Distribution Agreement

In presenting this thesis or dissertation as a partial fulfillment of the requirements for an advanced degree from Emory University, I hereby grant to Emory University and its agents the non-exclusive license to archive, make accessible, and display my thesis or dissertation in whole or in part in all forms of media, now or hereafter known, including display on the world wide web. I understand that I may select some access restrictions as part of the online submission of this thesis or dissertation. I retain all ownership rights to the copyright of the thesis or dissertation. I also retain the right to use in future works (such as articles or books) all or part of this thesis or dissertation.

Signature:

_____ _____

Rachel Parker Date

Predictors of Previous HIV Testing Among Couples Receiving Couples Voluntary Counseling and Testing (CVCT) in Three Regions of Zambia

By

Rachel Parker

MSPH

Epidemiology

Dr. Susan Allen, MD, MPH

Faculty Thesis Advisor

Predictors of Previous HIV Testing Among Couples Receiving Couples Voluntary Counseling and Testing (CVCT) in Three Regions of Zambia

By

Rachel Parker

B.S., University of Georgia, 2011

Emory University

2013

Faculty Thesis Advisor: Dr. Susan Allen, MD, MPH

An abstract of
A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Epidemiology
2013

Abstract

Predictors of Previous HIV Testing Among Couples Receiving Couples Voluntary Counseling and Testing (CVCT) in Three Regions of Zambia

By Rachel Parker

Background: Knowledge of HIV status and partner's HIV status has been shown to reduce transmission of HIV and increase protective behaviors. This analysis aims to better quantify predictors of previous testing among couples seeking CVCT services in three regions of Zambia: the northern Copperbelt region, the capital city of Lusaka, and rural Southern Province. Predictors of individual previous HIV testing and previous CVCT as a couple were examined.

Methods: 96,024 Zambian couples that sought CVCT services from ZEHRP from 2008 to 2012 were included in univariate, bivariate, and multivariate analysis of previous HIV testing predictors. Associations with previous testing were assessed using log-binomial regression and logistic regression.

Results: Overall, the prevalence of previous testing in individuals was 57.0%. In the individual previous testing analysis, living in Southern Province or the Copperbelt city of Chingola, being HIV-negative, partner being HIV-negative, being female, being pregnant or having a pregnant partner, and being age 25 to 34 were significantly associated with previous testing. In the analysis of previous CVCT indicators among couples, living in Southern Province or the Copperbelt city of Chingola, being concordant negative (both partners HIV-negative), and cohabitating for longer than 3 months were the strongest predictors of previous CVCT. Previous individual testing and previous CVCT also significantly increased over time from 2008 to 2012.

Conclusion: To address disparities in previous individual HIV testing and previous CVCT, services should be better targeted to men, the 45 and older age group, the 24 and younger age group, couples cohabitating less than 3 months, and couples living in Lusaka and the Copperbelt cities of Ndola, Kitwe, and Luanshya. In order to better understand predictors of previous testing, additional surveys could be administered to this cohort in order to determine the effect of unmeasured possible covariates such as education level, wealth, employment status, number of lifetime or current sexual partners, and condom use.

Predictors of Previous HIV Testing Among Couples Receiving Couples Voluntary Counseling and Testing (CVCT) in Three Regions of Zambia

By

Rachel Parker

B.S., University of Georgia, 2011

Emory University

2013

Faculty Thesis Advisor: Dr. Susan Allen, MD, MPH

A thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
in partial fulfillment of the requirements for the degree of
Master of Science in Public Health
in Epidemiology
2013

Table of Contents

CHAPTER I

BACKGROUND

HIV/AIDS in Zambia

The HIV/AIDS epidemic in sub-Saharan Africa remains the most devastating in the world, representing 70% of new HIV infections and half of the deaths from AIDS related illness (1). As of 2011, 22.9 million people in sub-Saharan Africa were living with HIV/AIDS, and 1.9 million new infections occurred that year (2). One of the largest HIV epidemics is occurring in Zambia, where 13.5% of adults aged 15 to 49 are living with HIV (2, 3). In urban areas of Zambia, like the capital city of Lusaka, estimates of the proportion of adults living with HIV reach as high as 25% (3). Of the over 13 million people living in Zambia, approximately 40% of the population live in the industrialized urban areas of Lusaka and the Copperbelt while 60% of the population are thinly spread across rural areas of the country like Southern Province (4, 5). Using data from the 2001 Zambia Demographic and Health Survey (DHS), Kandala *et al.* in 2008 found the risk of HIV infection in urban areas of was 2.73 times greater than the risk of HIV infection in rural areas (95% confidence interval (CI): 2.13, 3.28) (4). The three regions of Zambia found to have the highest prevalence of HIV infection were Lusaka (22.1%), Copperbelt (19.8%), and Southern Province (17.3%) (4), all of which are included in this analysis.

In addition to differences in HIV infection risk between regions, Kandala *et al.* also found that gender and age were significant predictors of risk of HIV infection. Kandala *et al.* determined that the risk of HIV infection in women was 1.59 times greater than the risk of HIV infection in men (95% CI: 1.32, 1.89) (4). The prevalence of HIV was also found to significantly increase before age 30, with young women at greater risk

than young men (4). These findings are supported by Glynn *et al*., which found that HIV prevalence was 6 times greater for women than men among sexually active 15 to 19 year olds and 3 times greater among 20 to 24 year olds in Ndola, Zambia (located in the Copperbelt region) and Kisumu, Kenya (6). This gender disparity is believed to be due in part to women on average having sex for the first time with men five years older than themselves, educational and economic gender inequities, and male dictated condom usage in addition to biological susceptibility (4, 6, 7).

Due to the high prevalence of HIV, the majority of new HIV infections in Zambia are acquired through heterosexual sex, which has an estimated transmission probability of 0.0011 per coital act (95% CI: 0.0008, 0.0015) (8), with a spouse or cohabitating partner (7, 9-16). In 2008, the Zambia National HIV/AIDS/STIs/TB Council reported that 37% of new HIV infections occurred in individuals whose partners had casual heterosexual sex, 34% in individuals who reported casual heterosexual sex, and 21% in individuals in mutually monogamous relationships (7). Within discordant couples, composed of one HIV-positive partner and one HIV-negative partner, mutual monogamy is not enough to protect the HIV-negative partner from HIV infection (6, 7, 10, 14, 17, 18). Using Zambia and Rwanda DHS data, Dunkle *et al.* modeled that 55.1% to 92.7% of new HIV infections acquired through heterosexual sex occurred with a spouse or cohabitating partner (10). Approximately 17% of couples in Lusaka, Zambia are discordant (17). Despite the prevalence of discordance, many of these discordant couples are unaware of their mixed status, leading to a transmission rate of 12-25% per year (10, 17, 19, 20, 21). Additionally, partners in discordant couples often believe that they must share the same HIV status and that it is not possible to have discordant HIV statuses (22-25).

Couples Voluntary Counseling and Testing

In response to the high-risk population of discordant couples, Couples' HIV Voluntary Counseling and Testing (CVCT) has been used throughout sub-Saharan Africa to target prevention of HIV transmission between cohabitating heterosexual partners. Couples undergoing CVCT are jointly counseled by a trained nurse or lay counselor to increase their knowledge about HIV, modes of transmission between heterosexual couples, and methods of reducing risk. Each partner is then tested for HIV using an algorithm of different rapid HIV tests (17). The couple is informed together of their HIV status so they can negotiate and develop a prevention plan based on their shared HIV status: concordant negative (both partners HIV-negative), discordant (one partner HIV-negative and one partner HIV-positive), and concordant positive (both partners HIV-positive). Being able to counsel, test, and provide results to couples on the same day is of particular importance in low resource settings where couples may have to travel long distances to receive services (11, 14). In 2007, the Centers for Disease Control and Prevention (CDC) in collaboration with the Rwanda Zambia HIV Research Group and the Liverpool School of Tropical Medicine and Hygiene developed a guideline for the training for CVCT counselors (26), allowing for CVCT methods to be disseminated to a wider audience.

