/NGO INAs (aOR=1.3) relative to private sector INAs. Married INAs were more successful versus others among cohabiting couples (aOR=1.3). Sales/service industry employees (aOR=1.5) versus unskilled manual labourers were more successful overall. Among non-cohabiting couples, INAs who could read English were more successful (aOR=2.0) whereas among cohabiting couples, INAs owning homes were less successful (aOR=0.7). INAs who had tested for HIV with a partner were more successful among all couples (aOR=1.4), while those who had tested for HIV alone were more successful among non-cohabiting couples (aOR=2.1), versus INAs who had never tested for HIV.

Table 2 Bivariate association between INA characteristics and couples' testing by couples' cohabitation status

	All couples				Cohabiting couples				Non-cohabiting couples			
INA characteristics	OR	95% CI		p Value	OR	95% CI		p Value	OR	95% CI		p Value
Network												
Private	Ref				Ref				Ref			
CBOs/NGOs	1.23	1.06	1.43	0.01	1.21	1.03	1.42	0.02	1.35	0.88	2.06	0.17
Health	1.29	1.12	1.49	0.001	1.25	1.07	1.46	0.01	1.56	1.04	2.35	0.03
Religious	1.06	0.90	1.26	0.48	1.07	0.90	1.27	0.47	1.02	0.63	1.66	0.94
Gender												
Male	Ref				Ref				Ref			
Female	0.97	0.88	1.07	0.58	1.01	0.91	1.12	0.84	0.79	0.60	1.03	0.09
Age (per year increase)	1.01	1.00	1.01	0.07	1.01	1.00	1.01	0.002	0.98	0.96	0.99	0.001
Years living in Lusaka (per year increase)	1.01	1.00	1.01	<0.001	1.01	1.01	1.01	<0.001	1.00	0.99	1.01	0.80
Relationship status												
Other (divorced, widowed, single)	Ref				Ref				Ref			
Married	1.19	1.07	1.32	0.001	1.22	1.09	1.36	0.001	0.96	0.73	1.26	0.75
Years of relationship (per year increase)*	1.00	0.99	1.01	0.97	1.01	1.00	1.01	0.09	0.95	0.93	0.97	<0.001
Occupation												
Unskilled manual labour	Ref				Ref				Ref			
Professional	1.14	0.97	1.35	0.11	1.02	0.86	1.22	0.82	2.25	1.42	3.57	0.001
Sales/service	1.36	1.18	1.56	<0.001	1.31	1.13	1.52	<0.001	1.73	1.12	2.67	0.01
Agricultural	1.13	0.81	1.57	0.48	0.95	0.66	1.38	0.79	2.34	1.01	4.97	0.05
Do not work for money	0.99	0.83	1.18	0.92	0.99	0.82	1.18	0.87	1.09	0.63	1.88	0.76
Read English												
No	Ref				Ref				Ref			
Yes	1.14	1.00	1.30	0.05	1.06	0.92	1.21	0.44	2.12	1.35	3.33	0.001
Housing												
Other housing (rental, free)	Ref				Ref				Ref			
Own home	0.89	0.80	0.98	0.02	0.89	0.79	0.99	0.03	0.88	0.66	1.16	0.36
Ever tested for HIV												
No	Ref				Ref				Ref			
Yes with partner	1.39	1.21	1.59	<0.001	1.26	1.09	1.45	0.002	2.97	1.85	4.78	<0.001
Yes alone	1.22	1.06	1.41	0.01	1.13	0.97	1.31	0.11	2.42	1.48	3.95	<0.001

*Among those with a partner.
INA, influential network agent; INL, influential network leader.

Cohabiting couples were more likely to test (aOR=1.4) versus non-cohabiting couples.

Invitation-level predictors of testing among cohabiting couples included inviting the couple versus the woman/man alone (aOR=1.2); also couple (aOR=1.4) or woman (aOR=1.6) versus INA initiated contact was predictive. Being socially acquainted with the INA (aOR=1.6) versus having just met was predictive among all couples, while home CVCT invitation delivery (aOR=1.4) versus elsewhere, and easy invitation delivery (aOR=1.9) versus difficult were predictive among cohabiting couples.

