HIV Among Couples in Mozambique:

HIV Status, Knowledge of Status, and Factors Associated with HIV Serodiscordance

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Further Analysis of the 2009 Inquérito Nacional de Prevalência, Riscos Comportamentais e Informação sobre o HIV e SIDA em Moçambique (INSIDA)

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This report presents findings from a further analysis study undertaken as part of the follow-up to the *2009 Inquérito Nacional de Prevalência, Riscos Comportamentais e Informação sobre o HIV e SIDA em Moçambique* (INSIDA). ICF International provided technical assistance for the report, and funding was provided by the Centers for Disease Control and Prevention (CDC) of the United States of America (USA).

Additional information about the survey can be obtained from the Instituto Nacional de Saúde of Mozambique (INS), Av. Eduardo Mondlane, nº 1008, 2º Andar, C.Postal 264, Cidade de Maputo, Moçambique; telefax +258-21-431103/311038; email: ins.direccao@misau.gov.mz. Additional information about the MEASURE DHS program can be obtained from MEASURE DHS, ICF International, 11785 Beltsville Drive, Suite 300, Calverton, MD 20705, USA; telephone: 301.572.0200; fax: 301.572.0999; e-mail: reports@measuredhs.com; internet: http://www.measuredhs.com.

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List of acronyms

AIS	AIDS Indicator Survey
ANC	Antenatal care
aOR	Adjusted odds ratio
aRRR	Adjusted relative risk ratio
ART	Antiretroviral therapy
ARV	Antiretroviral (medication)
ATS	*Aconselhmento e testagem em saúde* (counseling and testing in health)
CD4	Cluster of differentiation 4
CHCT	Couples HIV counseling and testing
DHS	Demographic and Health Survey
FD	Female discordant
FTM	Female-to-male
GUD	Genital ulcer disease
HSV-2	Genital Herpes Simplex Virus
INSIDA	*Inquérito Nacional de Prevalência, Riscos Comportamentais e Informação sobre o HIV e SIDA*
MD	Male discordant
µL	Microliter
mL	Milliliter
MTF	Male-to-female
NA	Not applicable
NR	Not reported
OR	Odds ratio
PMTCT	Prevention of mother-to-child transmission (of HIV)
PP	Positive prevention
PY	Person-years
RPR	Rapid plasma reagin
RRR	Relative risk ratio
STI	Sexually transmitted infection
TPHA	Treponemal pallidum particle agglutination
VCT	Voluntary counseling and testing (for HIV)

GLOSSARY

Binomial:	Having two possible values, e.g., a variable with two categories
Cohabitation:	Living together as if a married couple
Coinfection:	Two infections present in the same individual at the same time, for example, HIV and syphilis
Concordant:	Both members of a couple having the same HIV status
Concordant negative:	Both members of a couple being HIV-negative
Concordant positive:	Both members of a couple being HIV-positive
De facto:	*In fact*; used to refer to people who spent the night before the interview in the household where they were interviewed, irrespective of whether or not they usually live there
Discordant:	Two members of a couple having different HIV-status; one is HIV-positive while the other is HIV-negative
Dysuria:	Pain during urination; a potential symptom of a sexually transmitted infection (STI)
Female discordant:	A couple in which the woman is HIV-positive and the man is HIV-negative
Male discordant:	A couple in which the man is HIV-positive and the woman is HIV-negative
Multinomial:	Having several possible values, e.g., a variable with three categories
Person-years:	A measure of the duration of exposure to risk of infection equal to the product of the number of members in a population and the length of time each member has been exposed to the risk
Polygyny:	A type of marital union in which one man has two or more wives, also more generally called polygamy, which refers to one person of either gender having two or more spouses
Rate ratio:	A comparison of rates (e.g., of transmission) in two different groups, calculated by dividing one rate by the other
Seroconversion:	The development in blood serum of detectable antibodies to a specific infectious agent as the result of infection or immunization; refers in this report to the development of HIV antibodies