CVCT has been used in small, focused programs throughout Africa as a lasting and cost-effective behavioral intervention to prevent the spread of HIV. The Zambia Emory HIV Research Project (ZEHRP) has implemented CVCT for 20 years. A randomized trial conducted by the Voluntary HIV-1 Counseling and Testing Efficacy Study Group in Tanzania, Kenya, and Trinidad found that CVCT significantly reduced

unprotected intercourse within couples, particularly if one or both partners were HIV-positive, as compared to receiving a package of health information (27). In Zaire, Kamenga *et al.* found that condom use during all intercourse among married discordant couples increased from 5% before CVCT to 77.4% 18 months after receiving CVCT (28). A 2000 study by Sweat *et al.* showed that CVCT was more cost effective than individual voluntary counseling and testing (VCT) and most cost-effective in terms of cost per disability-adjusted life-year (DALY) saved for men counseled in a couple in Kenya ($2.75 per DALY saved) and women counseled in a couple in Tanzania ($2.96 per DALY saved) (29). The primary barriers to CVCT services are lack of knowledge about CVCT services, misunderstanding about the existence of discordant HIV status in couples, fear of discrimination related to being HIV-positive, gender inequities, and logistical difficulties related to distance and transportation cost (14, 22-25). In Lusaka, Zambia, 67% of households surveyed by Kelley *et al.* knew about HIV testing for couples, 56% knew a nearby place to receive HIV testing, 43% knew that couples could be discordant, 47% were willing to test with their spouse, and 51% reported stigma as the major obstacle to CVCT (25).

Since 1986, the Rwanda Zambia HIV Research Group (RZHRG) has been working in areas of Rwanda and Zambia to provide HIV testing and CVCT to heterosexual couples. Within RZHRG, the Zambia Emory HIV Research Project (ZEHRP) operates facilities in Zambia to manage a database of couples participating in HIV studies, store samples taken from couples, and perform laboratory testing and virologic analysis on samples. Past research studies conducted by Dr. Susan Allen and colleagues in Zambia and Rwanda have observed that CVCT programs lower rates of

new HIV transmission in discordant couples from 11-12 to 3-4 per 100 person-years in East and Central Africa, and from 20-25 to 7-8 per 100 person-years in Zambia. (9, 10, 17, 19, 20, 21). Based on modeling by Dunkle *et al.*, reducing transmission in urban, discordant cohabitating couples from 20% to 7% could prevent 35.7% to 60.3% of new heterosexually acquired HIV infections (10). Allen *et al.* has also consistently observed significant increases in condom use from less than 3% before CVCT to greater than 80% in the year of follow-up after CVCT (9, 30), which not only reduces rates of new HIV infection but also unwanted pregnancy and other sexually transmitted infections. Women in Rwanda also reported less coercive sex from their partners in the year after receiving CVCT services together (31). This data indicates that CVCT not only informs couples about their health status but also induces lasting behavior change to preserve the health of the HIV-negative partner in discordant couples.

Though voluntary counseling and testing on the individual level has been shown to increase the use of condoms and prevent the spread of sexually transmitted disease (STD) (12, 19, 26, 28, 32, 33), those who have learned their HIV status through VCT may choose not disclose their status to their partner(s). Arthur and colleagues reported in a 2007 *Lancet* article that after receiving VCT, clients in Kenya significantly reduced their number of sexual partners (16% reporting multiple partners at baseline versus 6% at follow-up, $p < 0.001$) and occurrences of STD (40% with STD symptoms at baseline versus 15% at follow-up, $p < 0.001$) and improved their condom use; however, only 55% of HIV-positive clients reported disclosure of their HIV status to partners (31). Rates of HIV status disclosure to sexual partners after VCT have been shown to be highly variable from 22% to 80% (34-38). Women often fail to disclose to their partner due to fear of

partner reaction, with 75% of women surveyed in Rwanda expecting a negative partner reaction (35). Women's fears are not unfounded as 10% of women who disclosed their status during a study in Kenya experienced partner violence or disruption of their relationship (39). HIV-positive status after VCT also negatively influences disclosure rates, with Grinstead *et al.* finding in Tanzania, Kenya, and Trinidad that 52% of HIV-positive participants disclosed their status to partners as compared to 79% of HIV-negative participants ($p < 0.001$) (34). Testing couples together and giving couples a forum to discuss their HIV results with the help of a trained counselor avoids disclosure failures and promotes status transparency and understanding in couples.

Knowledge of HIV Status

Though CVCT and VCT services have been promoted in high HIV prevalence areas throughout Africa for over twenty years, many living in those regions are still unaware of the HIV status and less than 1% know their own and their partners' serostatus. In several studies in Africa examining indicators of knowing one's HIV status, the proportion of adults who had been tested for HIV ranged from 21% to 47% (40-47). Knowledge of HIV status and partner's HIV status has been shown to increase condom use, particularly in those who are HIV-positive, and reduce rates of HIV transmission in discordant couples (12, 30, 41, 42, 48). In the Zambian couples cohort studied by Allen *et al*., HIV-positive men were more likely than HIV-negative men to report using condoms 100% of the time and less likely to report high frequency of intercourse, indicating that knowledge of their positive status led to an safer sex behaviors to protect their partner (30). Among HIV-infected adults in Uganda,

knowledge of HIV status tripled condom use at last sexual encounter and knowledge of partner's HIV status increased recent condom use by 2.3 times (42). CVCT capitalizes on the reduction in risky behaviors brought about by knowing one's HIV status and partner's status by allowing members of couples to discuss their results jointly with the assistance of a counselor.

Rates of previous HIV testing have been shown to vary significantly between men and women, with men being tested at lower rates (41, 43, 44, 45). Results from the Kenya AIDS Indicator Survey (KAIS) indicated that 27.4% of sexually active men and 44.2% of women had previously been tested for HIV (43). In South Africa, a census of HIV-testing records revealed that three times more women reported previous HIV testing than men, with women accounting for 73% of all testing (44). This disparity is largely due to HIV testing at antenatal clinics, as 49% of women surveyed by KAIS were last tested for HIV during antenatal care (43); however, even when pregnancy-related testing was excluded from analysis in South Africa, women still accounted for a majority of persons tested (44). CVCT addresses the disparity in rates of HIV testing between men and women by testing partners together as a couple.

Other factors associated with previous HIV testing were education, age, urban or rural area of residence, level of wealth, and employment status (41, 43, 45, 47). In a population-based survey in South Africa, Peltzer *et al.* found a significant association with previous HIV testing for respondents with grade 12 or more education (adjusted odds ratio (AOR) = 1.5, 95% CI: 1.1 - 2.1), age from 25 to 34 (AOR = 1.83, 95% CI: 1.4 – 2.4), living in an urban area (AOR = 2.0, 95% CI: 1.5 – 2.6), and being employed (AOR = 1.5, 95% CI: 1.2 – 1.9) (45). For men in Kenya surveyed by KAIS, the highest

quintile of wealth index was 1.8 times more likely to know their HIV status compared to the four lower quintiles combined (95% CI: 1.3 – 2.5) (43). The most frequently cited barriers to HIV testing were stigma towards HIV/AIDS, lack of confidentiality of results, and logistical barriers impeding access to services like transportation costs or not knowing a nearby location for testing (41, 44-47).

Increasing the proportion of people who know their HIV status is an essential component of improving access to other prevention programs including male circumcision and family planning, as well as secondary prevention of HIV disease. In addition to disseminating behavioral interventions to prevent HIV transmission and informing clients of their HIV status, CVCT connects HIV-positive clients to antiretroviral therapy (ART), which has been shown to reduce transmission in discordant couples by 96% (49). Determining predictors of previous testing for HIV can help target CVCT and VCT services to underserved groups. Though several analyses have looked at predictors of previous HIV testing among individuals, no papers were found that considered previous testing in the context of CVCT. This analysis aims to better quantify predictors of previous testing among couples seeking CVCT services in three regions of Zambia: the northern Copperbelt region, the capital city of Lusaka, and Southern Province. Predictors of previous testing will be analyzed not only on the individual level but also on the couple level by analyzing predictors of having previously received CVCT as a couple. Receiving counseling and testing for HIV should not be considered a once in a lifetime event but should be repeated frequently to ensure that the HIV status of negative partners has not changed and to reinforce safe sex behaviors. This is especially true for high-risk discordant couples. Findings from this thesis could significantly impact

the populations to which CVCT services are targeted in government clinics throughout Zambia, which would improve the quality of service couples receive and reduce the rate of new HIV infections in the local population.

CHAPTER II

PREDICTORS OF PREVIOUS TESTING AMONG COUPLES RECEIVING COUPLES VOLUNTARY COUNSELING AND TESTING (CVCT) IN THREE REGIONS OF ZAMBIA

Rachel Parker

Abstract

Background: Knowledge of HIV status and partner's HIV status has been shown to reduce transmission of HIV and increase protective behaviors. This analysis aims to better quantify predictors of previous testing among couples seeking CVCT services in three regions of Zambia: the northern Copperbelt region, the capital city of Lusaka, and rural Southern Province. Predictors of individual previous HIV testing and previous CVCT as a couple were examined.