DISCUSSION

In an African capital city where very few couples have jointly tested for HIV, a promotional programme using INIs and INAs prompted approximately 100 couples/month to seek CVCT. INA network, occupation, marital status and testing history, as well as couple cohabitation status and the INA–invitee relationship influenced invitation success. Invitations delivered to the couple, in the home, and invitations initiated by the woman partner were also significant CVCT uptake predictors.

CBOs/NGOs and health network INAs were more successful than faith-based or private sector INAs. CBO/NGO networks included parent-teacher, legal aid, skills training and health information organisations. Health networks included clinical officers, nurses, home healthcare visitors, community health workers, neighbourhood health committee members and traditional birth attendants. The private sector included individuals who were self-employed or those involved in providing the public with goods or services. Previous studies have similarly demonstrated the ability of influential people to effectively disseminate information and change attitudes and behaviours towards HIV in sub-Saharan Africa.[16–18] Unlike health and CBO/NGO INAs, private sector INAs may have been preoccupied with income

Table 3 Bivariate association between couple and invitation characteristics and couples' testing accounting for clustering within INAs and INLs

	All couples		Couples not tested		Couples tested		OR	95% CI		p Value
	N	%	N	%	N	%				
Couple characteristics										
Age of man (mean, SD)	33.25	9.03	33.16	8.99	34.61	9.43	1.01	1.01	1.02	<0.001
Age of woman (mean, SD)	27.12	7.75	27.03	7.72	28.60	8.15	1.02	1.02	1.03	<0.001
Relationship of couple										
Not cohabiting	5275	18	5058	19	217	13	Ref			
Cohabiting	23664	82	22161	81	1503	87	1.58	1.38	1.81	<0.001
Years of relationship (mean, SD)	6.27	6.42	6.22	6.35	7.18	7.38	1.02	1.01	1.03	<0.001
Number of children (mean, SD)	2.04	2.16	2.04	2.16	2.06	2.12	1.01	0.99	1.03	0.29
Invitation characteristics										
Invitee (1st contact)										
Woman	8984	31	8426	31	508	30	Ref			
Couple	8567	30	7972	29	595	35	1.24	1.08	1.43	0.002
Man	11467	40	10851	40	616	36	0.91	0.81	1.03	0.13
Who initiated contact?										
INA	26820	93	25103	93	1517	89	Ref			
Couple	527	2	475	2	52	3	1.71	1.34	2.18	<0.001
Man	877	3	811	3	66	4	1.18	0.88	1.58	0.26
Woman	690	2	624	2	66	4	1.59	1.20	2.10	0.001
Relationship to INA										
Just met/unknown	19688	68	18749	69	939	55	Ref			
Co-worker	287	1	269	1	18	1	1.35	0.89	2.06	0.16
Family	1697	6	1525	6	172	10	2.08	1.75	2.49	<0.001
Social acquaintance (neighbour, friend, church member)	7186	25	6601	24	585	34	1.64	1.43	1.87	<0.001
Place of invitation										
Community	9828	34	9339	35	489	29	Ref			
Couple home	15460	54	14532	54	928	55	1.41	1.23	1.61	<0.001
INA home	1636	6	1461	5	175	10	2.25	1.87	2.71	<0.001
Couple or INA work	1812	6	1702	6	110	6	1.21	0.97	1.51	0.09
Public endorsement										
No	18148	63	17080	63	1068	62	Ref			
Yes	10715	37	10066	37	649	38	1.04	0.92	1.17	0.53
Delivering invitation										
Difficult/somewhat difficult	3030	10	2912	65	118	0.4	Ref			
Easy	25860	89	1599	35	24261	99.5	1.60	1.33	1.93	<0.001
Mobile unit present at time of invitation										
No	14268	49	13713	50	909	53	Ref			
Yes	14622	51	13679	50	818	47	1.12	0.89	1.39	0.33
Neighbourhood of invitation										
Neighbourhood 1	13705	47	12911	47	794	46	Ref			
Neighbourhood 2	15414	53	14481	53	933	54	0.97	0.79	1.18	0.74