EXECUTIVE SUMMARY

One in ten cohabiting couples in Mozambique is discordant, that is, one member is HIV-positive while the other is HIV-negative. In recent years, interest in the spread of HIV within stable sexual partnerships has increased. The 2009 Mozambique INSIDA collected information on HIV serostatus, risk behaviors, and other background characteristics, allowing cohabitating couples to be matched and analyzed together. This investigation has two complementary objectives: (1) to estimate the number of discordant couples in Mozambique and to provide useful information about these couples, and (2) to identify factors that may help to protect the HIV-negative partner from becoming infected. The report includes a discussion of how the couples data file is created and its representativeness of the population of cohabiting couples in Mozambique, data on the distribution of couples by HIV status and estimates for the number of discordant couples in Mozambique, and multivariate models to identify factors associated with discordance.

A couples file was created from the 2009 INSIDA database of male and female respondents age 15-64. This file includes cohabiting couples, that is, couples in which the husband and wife live together in the same household.[1] This investigation includes all of the cohabiting couples in which the husband and wife were successfully matched and for whom information was available from both members of the couple for the individual interview and HIV test, a total of 2,490 unweighted couples (2,648 weighted). The included couples were found to be representative of all men and women in the main INSIDA database who reported that they were married[2] with respect to key demographic variables and HIV status.

As of 2009, there were an estimated 433,000 discordant couples in Mozambique. One-third of all HIV-positive individuals age 15-64 were married to someone who is uninfected, suggesting that discordance may be responsible for a substantial percentage of all new HIV infections. In 51 percent of discordant couples neither member had ever been tested for HIV and received the results, and at least 85 percent of couples who are discordant do not know it, ranging from 77 percent in the southern region (Maputo, Gaza, and Inhambane provinces) to 98 percent in the northern region (Nampula, Cabo Delgado, and Niassa provinces). Eleven percent of discordant couples in which the woman is HIV-positive used a condom the last time they had sex with each other compared with only one percent of discordant couples in which the man is HIV-positive.

Results from multinomial logistic regression analyses show that factors associated with transmission from women to men in a couple differ from factors associated with transmission from men to women. In both binomial and multinomial logistic regression models, couples in which neither member has had an STI in the past year are more likely to be discordant than couples in which either member has had an STI. Although the cross-sectional nature of the data does not allow determination of causality, this finding is consistent with a statistically significant association between presence of an STI and increased risk of HIV transmission within a discordant couple.

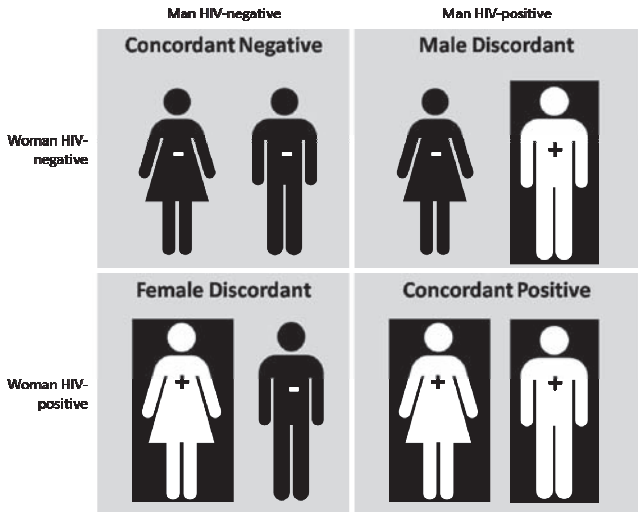
Discordant couples are an important population at risk for new HIV infection in Mozambique due both to the size of the population, as calculated in this report, and to the elevated risk of transmission from one spouse to the other, as shown in the scientific literature reviewed in this report on the incidence of HIV among discordant couples. Knowledge of status and condom use among discordant couples are low. Key recommendations include increasing awareness about serodiscordancy, increasing demand for and access to HIV counseling and testing for couples, and strengthening STI screening and surveillance.