Methods: 96,024 Zambian couples that sought CVCT services from ZEHRP from 2008 to 2012 were included in univariate, bivariate, and multivariate analysis of previous HIV testing predictors. Associations with previous testing were assessed using log-binomial regression and logistic regression.

Results: Overall, the prevalence of previous testing in individuals was 57.0%. In the individual previous testing analysis, living in Southern Province or the Copperbelt city of Chingola, being HIV-negative, partner being HIV-negative, being female, being pregnant or having a pregnant partner, and being age 25 to 34 were significantly associated with previous testing. In the analysis of previous CVCT indicators among couples, living in Southern Province or the Copperbelt city of Chingola, being concordant negative (both partners HIV-negative), and cohabitating for longer than 3 months were the strongest

predictors of previous CVCT. Previous individual testing and previous CVCT also significantly increased over time from 2008 to 2012.

Conclusion: To address disparities in previous individual HIV testing and previous CVCT, services should be better targeted to men, the 45 and older age group, the 24 and younger age group, couples cohabitating less than 3 months, and couples living in Lusaka and the Copperbelt cities of Ndola, Kitwe, and Luanshya. In order to better understand predictors of previous testing, additional surveys could be administered to this cohort in order to determine the effect of unmeasured possible covariates such as education level, wealth, employment status, number of lifetime or current sexual partners, and condom use.

Introduction

The HIV/AIDS epidemic in sub-Saharan Africa remains the most devastating in the world, representing 70% of new HIV infections and half of the deaths from AIDS related illness (1). One of the largest HIV epidemics is occurring in Zambia, where 13.5% of adults aged 15 to 49 are living with HIV (2, 3). The three regions of Zambia with the highest prevalence of HIV infection are Lusaka (22.1%), Copperbelt (19.8%), and Southern Province (17.3%) (4). Due to the high prevalence of HIV, the majority of new HIV infections in Zambia are acquired through heterosexual sex with a spouse or cohabitating partner (7, 9-16). Within discordant couples, composed of one HIV-positive partner and one HIV-negative partner, mutual monogamy is not enough to protect the HIV-negative partner from infection (6, 7, 10, 14, 17, 18). Using Zambia and Rwanda DHS data, Dunkle *et al.* modeled that 55.1% to 92.7% of new HIV infections acquired

through heterosexual sex occurred with a spouse or cohabitating partner (10). Partners in discordant couples are often unaware of their mixed status or believe that they must share the same HIV status (22-25).

In response to this high-risk population of discordant couples, Couples' HIV Voluntary Counseling and Testing (CVCT) has been used throughout sub-Saharan Africa to cost-effectively target prevention of HIV transmission between cohabitating heterosexual partners (11, 14, 26, 29). Since 1986, the Rwanda Zambia HIV Research Group (RZHRG) headed by Dr. Susan Allen has been working in areas of Rwanda and Zambia to provide HIV testing and CVCT to heterosexual couples. Allen and colleagues have observed that CVCT programs lower rates of new HIV transmission in discordant couples from 11-12 to 3-4 per 100 person-years in East and Central Africa, and from 20-25 to 7-8 per 100 person-years in Zambia. (9, 10, 17, 19, 20, 21). Based on modeling by Dunkle *et al.*, reducing transmission in urban discordant cohabitating couples from 20% to 7% could prevent 35.7% to 60.3% of new heterosexually acquired HIV infections (10). Allen *et al.* has also consistently observed significant increases in condom use from less than 3% before CVCT to greater than 80% in the year of follow-up after CVCT (9, 30), which not only reduces rates of new HIV infection but also unwanted pregnancy and other sexually transmitted infections.

Despite the prevalence of CVCT and individual VCT services, the proportion of sexually active adults who know their HIV status has been observed to range between 21% and 47% (40-47). Knowledge of HIV status and partner's HIV status has been shown to increase condom use, particularly in those who are HIV-positive, and reduce rates of HIV transmission in discordant couples (12, 30, 41, 42, 48). Several studies have

shown that female gender, higher level of education, age from 25 to 34, living in an urban area, higher level of wealth, and being employed are predictors of previous HIV testing (41, 43-47). Increasing the proportion of people who know their HIV status is an essential component of improving access to HIV treatment and prevention.

Though several analyses have looked at predictors of previous HIV testing among individuals (41, 43-47), few have considered previous testing in the context of CVCT. This analysis aims to better quantify predictors of previous testing among couples seeking CVCT services in three regions of Zambia: the northern Copperbelt region, the capital city of Lusaka, and rural Southern Province. Predictors of individual previous HIV testing and previous CVCT as a couple are examined. Receiving counseling and testing for HIV should not be considered a once in a lifetime event but should be repeated frequently to ensure that the HIV status of negative partners has not changed and to reinforce safe sex behaviors, particularly for discordant couples. Findings from this analysis could significantly impact the populations to which CVCT services are targeted in government clinics throughout Zambia, which would improve the quality of service couples receive and reduce the rate of new HIV infections in the local population.

Methods

Data collection and study population

The data used in this analysis was collected between 2008 and 2012 from CVCT clients by nurses and lay counselors employed by the government of Zambia health clinics and sponsored to work overtime on weekends by the Zambia Emory HIV Research Project (ZEHRP), a Zambia-specific organization within RZHRG. ZEHRP

provided training, monitoring and evaluation, assistance with procurement of test kits, and data reporting to the MoH. CVCT services were offered in government clinics in Lusaka, the Copperbelt, which includes the cities of Kitwe, Chingola, Ndola, and Luanshya, and Southern Province. Nurses and counselors used logbooks to record client data during the counseling and testing process, which has been detailed in other publications (14). Data was maintained by ZEHRP in a Microsoft Access database and contained no personal identifiers that could link couples to their HIV status. Couples were assigned a sequential CVCT identification number when they arrived at the clinic that was used as their identifier in the dataset. As the data used was collected in the course of routine services provided in government facilities and was de-identified, a letter from the Institutional Review Board (IRB) exempted this analysis from IRB approval. This dataset is not publicly available.

The study population consists of heterosexual Zambian couples that received HIV testing and counseling in ZEHRP sponsored CVCT programs in Lusaka, Copperbelt, or Southern Province from 2008 to 2012. The cohort analyzed consists of 96,024 couples, with 23,666 (24.8%) from Lusaka, 59,704 (61.9%) from Copperbelt, and 12,654 (13.3%) from Southern Province. For analysis on the individual level, each couple was split to represent the man and woman in the couple for a total of 192,048 individuals. Couples were excluded from the analysis if one or both partners had indeterminate results.

Variables

The outcome variable considered in the individual analysis is reported previous testing for HIV (0 = not previously tested, 1 = previously tested). Predictors of previous testing considered in the individual analysis were year the individual was seen for CVCT

(coded as dummy variables for 2008, 2009, 2010, 2011, or 2012), the individual's HIV results (0 = HIV-negative, 1 = HIV-positive), their partner's HIV results (0 = HIV-negative, 1 = HIV-positive), gender (0 = woman, 1 = man), age (coded as dummy variables for under 24, 25-34, 35-44, and 45 and older), pregnancy for women or partner pregnancy for men (0 = not pregnant, 1 = pregnant), region (coded as dummy variable for Lusaka, Copperbelt and Southern Province) and city (coded as dummy variables for Lusaka, Kitwe, Chingola, Ndola, Luanshya, and Southern Province).

In the couple analysis, the outcome variable is having previously received CVCT as a couple (0 = no previous CVCT, 1 = previous CVCT). Predictors of previous testing considered in the couple analysis were year the couple was seen for CVCT, shared HIV status of couple (coded as dummy variables for concordant positive, discordant where the man is positive, discordant where the woman is positive, and concordant negative), if the woman is pregnant, region, city, and cohabitation (0 = not cohabitating or cohabitating less than 3 months, 1 = cohabitating for 3 months or longer). Exposure variables also considered in the individual analysis were coded the same way in the couple analysis.

Data analysis

Univariate, bivariate and multivariate analyses were carried out using SAS software (version 9.3; SAS Institute, North Carolina, USA). Descriptive data is reported as number counts, percentages, and means. Univariate and bivariate analysis on categorical variables was carried out using PROC FREQ and on continuous variables using PROC UNIVARIATE. Log-binomial regression and logistic regression was carried out using PROC GENMOD to calculate prevalence ratios (PR) and odds ratios (OR) of association and 95% confidence intervals (CI) between predictors and the

outcome of prior testing (0 = not tested, 1 = previously tested). Prevalence ratios calculated in addition to odds ratios due to the high prevalence of having previously been tested individually (57%) and having previously received CVCT as a couple (13%). For non-rare outcomes (greater than 10%), the odds ratio fails to accurately approximate risk or prevalence ratios (50, 51). Adjusted prevalence ratios (aPR) and adjusted odds ratios (aOR) are reported from multivariate models.