Community: church/mosque, clinic, market, street/public place, social gathering.
INA, Influential network agent; INL, Influential network leader.

generation and/or did not have similar opportunities to integrate CVCT promotions into their daily routine. The marginal performance of faith-based INAs was surprising given Zambia is strongly religious; however, though religious leaders have opportunities to promote from the pulpit, the stigma associated with sexually transmitted infections (STIs) may inhibit open discussion on CVCT.[17 25]

Cohabiting couples were more likely than non-cohabiting couples to test, and married INAs delivered more successful invitations than unmarried INAs. Fear of stigma among married couples is common,[9 26 27] and perhaps married INAs were able to more successfully overcome this barrier with their fellow married couples. INAs who previously tested for HIV with a partner were also more successful than those who had not tested, likely due to their first hand knowledge of CVCT procedures and ability to speak personally to perceived CVCT barriers.

INAs socially acquainted with the invitee were more successful versus those who were previously

Table 4 Multivariate model of INA-level, couple-level and invitation-level characteristics associated with couples' testing

	All couples				Cohabiting couples				Non-cohabiting couples			
	OR	95% CI		p Value	OR	95% CI		p Value	OR	95% CI		p Value
INA characteristics												
Network												
Private	Ref				Ref				Ref			
Religious	1.01	0.71	1.43	0.95	1.01	0.73	1.40	0.94	1.16	0.49	2.77	0.74
Health	1.53	1.15	2.04	0.004	1.48	1.11	1.97	0.01	1.80	0.96	3.35	0.07
CBOs/NGOs	1.34	1.01	1.77	0.04	1.31	0.98	1.76	0.07	1.53	0.84	2.79	0.16
Years living in Lusaka	1.01	1.00	1.02	0.14	1.01	1.00	1.02	0.07	1.01	0.99	1.04	0.24
Age (per 1 year increase)	1.00	0.99	1.02	0.79	1.00	0.99	1.02	0.53	0.99	0.97	1.01	0.35
Marital status												
Other (divorced, widowed, single)	Ref				Ref				Ref			
Married	1.23	0.99	1.53	0.06	1.28	1.02	1.60	0.03	1.06	0.70	1.62	0.77
Occupation												
Unskilled manual labour	Ref				Ref				Ref			
Professional	1.19	0.77	1.84	0.45	1.06	0.69	1.64	0.79	1.98	0.92	4.27	0.08
Sales/service	1.45	1.01	2.10	0.05	1.37	0.94	1.99	0.11	1.67	0.88	3.19	0.12
Agricultural	1.14	0.65	2.01	0.64	0.97	0.55	1.72	0.93	1.68	0.60	4.67	0.32
Do not work for money	0.95	0.62	1.45	0.81	0.95	0.62	1.45	0.80	0.69	0.26	1.82	0.45
Reads English												
No	Ref				Ref				Ref			
Yes	1.18	0.90	1.55	0.22	1.15	0.87	1.51	0.32	1.98	1.05	3.72	0.03
Housing												
Other housing (rental, free)	Ref				Ref				Ref			
Own home	0.74	0.59	0.92	0.01	0.73	0.58	0.91	0.01	0.93	0.62	1.38	0.71
Ever tested for HIV												
No	Ref				Ref				Ref			
Yes with partner	1.36	1.07	1.72	0.01	1.29	1.01	1.66	0.04	2.13	1.27	3.57	0.004
Yes alone	1.28	1.00	1.64	0.05	1.21	0.94	1.56	0.15	1.92	1.10	3.35	0.02
Couple characteristics												
Age of man (per 1 year increase)	1.00	1.00	1.01	0.30	1.01	1.00	1.02	0.10	1.03	1.00	1.05	0.02
Years of relationship (per 1 year increase)	1.01	0.99	1.02	0.35	1.02	1.01	1.03	<0.001	0.45	0.37	0.55	<0.001
Relationship of couple					n/a				n/a			
Not cohabiting	Ref											
Cohabiting	1.39	1.19	1.63	<0.001								
Invitation characteristics												
Invitee (1st contact)												
Individual (woman/man)	Ref				Ref				Ref			
Couple	1.20	1.04	1.39	0.01	1.27	1.09	1.49	0.003	0.82	0.52	1.28	0.38
Who initiated contact?												
INA	Ref				Ref				Ref			
Couple	1.35	1.03	1.78	0.03	1.43	1.05	1.94	0.02	0.94	0.27	3.20	0.92
Man	1.22	0.89	1.67	0.22	1.26	0.90	1.75	0.18	1.00	0.47	2.12	1.00
Woman	1.60	1.17	2.19	0.003	1.53	1.10	2.12	0.01	1.54	0.73	3.27	0.26
Relationship to INA												
Just met/unknown	Ref				Ref				Ref			
Co-worker	1.48	0.89	2.43	0.13	1.47	0.84	2.55	0.18	1.11	0.27	4.56	0.89
Social acquaintance (neighbour, friend, church member, family)	1.62	1.41	1.87	<0.001	1.60	1.37	1.87	<0.001	1.60	1.15	2.24	0.01
Place of invitation												
Other (community or couple/INA work)	Ref				Ref				Ref			
Couple or INA home	1.30	1.14	1.48	<0.001	1.39	1.21	1.61	<0.001	0.93	0.68	1.27	0.65
Delivering invitation												
Difficult/somewhat difficult	Ref				Ref				Ref			
Easy	1.75	1.41	2.17	<0.001	1.87	1.47	2.37	<0.001	1.15	0.67	1.99	0.61