[1] In this report, the terms *husband* and *wife* are used to describe a man and a woman who are formally married to each other or a man and a woman who are not formally married but are living together as if they are married.
[2] In this report, the term *married* is used to describe couples who are formally married as well as those in which the man and woman are not formally married but are living together as if married.

I. INTRODUCTION

This report investigates the HIV status of cohabiting couples. A cohabiting couple is defined as a man and a woman who are formally married and who live together in the same household or a man and a woman who are not formally married but who live together as if married. According to the results of the 2009 Mozambique *Inquérito Nacional de Prevalência, Riscos Comportamentais e Informação sobre o HIV e SIDA* (INSIDA), 15 percent of cohabiting couples in Mozambique are affected by HIV; that is, either or both members are HIV-positive. In 5 percent of couples, both members are HIV-positive (concordant positive), and in 10 percent of couples, one member is HIV-positive while the other is HIV-negative (serodiscordant). In recent years, there has been increasing interest in the spread of HIV within stable sexual partnerships. As the HIV epidemic has matured in many countries, the proportion of new infections occurring within couples is believed to have risen. Evidence has shown that, across countries, a sizeable proportion of couples with any HIV infection are discordant (Ewayo et al., 2010). The HIV-negative members of discordant couples are a population at increased risk of infection and are in need of specially designed services.

Box 1 **What is HIV Discordance and Concordance?**



The 2009 Mozambique INSIDA collected information on HIV serostatus, risk behaviors, and other background characteristics of 11,212 individuals age 15-64. The methodology of this survey is described elsewhere (INS, INE, and ICF Macro, 2010). Men and women who reported that they were married[3] were asked to identify their spouse.[4] Through a methodology standardized by the MEASURE DHS project, cohabiting couples are matched together, allowing for an analysis of their serostatus and other characteristics.

This investigation has two complementary objectives: (1) to estimate the number of discordant couples in Mozambique and to provide information about these couples that will be useful for program planners, including information about history of HIV testing and potential knowledge of status, and (2) to compare discordant couples with concordant positive couples to identify factors that may help to protect the HIV-negative partner in a discordant couple from becoming infected.

The next section of this report provides background information regarding the prevalence of HIV discordance among couples in various countries, factors associated with discordance, couples HIV counseling

[3] Throughout the report the term *married* is used to describe couples who are formally married as well as those in which the man and woman are not formally married but are living together as if married. Further, *married* in this report refers to persons who are married at the time of the survey. It excludes persons who previously were married but who are currently separated, divorced or widowed.

[4] The terms *spouse*, *husband*, and *wife* are used in this report to refer to members of a couple who are formally married to each other or those who are not formally married but are living together as if they are married.

and testing programs, and Mozambique's Positive Prevention Program. Section III describes the couples sample and assesses the degree to which the couples included in the couples data file are representative of the population of all Mozambicans who are married. This background is needed to aid in interpretation of the results presented in the remainder of the report. Section IV of the report presents findings regarding the distribution of Mozambican couples by HIV status and produces estimates for the number of discordant couples in Mozambique. This section also includes information that may be helpful for program planners, such as the proportion of couples who may be aware of their HIV status and the extent of condom use among couples. In Section V, the report presents a conceptual framework for transmission of HIV within couples and a discussion of variables included in multivariate analysis. Binomial and multinomial logistic regression models examining factors potentially associated with couple discordance in Mozambique are presented in Section VI.