Results

Characteristics of couples by region

From 2008 to 2012, 96,024 heterosexual Zambian couples received ZEHRP administered CVCT services, with 24.8% of couples seen in Lusaka, 61.9% in Copperbelt, and 13.3% in Southern Province. The number of couples seeking CVCT varied over time, in keeping with available funding for promotions and weekend services. In Copperbelt, 372 couples were tested in 2009, increasing to 42,148 couples in 2012. The number of couples seen per year ranged from 3,027 to 5,680 in Lusaka and 1,070 to 5,027 in Southern Province. The mean age was 35 years old for men and 29 years old for women in all three regions (**Table 1**). Lusaka had the highest proportion of concordant positive couples (25.9%), while the highest proportion of concordant negative couples was in Copperbelt (77.5%) and discordant couples was in Lusaka (20.2%) (**Table 1**). All regions have a greater proportion of discordant couples where the woman was HIV-positive compared to the proportion of couples where the man was HIV-positive. Lusaka also had the highest proportion of couples with women that were currently pregnant (30.9%) (**Table 1**). Southern Province had the highest frequency of couples where both

partners have previously been tested for HIV (45.5%), while Lusaka had the highest frequency of couples where both partners had never been tested before (29.2%) (**Table 1**). Couples where only the women partner had been previously tested were far more frequent than couples where only the man had previously been tested. The disparity was greatest in Lusaka where only the woman partner had been tested in 32.7% of couples and only the man had been tested in 6.7% of couples (**Table 1**). Southern Province also had the highest proportion of couples that have previously received CVCT services (22.7%) (**Table 1**). An overwhelming majority of couples in all three regions have been cohabitating for longer than 3 months: 94.7% of couples in Lusaka, 98.8% of couples in Southern Province, and 93.6% of couples in Southern Province (**Table 1**).

Individual analysis

Overall, the prevalence of individual previous testing was 57%, with 46.8% of men and 66.8% of women reporting prior testing. The proportion of individuals reporting previous testing increased steadily from 2008 to 2012 for both men (24.2% in 2008 and 50.6% in 2012) and women (53.7% in 2008 and 69.0% in 2012) (**Table 2**). In an unadjusted bivariate model with year of CVCT as a predictor of previous HIV testing, the odds ratio for previous HIV testing increased for each subsequent year compared to 2008 (OR = 1.47, 95% CI: 1.39, 1.55 in 2009; OR = 2.38, 95% CI: 2.29, 2.48 in 2012) (**Table 3**). The prevalence ratio for previous individual HIV testing also increased for each year compared to 2008 (PR = 1.24, 95% CI: 1.21, 1.28 in 2009; PR = 1.56, 95% CI: 1.52, 1.59 in 2012) (**Table 3**).

Examining individual prior testing by couple HIV status, concordant negative couples had the highest proportion of men reporting previous testing (49.2%), while

discordant couples where the man was the HIV positive partner had the highest proportion of women reporting prior HIV testing (70.1%) (**Table 2**). Concordant positive couples had the lowest proportion of men and women reporting prior testing (38.1% for men and 59.4% for women) (**Table 2**). Individual HIV status and partner's HIV status were each analyzed as in a bivariate model with reported prior testing. Unadjusted odds and prevalence ratios for HIV status and partner's HIV status were also significant (HIV status: PR = 1.17, 95% CI: 1.16, 1.18; OR = 1.41, 95% CI: 1.38, 1.44; partner's HIV status: PR = 1.16, 95% CI: 1.15, 1.17; OR = 1.38, 95% CI: 1.35, 1.41) (**Table 3**).

The disparity in the proportion of men and women reporting prior HIV testing produced a significant effect in bivariate analysis. The odds of previous HIV testing were 2.29 times greater (95% CI: 2.24, 2.33) and the prevalence of previous testing was 1.43 times greater (95% CI: 1.42, 1.44) in women as compared to men (**Table 3**). Among pregnant women, 75.2% reported prior HIV testing (**Table 2**). Pregnant women and men with a pregnant partner have 1.32 times greater odds (95% CI: 1.29, 1.35) and 1.12 times greater prevalence (95% CI: 1.11, 1.13) of prior testing in bivariate analysis (**Table 3**). Among individuals who were not cohabitating or were cohabitating less than 3 months, a higher proportion of men reported prior testing compared to the overall population (51.2% versus 46.8%) and a lower proportion of women reported prior testing compared to the overall population (54.1% versus 66.8%) (**Table 2**).

Men and women in the 25 to 34 age category reported the most prior testing (49.6% of men and 74.5% of women) (**Table 2**). The proportion of men reporting prior testing was lowest in the under 24 age group (43.1%), while the proportion of women reporting prior HIV testing was lowest in the 45 and older age group (44.9%) (**Table 2**).

In the bivariate analysis of all individuals, those 45 and older were significantly less likely to have been previously tested compared to those under 24 years of age (PR = 0.76, 95% CI: 0.74, 0.78; OR = 0.56, 95% CI: 0.54, 0.58) (**Table 3**). In bivarite analysis, ages 25 to 34 were slightly more associated with previous testing compared to the under 24 age group (PR = 1.04, 95% CI: 1.03, 1.05; OR = 1.10, 95% CI: 1.08, 1.13), while ages 35 to 44 were slightly less associated with previous testing (PR = 0.92, 95% CI: 0.91, 0.93; OR = 0.82, 95% CI: 0.80, 0.84) (**Table 3**).

Comparing region and cities, the highest proportion of men and women reporting prior testing was highest in the city of Chingola in the Copperbelt region (61.9% of men and 76.9% of women) (**Table 2**). Report of prior testing was lowest for men in Lusaka (38.1%) and for women in the city of Kitwe in the Copperbelt (63.9%) and Lusaka (64.1) (**Table 2**). Copperbelt and Southern Province have higher prevalence and odds of previous HIV testing as compared to Lusaka. The city of Chingola in the Copperbelt had the highest prevalence and odds of previous HIV testing as compared to Lusaka (PR = 1.36, 95% CI: 1.34, 1.38; OR = 2.17, 95% CI: 2.10, 2.25) (**Table 3**).

In a multivariate model that adjusted for year, HIV status, partner's HIV status, gender, currently pregnant/partner pregnant, age, and region/city, the strongest associations with previous HIV testing among individuals were receiving CVCT in 2012 as compared to 2008 (aPR = 1.45, 95% CI: 1.41, 1.49; aOR = 2.28, 95% CI: 2.17, 2.40) and female gender (aPR = 1.44, 95% CI: 1.43, 1.46; aOR = 2.48, 95% CI: 2.43, 2.53) (**Table 3**). The association between previous testing and HIV status was weakened in the multivariate model (aPR = 1.13, 95% CI: 1.12, 1.15; aOR = 1.33, 95% CI: 1.29, 1.37), as well as the association with partner's HIV status (aPR = 1.08, 95% CI: 1.07, 1.09; aOR =

1.23, 95% CI: 1.21, 1.26) (**Table 3**). Being in the 25-34 or 35-44 age group was associated with significantly increased prevalence and odds of previous testing as compared to the under 24 age group in the multivariate model, while the 45 and older age group was associated with significantly decreased prevalence and odds of previous testing (**Table 3**). For region and city, Chingola still had the strongest association with previous testing as compared to Lusaka, though the association was weakened in the multivariate model (aPR = 1.15, 95% CI: 1.13, 1.16; aOR = 1.61, 95% CI: 1.54, 1.67) (**Table 3**). All other regions and cities had a null or near null association with previous testing as compared to Lusaka in the multivariate model.

Couple Analysis

Overall, the prevalence of previous joint testing in couples was 13.0% (**Table 2**). In couples, previously receiving CVCT as a couple was significantly associated in bivariate analysis with each subsequent year of CVCT, concordant negative HIV status, cohabitating longer than 3 months, and living in Chingola or Southern Province (**Table 4**). The proportion of couples reporting prior CVCT steadily increased by year from 5.0% in 2008 to 14.8% in 2012 (**Table 2**). Prevalence of previous CVCT increased from 1.39 times greater in 2009 compared to 2008 to 2.95 times greater in 2012 compared to 2008 (**Table 4**). Concordant negative couples reported the highest proportion of prior joint testing (14.3%), while discordant couples with an HIV-positive female partner reported the lowest proportion of prior join testing (9.0%) (**Table 2**). Compared to concordant positive couples in bivariate analysis, concordant negative couples have a 1.56 times greater odds (95% CI: 1.47, 1.65) and 1.48 times greater prevalence (95% CI: 1.40, 1.56) of prior joint testing (**Table 4**). Discordant couples where the male partner

was HIV-positive were slightly more associated with previous joint testing while discordant couples where the female partner was HIV-positive were slightly less associated with previous joint testing. Only 0.2% of couples that were not cohabitating or have been cohabitating less than 3 months reported prior joint testing (**Table 2**). Couples cohabitating longer than 3 months have 2.80 times greater odds (95% CI: 2.36, 3.32) and 2.56 times greater prevalence (95% CI: 2.18, 3.01) of prior joint testing (**Table 4**).