INA, influential network agent

unacquainted. The strength of INA–invitee relationship may facilitate open discussion on CVCT and engender confidence. INAs inviting the couple together versus either partner alone, potentially removing pressure for one partner to propose testing to the other, were also more successful. Previous studies support the effectiveness of couple-level-targeted prevention strategies.[15 29–31]

Although most invitations were initiated by INAs, when the woman partner initiated contact with the INA, the CVCT uptake increased. This finding likely reflects pre-existing motivation to discuss or participate in CVCT.

Invitations delivered in the home versus community were more effective. Previous studies indicate that home and workplace HIV counselling and testing promotions are more successful in Zambia, Uganda and Malawi relative to community locations.[32–35] These findings are likely due to increased discretion and comfort associated with home settings.

Results from a similar study using both INIs and INAs in Kigali, Rwanda highlight country-specific similarities and differences. Similar to Zambia, Rwandan health INAs were more successful relative to private network INAs. Married Rwandan INAs were more successful than single INAs, and cohabiting couples were more likely to test than non-cohabiting couples in univariate analyses. We similarly found that invitations delivered to couples socially acquainted with the INA, woman partner initiated contact and invitations delivered at home were more successful in multivariate analyses in Rwanda. In contrast to this study, Rwandan faith-based INAs were more successful in univariate analyses relative to private network INAs, and the overall INA success rate in Rwanda was higher (18%). Mobile units were also associated with increased testing in Rwanda.[20] We were surprised that the mobile unit was not predictive of testing in this analysis as in Rwanda, not because of mitigated transportation costs, which were reimbursed, but because of the increased convenience and decreased time commitments engendered by mobile testing. More research is needed to determine why the mobile testing units did not increase uptake.

Kigali and Lusaka, though both capital cities, differ in several important ways: Kigali has a monolingual population of 800 000 with easy and inexpensive transportation. In contrast, Lusaka's 1.7 million inhabitants represent all 75 Zambian languages/dialects, the city is large and transportation is expensive. Another study in the Bemba-speaking Copperbelt region of Zambia combined INA promotions with mass media strategies in two cities of 600 000 each and obtained success rates between those found in Lusaka and Kigali.[14] These linguistic and infrastructural differences highlight the importance of testing and adapting network-based promotional models to different environments.