Analysis of the INSIDA database of individual respondents age 15-64 and the matched couples file was conducted using SPSS 18. The complex samples module of SPSS was used throughout the analysis to take into account the two-stage, stratified sample design employed by the 2009 Mozambique INSIDA. The sample weight applied to couples is the same as the sample weight calculated for men who participated in the INSIDA HIV test.[5]

II. BACKGROUND AND RATIONALE

This section first provides background on the prevalence of couple discordance in several African countries and an overview of estimates for how efficiently HIV is transmitted between members of a cohabiting couple. If HIV were transmitted very quickly to the second member of the couple after the first member became infected, then discordance would not last long enough to comprise a sizeable proportion of a population at any given time. However, as the data below show, it is possible for the second member of a couple to remain HIV-negative for quite some time. The section then presents a review of the evidence on factors that affect the probability that the HIV-negative member of a discordant couple will become infected. Data on many of these factors are available from INSIDA data. Section II concludes with a description of couples HIV counseling and testing interventions found in published literature and a summary of the Positive Prevention (PP) Program in Mozambique.

How common is HIV serodiscordance among couples?

Table 1, which summarizes the work of Staveteig and Wang (forthcoming), shows the HIV status of couples in 20 Demographic and Health (DHS) and AIDS Indicator Surveys carried out in Africa between 2003 and 2008 as part of the MEASURE DHS project.[6] Among these surveys, the proportion of all couples who are discordant ranges from 0.4 percent in Senegal to 16.4 percent in Swaziland (see Figure 1). In Mozambique and 12 other countries in Africa, the percentage of couples that are discordant is higher than the percentage of couples that are concordant positive. The percentage of couples who are discordant is lower than the percentage that is concordant positive only in Swaziland; in the remaining seven countries there is no significant difference between these two percentages. The results for the distribution of HIV infection among couples in Mozambique are similar to those found in other African countries. Table 1 shows that in a substantial percentage of couples in each country the woman is HIV-positive and the man is HIV-negative. This contradicts conventional wisdom that HIV is usually introduced into a stable couple by men through sexual partnerships outside of the marriage (de Walque, 2007). A meta-analysis of 27 cross-sectional and prospective studies found the proportion of discordant couples in which the woman was HIV-positive to be 47 percent (Ewayo et al., 2010). The same investigation also pooled data from 14 DHS surveys and found the woman to be the HIV-positive member in a similar percentage of discordant couples (48 percent). These findings are also consistent with the results of the 2009 Mozambique INSIDA, in which the proportion of couples where the man is HIV-positive and the woman is HIV-negative (male discordant couples) is similar to the proportion of couples in which the woman is HIV-positive and the man is HIV-negative (female discordant couples).

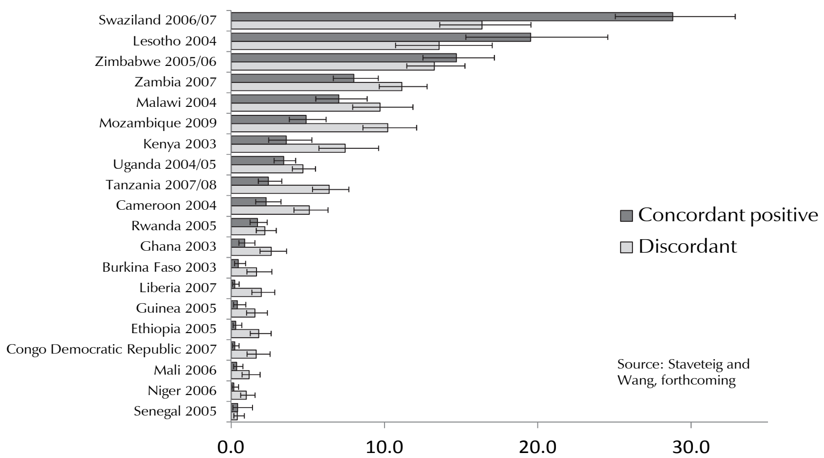
[5] All tables and figures are weighted using the men's HIV weight unless otherwise specified. An explanation of the calculation of sample weights can be found in Appendix A.
[6] All survey reports and general information on the MEASURE DHS project can be accessed at www.MEASUREDHS.com.