Increasing age for men and women was associated with increased odds and prevalence of prior joint testing. For men, a ten year increase in age results in a 1.11 times greater odds (95% CI: 1.09, 1.13) and 1.09 (95% CI: 1.08, 1.11) times greater prevalence of prior couples testing; for women, a ten year increase in age results in a 1.12 times greater odds (95% CI: 1.10, 1.14) and 1.08 times greater prevalence (95% CI: 1.08, 1.12) of prior couples testing (**Table 4**). The association between current pregnancy and prior joint testing was null in bivariate analysis. By region, the proportion of couples reporting prior joint testing was highest in Southern Province (22.7%) and Chingola (17.6%) and lowest in Lusaka (8.2%). In bivariate analysis, all cities and regions were associated with increased prior joint testing in comparison to Lusaka. In Southern Province, the prevalence of previous CVCT was 2.79 times greater and the odds of previous CVCT were 3.31 times greater as compared to Lusaka (**Table 4**). Within Copperbelt, Chingola had the highest prevalence and odds of previous CVCT as compared to Lusaka (PR = 2.16, 95% CI: 2.03, 2.29; OR = 2.41, 95% CI: 2.25, 2.58) (**Table 4**).

The multivariate analysis of predictors of prior couples testing was adjusted for

year, couple HIV status, pregnancy, cohabitation, male age, female age, and region/city. The strongest associations with prior couples testing were observed for year 2011 in comparison to 2008 (aPR = 2.15, 95% CI: 1.88, 2.46; aOR = 2.36, 95% CI: 2.04, 2.73), year 2012 in comparison to 2008 (aPR = 2.51, 95% CI: 2.20, 2.87; aOR = 2.74, 95% CI: 2.37, 3.16), cohabitating 3 months or longer (aPR = 2.64, 95% CI: 2.25, 3.10; aOR = 2.99, 95% CI: 2.52, 3.56), and Southern Province in comparison to Lusaka (aPR = 2.38, 95% CI: 2.25, 2.52; aOR = 2.80, 95% CI: 2.62, 3.01) (**Table 4**). Couples who came in for CVCT in 2011 and 2012 were 2.16 times and 2.45 times more likely to report previous CVCT, respectively (**Table 4**). Adjusted for all other factors, concordant negative couples have increased odds and prevalence of prior joint testing compared to concordant positive couples (aPR = 1.29, 95% CI: 1.22, 1.36; aOR = 1.36, 95% CI: 1.28, 1.45) (**Table 4**). Discordant couples where the female partner was HIV-positive have slightly decreased odds of prior testing compared to concordant positive couples. The effect of ten-year increases in continuous age for men and women was near null in the adjusted model. Besides Chingola (aPR = 2.41, 95% CI: 2.28, 2.55; aOR = 2.82, 95% CI: 2.63, 3.02), all other cities have null or near null results in comparison to Lusaka (**Table 4**).

Discussion

CVCT is an effective HIV intervention for couples that combines personalized counseling on HIV transmission and prevention with same-day HIV testing and status disclosure (9, 10, 11, 14, 17, 19-21, 26, 29). Knowledge of one's own and one's partner's HIV status have been shown to reduce transmission of HIV and increases

protective behaviors (12, 30, 41, 42, 48). This analysis examined predictors of previous HIV testing on the individual level and predictors of previous CVCT on the couple level in the regions of Copperbelt, the capital city `Lusaka and Southern Province. The prevalence of individual previous HIV testing in this cohort increased steadily over time and at 57% was higher overall than that observed in other studies (40-47). On the individual level, other significant associations with previous testing were observed for city, HIV status, partner's HIV status, gender, pregnancy or partner pregnancy, and age. Previous testing was more common in rural Southern Province than in the capital city of Lusaka, or the industrial cities in the Copperbelt, contrary to what has been observed in previous studies of predictors of individual VCT (43, 45). It is possible this difference could be explained by behavioral differences between those who seek CVCT as a couple and the general population or those who seek individual VCT. The city of Chingola in the Copperbelt had the highest rate of previous individual HIV testing, with 1.4 times greater prevalence and 2.2 times greater odds of previous testing in comparison to Lusaka.

As in previous surveys, the urban area of Lusaka had the greatest prevalence of HIV infection (4), confirming that urban areas are at high risk for HIV infection. Lusaka had over twice the prevalence of concordant positive couples than Copperbelt or Southern Province (25.9% versus 12.3% and 11.0% respectively), though Lusaka and Southern Province had a similar proportion of discordant couples. The proportion of discordant couples in Lusaka was similar to that used in epidemiologic modeling by Dunkle *et al*. (19% vs 17%) (10). Being HIV-negative was a significant but fairly weak predictor of previous testing in unadjusted and adjusted models. The partner's status as

HIV-negative was a weak predictor of previous testing in unadjusted models and nearly null as a predictor once adjusted for other possible predictors.

In the individual analysis, being a woman was one of the strongest predictors of previous testing in unadjusted and adjusted analysis. Compared to men, previous testing was 1.4 times more prevalent among women and the odds of previous tested were 2.5 times greater among women adjusting for HIV status, partner's HIV status, pregnancy, year of CVCT, age, and region. Overall, 66.8% of women reported prior HIV testing compared to 46.8% of men. These findings agree with other studies that found higher rates of HIV testing and knowledge of HIV status in women (41, 43-47). Additionally, 75.2% of currently pregnant women reported prior HIV testing, suggesting that higher rates of testing may be due in part to antenatal care (43, 44).

Significant differences in previous testing were evident between age groups. The 25 to 34 age group was the most likely to report previous testing, which supports the findings of other studies (45). The age group least associated with previous testing, particularly in women, was the 45 and older group. In the unadjusted analysis, those 45 and older were nearly half as likely as those under 24 to have been previously tested. The prevalence and odds of previous testing also increased significantly over time by year, adjusted for other factors. Previous HIV testing was 1.5 times more prevalent and the odds of previous testing were 2.4 times greater in 2012 as compared to 2008.

In the analysis of previous joint testing indicators among couples, significant associations were observed for year, city, couple HIV status, and cohabitating longer than 3 months. The percentage of couples reporting prior joint testing nearly tripled from 5.0% in 2008 to 14.8% in 2012. Among non-cohabitating couples, the proportion of

couples reporting prior joint testing was only 0.2% compared to 13.0% overall, indicating a greater need for joint testing targeted to casual or non-cohabitating couples. For those living in the rural Southern Province, previous CVCT was 2.4 times more prevalent and 2.8 times more likely than for those living in Lusaka, adjusted for other factors. Chingola in the Copperbelt also showed had a higher proportion of couples who had been previously tested together, even when adjusted for other factors. For couple HIV status, discordant couples where the woman was HIV-positive were least likely to have had previous CVCT. Concordant negative couples had the greatest prevalence and odds of prior joint testing in unadjusted and adjusted analyses. The woman partner being pregnant had nearly no effect in unadjusted or adjusted analysis.

Strengths of this analysis include the large size and regional diversity of the available couple cohort. This study is unique in that it is able to look at indicators of previous individual HIV testing as well as previous CVCT as a couple in a cohort of almost 100,000 couples. The regional diversity of the cohort also allows for a more complete picture of predictors of individuals and couples across the country to be drawn. Analyzing a cohort of couples also allows for predictors of HIV testing for men and women to be analyzed at the same time. Several past studies have been limited to looking at predictors previous HIV testing or knowledge of HIV status for only men or women (41, 44, 46). Analysis of this cohort also allows for increased understanding about predictors of previous HIV testing among individuals who consider themselves to be members of a couple. Given the risk of HIV infection associated with heterosexual sex between cohabitating and monogamous couples, understanding predictors of HIV testing in this population is of particular importance.