Results from a pilot study of promotions in Lusaka with 55 INAs (no INIs) showed that, while invitation-level predictors were similar to those found in this larger study, the small sample size did not allow simultaneous detection of INA-level, couple-level and invitation-level characteristics in hierarchical analysis.[15] Similarly, the Copperbelt study described previously did not examine INA-level, couple-level or invitation-level predictors of success.[14]

The exclusion of the 70 INAs who did not achieve 1.5% success was considered necessary in order to determine the INA-level predictors of successful invitation delivery among INAs not returning fraudulent invitation receipts. We acknowledge that this exclusion may discount INAs who were poor performers in addition to INAs returning fraudulent receipts thereby reducing the generalisability of our findings to more productive INAs.

Overall, this study demonstrated the feasibility of CVCT promotions in Lusaka, and we believe success rates could be considerably increased by utilising the modifiable predictors of CVCT uptake identified: recruiting INAs who have tested with partners, focusing invitations on INA acquaintances, issuing invitations to couples and in a discreet location and utilising INAs from CBOs/NGOs and health networks. It should be noted that most of the statistically significant aORs are close to the null, suggesting cautious interpretation of these associations. More research is especially needed to encourage faith-based leaders in Zambia to promote CVCT more effectively.

CONCLUSION

CVCT is an evidence-based testing strategy shown to reduce transmission of HIV and other STIs and to help prevent unintended pregnancies in sub-Saharan Africa. However, CVCT is yet to be widely implemented in this region.[4 6 7 36–40] Here, we demonstrated not only the feasibility of CVCT promotions using INAs and INIs, but also identified practical INA-level, couple-level and invitation-level factors that were marginally though significantly predictive of CVCT uptake in these analyses. These predictors can be used to enhance CVCT promotions in Zambia and may be extended as a framework to other locales, with adaptation based on location-specific predictors of CVCT promotions.

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Acknowledgements We would like to thank the Project Management Group, staff, and study participants of the Zambia-Emory HIV Research Project in Lusaka, Zambia. We would also like to thank Drs. Patrick Sullivan, David L. Roth, Leslie Clark, and Joseph Telfair and interns Steve Dunham and Helen Ji for their contributions.

Contributors KMW made substantial contributions to the analysis and interpretation of data, drafting the article and revising it critically for important intellectual content and gave final approval of the version to be published. WK made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published. AN made substantial contributions to the analysis and interpretation of data, revising the article critically for important intellectual content, and gave final approval of the version to be published. CV made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published. MK made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published. EC made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published. AT made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published. GS made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published. DC made substantial contributions to data aquisition, revising the article critically for important intellectual content, and gave final approval of the version to be published. FH made substantial contributions to data aquisition, revising the article critically for important intellectual content, and gave final approval of the version to be published. JM made substantial contributions to data aquisition, revising the article critically for important intellectual content, and gave final approval of the version to be published. DK made substantial contributions to the analysis and interpretation of data, revising the article critically for important intellectual content, and gave final approval of the version to be published. SA was the PI of the chief sponsoring grant NIMH 66767 and made substantial contributions to study conception and design, revising the article critically for important intellectual content, and gave final approval of the version to be published.

Funding This work was supported by funding from the National Institute of Mental Health (R01 66767); the AIDS International Training and Research Program Fogarty International Center (D43 TW001042); the Emory Center for AIDS Research (P30 AI050409); National Institutes of Health (R01s AI40951, AI51231, HD40125); International AIDS Vaccine Initiative. In addition, this publication has been supported by the President's Emergency Plan for AIDS Relief (PEPFAR) through the Centers for Disease Control and Prevention under the terms of Cooperative Agreement 3U2GPS001904-03. Its contents are solely the responsibility of the authors and do not necessarily represent official views of PEPFAR or the Centers for Disease Control and Prevention.

Competing interests None.

Patient consent Obtained.

Ethics approval The study was approved by the Emory University IRB and the University of Zambia Research Ethics committee.

Provenance and peer review Not commissioned; externally peer reviewed.

Data sharing statement No additional data are available.

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