One of the main limitations of this analysis is the lack of detailed demographic measures available for analysis. Other studies of predictors of previous HIV testing found significant associations between previous testing and level of education, wealth, employment status, number of lifetime or current sexual partners, and condom usage (41, 43, 45, 47), variables that were not collected for this cohort. A possible source of bias for this study is that couples have self-selected to be in the analyzed cohort by seeking CVCT services. Predictors of previous testing may be different for individuals and couples that do not seek CVCT services as compared to this cohort of couples that did seek CVCT services. Additionally, previous HIV testing is a self-reported outcome and could be subject to misclassification bias. HIV-positive individuals may be using CVCT as an opportunity to reveal their status to their partner so they do not report previous testing and knowledge of HIV status in front of their partner.

The results of this analysis indicate that among Zambian CVCT clients, most men and women report having been previously tested for HIV alone. To increase the prevention impact and efficiency of HIV testing, when possible couples should be jointly tested and counseled. These services must be promoted among men, the 45 and older age group, the 24 and younger age group, and couples cohabitating less than 3 months. CVCT services in Lusaka and the Copperbelt cities of Ndola, Kitwe, and Luanshya should learn from comparisons of their services with those in Southern province and Chingola. In order to better understand predictors of previous testing, additional surveys could be administered to determine the effect of covariates such as education level, wealth, employment status, relationship status, number of sexual partners, and condom use.

REFERENCES

1. Joint United Nations Programme on HIV/AIDS. UNAIDS World AIDS Day Report 2011. Geneva, Switzerland; 2011. (http://www.unaids.org/en/media/unaids/contentassets/documents/unaidspublication/2011/JC2216_WorldAIDSday_report_2011_en.pdf). (Accessed March 3, 2013).
2. United States Agency for International Development (USAID). HIV/AIDS Health Profile: Sub-Saharan Africa. Washington, D.C.; 2012. (http://transition.usaid.gov/our_work/global_health/aids/Countries/africa/hiv_summary_africa.pdf). (Accessed March 3, 2013).
3. Joint United Nations Programme on HIV/AIDS. UNAIDS Report of the Global AIDS Epidemic: 2010. Geneva, Switzerland; 2011. (http://www.unaids.org/globalreport/Global_report.htm). (Accessed March 3, 2013).
4. Kandala N-B, Ji C, Cappuccio PF, et al. The epidemiology of HIV infection in Zambia. *AIDS Care: Psychological and Socio-medical Aspect of AIDS/HIV*. 2008; 20:7, 812-819.
5. Zambia. Central Statistical Office. 2010 Census of population and housing preliminary report. Lusaka: Republic of Zambia, Central Statistical Office; 2011.
6. Glynn JR, Carael M, Auvert B, et al. Why do young women have a much higher prevalence of HIV than young men? A study in Kisumu, Kenya and Ndola, Zambia. *AIDS*. 2001;15(Suppl 4):S51–S60.
7. Zambia. National HIV/AIDS/STIs/TB Council. Zambia HIV Prevention Response and Modes of Transmission Analysis. Lusaka, Zambia: National HIV/AIDS/STI/TB Council; 2009.

8. Gray RH, Wawer MJ, Brookmeyer R, et al. Probability of HIV-1 transmission per coital act in monogamous, heterosexual, HIV-1-discordant couples in Rakai, Uganda. *Lancet*. 2001;357:1149–1153.
9. Fideli US, Allen SA, Musonda R, et al. Virologic and Immunologic Determinants of Heterosexual Transmission of Human Immunodeficiency Virus Type 1 in Africa. *AIDS Res Hum Retroviruses*. 2001;17:901-910.
10. Dunkle KL, Stephenson R, Karita E, et al. New heterosexually transmitted HIV infections in married or cohabiting couples in urban Zambia and Rwanda: an analysis of survey and clinical data. *Lancet*. 2008;371:2183-2191.
11. Painter TM. Voluntary counseling and testing for couples: a high leverage intervention for HIV/AIDS prevention in sub-Saharan Africa. *Soc Sci Med*. 2001;53:1397-1411.
12. Allen S, Serufilira A, Bogaerts J, et al. Confidential HIV Testing and Condom Promotion in Africa. Impact on HIV and Gonorrhea Rates. *JAMA*. 1992;268:3338-3343.
13. Fylkesnes K, Musonda RM, Kasumba K, et al. The HIV epidemic in Zambia: socio-demographic prevalence patterns and indications of trends among childbearing women. *AIDS*. 1997;11:339–345.
14. McKenna SL, Muyinda GK, Roth D, et al. Rapid HIV testing and counseling for voluntary testing centers in Africa. *AIDS*. 1997;11(Suppl 1):S103–S110.
15. Trask SA, Derdeyn CA, Fideli U, et al. Molecular Epidemiology of Human Immunodeficiency Virus Type 1 Transmission in a Heterosexual Cohort of Discordant Couples in Zambia. *J Virol*. 2002;76:397–405.

16. Skurnick JH, Kennedy CA, Perez G, et al. Behavioral and demographic risk factors for transmission of human immunodeficiency virus type 1 in heterosexual couples: report from the Heterosexual HIV Transmission Study. *Clin Infect Dis*. 1998;26:855–864.

17. Boeras DI, Luisi, N, Karita E, et al. Indeterminate and discrepant rapid HIV test results in couples' HIV testing and counseling centres in Africa. [published online April 8, 2011]. *J Int AIDS Soc*. 2011;14:18. (doi: 10.1186/1758-2652-14-18).

18. de Zoysa I, Sweat MD, Denison JA. Faithful but fearful: reducing HIV transmission in stable relationships. *AIDS*. 1996;10(Suppl A): S197–203.

19. Allen S, Tice J, Van de Perre P, et al. Effect of serotesting with counselling on condom use and seroconversion among HIV discordant couples in Africa. *BMJ*. 1992;304:1605-1609.

20. Hira SK, Nkowane BM, Kamanga J, et al. Epidemiology of Human Immunodeficiency Virus in Families in Lusaka, Zambia. *J Acquir Immune Defic Syndr*. 1990;3:83-86.

21. Quinn TC, Wawer MJ, Sewankambo N, et al. Viral Load and Heterosexual Transmission of Human Immunodeficiency Virus Type 1. Rakai Project Study Group. *N Engl J Med.* 2000;342:921-929.

22. Bunnell RE, Nassozi J, Marum E, et al. Living with discordance: knowledge, challenges, and prevention strategies of HIV-discordant couples in Uganda. *AIDS Care*. 2005;17(8):999–1012.

23. Desgrees-du-Lou A, Ome-Gliemann J. Couple-centred testing and counseling for HIV serodiscordant heterosexual couples in sub-Saharan Africa. *Reproductive Health Matters*. 2008;16(32):151–161

24. Chomba E, Allen S, Kanweka W, et al. Evolution of Couples' Voluntary Counseling and Testing for HIV in Lusaka, Zambia. *J Acquir Immune Defic Syndr*. 2008;47:108-115.

25. Kelley AL, Karita E, Sullivan PS, et al. Knowledge and Perceptions of Couples' Voluntary Counseling and Testing in Urban Rwanda and Zambia: A Cross-Sectional Household Survey. *PLoS ONE.* 2011;6(5): e19573.

26. CDC (2007) Couples HIV Counseling and Testing Interventions and Curriculum. Atlanta, GA, USA: CDC.

27. The Voluntary HIV-1 Counseling and Testing Efficacy Study Group: Efficacy of voluntary HIV-1 counselling and testing in individuals and couples in Kenya, Tanzania, and Trinidad: a randomized trial. *Lancet*. 2000;356:103-112.

28. Kamenga M, Ryder RW, Jingu M, et al. Evidence of marked sexual behavior change associated with low HIV-1 seroconversion in 149 married couples with discordant HIV-1 serostatus: experience at an HIV counselling center in Zaire. *AIDS*. 1991;5:61–67.

29. Sweat M, Gregorich S, Sangiwa G, et al. Cost-effectiveness of voluntary HIV-1 counselling and testing in reducing sexual transmission of HIV-1 in Kenya and Tanzania. *Lancet*. 2000;356:113–121.

30. Allen S, Meinzen-Derr J, Kautzman M, et al. Sexual behavior of HIV discordant couples after HIV counseling and testing. *AIDS*. 2003;17:733-740.

31. Roth DL, Stewart KE, Clay OJ, et al. Sexual practices of HIV discordant and concordant couples in Rwanda: effects of a testing and counseling programme for men. *Int J STD AIDS*. 2001;12(3):181-8.

32. Arthur G, Nduba V, Forsythe S, Mutemi R, Odhiambo J, Gilks C. Behavior change in clients of health centre-based voluntary HIV counseling and testing services in Kenya. [published online November 8, 2007] *Sex Transm Infect*. 2007;83:541–6. (doi:10.1136/sti.2007.026732).

33. Bentley ME, Spratt K, Shepherd ME, et al. HIV testing and counseling among men attending sexually transmitted disease clinics in Pune, India: changes in condom use and sexual behavior over time. *AIDS*. 1998;12:1869–77.

34. Grinstead OA, Gregorich SE, Choi KH, et al. Positive and negative life events after counselling and testing: the Voluntary HIV-1 Counselling and Testing Efficacy Study. *AIDS*. 2001;15:1045–52.

35. Keogh P, Allen S, Almedal C, et al. The social impact of HIV infection on women in Kigali, Rwanda: a prospective study. *Soc Sci Med*. 1994;38:1047–53.

36. Antelman G, Smith Fawzi MC, Kaaya S, et al. Predictors of HIV-1 serostatus disclosure: a prospective study among HIV-infected pregnant women in Dar es Salaam, Tanzania. *AIDS*. 2001;15:1865–74.

37. Maman SMJ, Hogan N, Weiss E, et al. High Rates and Positive Outcomes of HIV-Serostatus Disclosure to Sexual Partners: Reasons for Cautious Optimism From a Voluntary Counseling and Testing Clinic in Dar es Salaam, Tanzania. *AIDS Behav*. 2003;7:373–381.

38. King R, Katuntu D, Lifshay J, et al. Process and outcomes of HIV serostatus disclosure to sexual partners among people living with HIV in Uganda. *AIDS Behav*. 2008;12:232–243.

39. Gaillard P, Melis R, Mwanyumba F, et al. Vulnerability of women in an African setting: lessons for mother-to- child HIV transmission prevention programmes. *AIDS*. 2002;16:937–9.

40. Joint United Nations Programme on HIV/AIDS. UNAIDS World AIDS Day Report 2012. Geneva, Switzerland; 2012. (http://www.unaids.org/en/media /unaids/contentassets/documents/epidemiology/2012/gr2012/JC2434_WorldAIDS day_results_en.pdf). (Accessed March 3, 2013).

41. Conserve D, Sevilla L, Mbwambo J, King G. Determinants of Previous HIV Testing and Knowledge of Partner's Status Among Men Attending a Voluntary Counseling and Testing Clinic in Dar es Salaam, Tanzania. [published online ahead of print 4 December 2012]. *Am J Mens Health*. (doi: 10.1177/1557988312468146).

42. Bunnell, R., Opio, A., Musinguzi, J., et al. HIV transmission risk behavior among HIV-infected adults in Uganda: Results of a nationally representative survey. *AIDS*. 2008;22:617-24.

43. Cherutich P, Kaiser R, Galbraith J, et al. Lack of Knowledge of HIV Status a Major Barrier to HIV Prevention, Care and Treatment Efforts in Kenya: Results from a Nationally Representative Study. [published online May 4, 2012]. *PLoS ONE*. 2012;7(5):e36797. (doi:10.1371/journal.pone.0036797).

44. Snow R, Madalane M, Poulsen, M. Are men testing? Sex differentials in HIV testing in Mpumalanga Province, South Africa. *AIDS Care*. 2010;22:1060-5.

45. Peltzer K, Matseke G, Mzolo T., et al. Determinants of knowledge of HIV status in South Africa: results from a population-based HIV survey. *BMC Public Health*. 2009;9:174. (doi:10.1186/1471-2458-9-174).

46. Bwambale F, Ssali S, Byaruhanga S, et al. Voluntary HIV counselling and testing among men in rural western Uganda: Implications for HIV prevention. *BMC Public Health*. 2008;8(1):263.

47. Kalichman SC, Simbayi, LC. HIV testing attitudes, AIDS stigma, and voluntary HIV counselling and testing in a Black township in Cape Town, South Africa. *Sex Transm Infect*. 2003;79,442-7.

48. Conserve D, Sevilla L, Younge S, et al. Condom use among HIV positive sexually active adults and partner's HIV status in Dar es Salaam, Tanzania. *J Health Care Poor Underserved*. 2012;23:191-203.

49. Cohen MS, Chen YQ, McCauley M, et al. Prevention of HIV-1 infection with early antiretroviral therapy. *N Engl J Med*. 2011;365(6):493–505.

50. McNutt LA, Wu C, Xue X, et al. Estimating the relative risk in cohort studies and clinical trials of common outcomes. *Am J Epidemiol.* 2003;157:940–3.

51. Spiegelman D, Hertzmark E. Easy SAS Calculations for Risk or Prevalence Ratio and Differences. *Am J Epidemiol*. 2005;162:199–200.

TABLES

Table 1. Characteristics of Zambian couple cohort by region. Values are numbers (n) and percentages (%) unless otherwise indicated.

	Lusaka		Copperbelt		Southern Province	
	n	**%**	**n**	**%**	**n**	**%**
Total Couples	23,666	24.8	59,704	61.9	12,654	13.3
Year						
2008	5,519	23.3	---	---	---	---
2009	4,312	18.2	372	0.6	1,070	8.5
2010	3,027	12.8	1,309	2.2	3,374	26.7
2011	5,128	21.7	15,245	25.8	3,183	25.2
2012	5,680	24.0	42,148	71.4	5,027	39.7
HIV serostatus[a]						
Concordant positive	6,110	25.9	7,264	12.3	1,387	11.0
Discordant						
Man positive	1,848	7.8	2,627	4.5	1,056	8.4
Woman positive	2,624	11.1	3,389	5.8	1,488	11.8
Concordant negative	13,052	55.2	45,648	77.5	8,718	68.9
Previous HIV testing[b]						
Both tested	7,366	31.4	24,507	41.8	5,757	45.5
Man only tested	1,575	6.7	4,148	7.1	1,031	8.2
Woman only tested	7,684	32.7	15,430	26.3	2,601	20.6
Neither tested	6,867	29.2	14,608	24.9	3,258	25.8
Previous CVCT[c]	1,903	8.2	7,495	12.8	2,873	22.7
Woman pregnant[d]	7,137	30.9	14,272	24.3	1,870	14.8
Cohabitating ≥3 months[e]	21,608	94.7	57,975	98.8	11,788	93.6
Mean (SD) age (years)[f]						
Men	34.7 (9.6)		35.3 (12.3)		34.5 (12.0)	
Women	28.8 (8.5)		28.9 (10.7)		28.7 (10.5)	

a. 32 Lusaka couples, 146 Copperbelt couples, 5 Southern Province couples missing.
b. 174 Lusaka couples, 381 Copperbelt couples, 7 Southern Province couples missing.
c. 322 Lusaka couples, 391 Copperbelt couples, 7 Southern Province couples missing.
d. 582 Lusaka couples, 376 Copperbelt couples, 2 Southern Province couples missing.
e. 837 Lusaka couples, 391 Copperbelt couples, 64 Southern Province couples missing.
f. Lusaka: 149 men, 151 women missing; Copperbelt: 377 men, 398 women missing; Southern Province: 7 men, 10 women missing.

Table 2. Percentage of men and women in the Zambian cohort reporting prior HIV testing and percentage of couples in the Zambian cohort reporting prior joint testing.

	% Men reporting prior testing[a]	% Women reporting prior testing[a]	% Couples reporting prior joint testing[a]
Overall	46.8	66.8	13.0
Year			
2008	24.2	52.7	5.0
2009	34.2	61.4	7.0
2010	38.4	60.3	9.7
2011	49.3	68.4	13.0
2012	50.6	69.0	14.8
Couple HIV status[b]			
M+F+	38.1	59.4	9.7
M+F-	45.0	70.1	10.4
M-F+	43.1	59.5	9.0
M-F-	49.2	68.9	14.3
Pregnant[c]	---	75.2	13.2
Cohabitating <3 months[d]	51.2	54.1	0.2
Age[e]			
≤24	43.1	65.0	---
25-34	49.6	74.5	---
35-44	46.6	66.6	---
45+	44.2	44.9	---
Region			
Copperbelt	48.8	68.1	12.8
Chingola	61.9	76.9	17.6
Kitwe	44.9	63.9	12.3
Luanshya	44.6	72.9	12.6
Ndola	48.1	68.7	10.8
Lusaka	38.1	64.1	8.2
Southern Province	53.7	66.1	22.7

a. Prior testing data missing for 551 men and 544 women; prior joint testing missing for 720 couples
b. 734 men, 727 women, and 903 couples missing
c. 947 women and 1,116 couples missing
d. 1,321 men, 1315 women, and 1,484 couples missing
a. 577 men and 599 women missing

Table 3. Unadjusted bivariate models and adjusted multivariate model of prevalence ratios (PR) and odds ratios (OR) with 95% confidence intervals (CI) for individual analysis of predictors of having previously been tested for HIV.

	Unadjusted Bivariate Models				Adjusted Multivariate Model			
	Prevalence Ratio	**PR 95% CI**	**Odds Ratio**	**OR 95% CI**	**Prevalence Ratio**	**PR 95% CI**	**Odds Ratio**	**OR 95% CI**
Year								
2008	1.00	---	1.00	---	1.00	---	1.00	---
2009	1.24	1.21, 1.28	1.47	1.39, 1.55	1.21	1.18, 1.25	1.43	1.35, 1.51
2010	1.28	1.25, 1.32	1.56	1.48, 1.64	1.21	1.18, 1.25	1.43	1.35, 1.51
2011	1.53	1.49, 1.57	2.29	2.19, 2.39	1.44	1.40, 1.47	2.27	2.16, 2.39
2012	1.56	1.52, 1.59	2.38	2.29, 2.48	1.45	1.41, 1.49	2.28	2.17, 2.40
HIV negative	1.17	1.16, 1.18	1.41	1.38, 1.44	1.13	1.12, 1.15	1.33	1.29, 1.37
Partner HIV negative	1.16	1.15, 1.17	1.38	1.35, 1.41	1.02	1.01, 1.03	1.08	1.05, 1.11
Female gender	1.43	1.42, 1.44	2.29	2.24, 2.33	1.44	1.43, 1.46	2.48	2.43, 2.53
Pregnant/Partner Pregnant	1.12	1.11, 1.13	1.32	1.29, 1.35	1.08	1.07, 1.09	1.23	1.21, 1.26
Age								
≤24	1.00	---	1.00	---	1.00	---	1.00	---
25-34	1.04	1.03, 1.05	1.10	1.08, 1.13	1.19	1.18, 1.20	1.56	1.52, 1.60
35-44	0.92	0.91, 0.93	0.82	0.80, 0.84	1.12	1.11, 1.14	1.33	1.29, 1.37
45+	0.76	0.74, 0.78	0.56	0.54, 0.58	0.88	0.87, 0.90	0.87	0.84, 0.90

Region/City								
Copperbelt	1.14	1.13, 1.16	1.35	1.32, 1.38	---	---	---	---
Chingola	1.36	1.34, 1.38	2.17	2.10, 2.25	1.15	1.13, 1.16	1.61	1.54, 1.67
Kitwe	1.07	1.05, 1.08	1.15	1.12, 1.17	0.94	0.93, 0.96	0.83	0.80, 0.86
Luanshya	1.15	1.12, 1.18	1.37	1.29, 1.44	1.05	1.02, 1.07	1.03	0.97, 1.10
Ndola	1.14	1.13, 1.16	1.35	1.31, 1.38	1.00	0.99, 1.01	0.99	0.96, 1.02
Lusaka	1.00	---	1.00	---	1.00	---	1.00	---
Southern Province	1.17	1.16, 1.19	1.43	1.39, 1.48	1.07	1.05, 1.08	1.28	1.23, 1.32

Table 4. Unadjusted bivariate models and adjusted multivariate models of prevalence ratios (PR) and odds ratios (OR) with 95% confidence intervals (CI) for couple analysis of predictors of the dichotomous outcome of having previously been tested together as a couple for HIV.

	Unadjusted Bivariate Models				Adjusted Multivariate Model			
	Prevalence Ratio	**PR 95% CI**	**Odds Ratio**	**OR 95% CI**	**Prevalence Ratio**	**PR 95% CI**	**Odds Ratio**	**OR 95% CI**
Year								
2008	1.00	---	1.00	---	1.00	---	1.00	---
2009	1.39	1.20, 1.62	1.42	1.21, 1.66	1.14	0.98, 1.33	1.14	0.97, 1.35
2010	1.93	1.69, 2.21	2.03	1.76, 2.34	1.27	1.09, 1.47	1.26	1.08, 1.48
2011	2.58	2.29, 2.91	2.82	2.48, 3.20	2.15	1.88, 2.46	2.36	2.04, 2.73
2012	2.95	2.62, 3.31	3.29	2.90, 3.72	2.51	2.20, 2.87	2.74	2.37, 3.16
Couple HIV status								
M+F+	1.00	---	1.00	---	1.00	---	1.00	---
M+F-	1.08	0.98, 1.18	1.08	0.98, 1.20	0.99	0.90, 1.08	1.00	0.90, 1.11
M-F+	0.93	0.85, 1.01	0.92	0.84, 1.02	0.85	0.78, 0.93	0.84	0.76, 0.93
M-F-	1.48	1.40, 1.56	1.56	1.47, 1.65	1.29	1.22, 1.36	1.36	1.28, 1.45
Woman pregnant	1.02	0.98, 1.06	1.02	0.98, 1.07	1.11	1.07, 1.16	1.14	1.09, 1.19
Cohabitating ≥3 months	2.56	2.18, 3.01	2.80	2.36, 3.32	2.64	2.25, 3.10	2.99	2.52, 3.56
Age (10 year increase)								

Man	1.09	1.08, 1.11	1.11	1.09, 1.13	1.07	1.04, 1.10	1.09	1.05, 1.13
Woman	1.10	1.08, 1.12	1.12	1.10, 1.14	1.05	1.01, 1.09	1.06	1.02, 1.11
Region/City								
Copperbelt	1.57	1.49, 1.64	1.65	1.56, 1.74	---	---	---	---
Chingola	2.16	2.03, 2.29	2.41	2.25, 2.58	1.34	1.25, 1.43	1.42	1.31, 1.54
Kitwe	1.51	1.43, 1.59	1.57	1.49, 1.67	0.97	0.91, 1.03	0.96	0.89, 1.02
Luanshya	1.54	1.39, 1.72	1.62	1.44, 1.83	0.89	0.80, 1.00	0.88	0.78, 1.00
Ndola	1.32	1.24, 1.40	1.36	1.27, 1.45	0.89	0.84, 0.95	0.87	0.81, 0.94
Lusaka	1.00	---	1.00	---	1.00	---	1.00	---
Southern Province	2.79	2.64, 2.94	3.31	3.11, 3.53	2.38	2.25, 2.52	2.80	2.62, 3.01

CHAPTER III

SUMMARY, PUBLIC HEALTH IMPLICATIONS, AND FUTURE DIRECTIONS

In this analysis, predictors of previous individual HIV testing and previous Couples' Voluntary Counseling and Testing are examined for a cohort of 96,024 Zambian couples seen in ZEHRP-sponsored CVCT clinics in Lusaka, Copperbelt, and Southern Province from 2008 to 2012. Past studies looking at HIV testing predictors have often been limited to only men or women and no previous studies have looked at predictors for individual testing in couples or predictors of previous CVCT. On the individual level, significant associations with previous HIV testing are observed for individuals that were living in Southern Province or the Copperbelt city of Chingola, HIV-negative, have an HIV-negative partner, female, and age 25 to 34. On the couple level, the strongest associations with previous CVCT were observed for couples living in Southern Province or the Copperbelt city of Chingola, concordant negative couples, and cohabitating for 3 months or longer. Previous individual testing and previous CVCT also significantly increased over time from 2008 to 2012.

Given the risk of HIV infection associated with heterosexual sex between cohabitating and monogamous couples, understanding predictors of HIV testing in this population is of particular importance. Increasing the proportion of people who know their HIV status is an essential component of improving access to HIV treatment and prevention. Findings from this analysis indicate that populations in need of greater access to HIV testing and CVCT services were men, those aged 45 and older, those aged 24 and younger, couples cohabitating less than three months, and couples in Lusaka and the Copperbelt cities of Ndola, Kitwe, and Luanshya. Using this information, CVCT

services in Zambia can be better promoted to target the populations with the lowest rates of previous testing. This would improve the quality of service couples receive and reduce the rate of new HIV infections in underserved populations.

The Zambian couples analyzed in this study present a unique opportunity to examine predictors of previous HIV testing in a large and regionally diverse cohort. Further analysis on this dataset that is stratified by gender, region, or HIV status could better define specific populations in need of HIV testing and CVCT. Analysis of follow-up data on concordant negative and discordant couples who returned to the clinic for repeat testing and counseling could provide additional insight. A limitation of this analysis is the small number of variables collected on couples when they seek CVCT services. Based on the findings of other studies, education level, wealth, employment status, relationship status, number of sexual partners, and condom use could also be significant predictors of previous testing in this cohort. Collecting this information through surveys to couples as they wait for services could provide further insight into determinants of HIV testing. A survey of predictors of previous HIV testing administered to the general Zambian population would also avoid the possible bias of only analyzing data for couples that seek CVCT services.