Table 1 HIV status of couples from recent DHS and AIS surveys

Country/year	HIV prevalence[1]	Both positive	Man+ woman-	Woman+ man-	Both negative
Central Africa					
Cameroon 2004	5.5	2.3	2.4	2.7	92.6
Democratic Republic of Congo 2007	1.3	0.2	0.6	1.1	98.1
East Africa					
Ethiopia 2005	1.4	0.3	0.8	1.0	97.9
Kenya 2003	6.7	3.6	2.9	4.6	89.0
Malawi 2004	11.8	7.0	5.7	4.0	83.3
Mozambique 2009	**11.5**	**4.9**	**5.1**	**5.2**	**84.9**
Rwanda 2005	3.0	1.7	1.4	0.8	96.1
Tanzania 2007/08	5.7	2.4	3.5	2.9	91.2
Uganda 2004/05	6.4	3.4	2.8	1.9	91.9
Zambia 2007	14.3	8.0	6.6	4.6	80.9
Zimbabwe 2005/06	18.1	14.7	8.1	5.2	72.1
Southern Africa					
Lesotho 2004	23.5	19.5	9.0	4.6	66.9
Swaziland 2006/07	25.9	28.8	7.7	8.7	54.8
West Africa					
Burkina Faso 2003	1.8	0.5	0.9	0.7	97.9
Ghana 2003	2.2	0.9	1.4	1.2	96.5
Guinea 2005	1.5	0.4	0.9	0.6	98.0
Liberia 2007	1.5	0.2	0.7	1.2	97.8
Mali 2006	1.2	0.4	0.3	0.8	98.5
Niger 2006	0.7	0.2	0.6	0.4	98.8
Senegal 2005	0.7	0.4	0.3	0.2	99.2

[1] National HIV prevalence among women and men age 15-49
Source for national HIV prevalence estimates except for Mozambique, Macro International Inc, 2008; source for couple HIV prevalence estimates except for Mozambique, Staveteig and Wang, forthcoming; source for national and couple HIV prevalence estimates for Mozambique, INS, INE, and ICF Macro, 2010.

Figure 1: How Does Mozambique Compare?
Levels of HIV Discordance and Positive Concordance in Mozambique and Other African Countries, DHS/AIS Surveys 2003-2008 and the 2009 INSIDA



How long does it take for a discordant couple to become a concordant positive couple, on average?

Table 2 summarizes the results of several prospective studies that have measured HIV seroconversion rates among couples who were discordant at the time of enrollment. According to the data presented in the table and a review of the literature by Guthrie et al. (2007), sex-specific estimates of HIV transmission rates within discordant couples have ranged from 1.2 to 19.0 per 100 person-years. In other words, the studies suggest that among any 100 discordant couples, in the period of a year only 1.2 to 19 discordant couples will convert to concordant positive couples.

Studies have also attempted to estimate a per coital act probability of HIV transmission for heterosexual couples. Two estimates of the risk of infection per coital act have been calculated based on data from Rakai, Uganda: 0.0011/coital act (Gray et al., 2001) and 0.0012 (Wawer et al., 2005), and one from Lusaka, Zambia: 0.0009/coital act (Hira et al., 1997), or approximately one infection per every 1,000 coital episodes. The evidence on HIV incidence rates among discordant couples and the per coital act probability of infection indicate that it is possible for discordant couples to live together for several years after the infection of the first partner while the second partner remains uninfected.

Table 2 Incidence rates of HIV seroconversion among discordant couples

Study (Country)	Total sero-conversion rate in discordant couples	Sero-conversion rate of men in discordant couples	Sero-conversion rate of women in discordant couples	Difference statistically significant	Restricted to sero-conversions from inside the couple	Positive partners using ART	Condom use among couples	Number of couples	Duration of follow up	Number of sero-conversions
Sarraco et al., 1993 (Italy)	NA	NA	3.6/100 PY	NA	Yes, by risk history	No, but symptomatic participants were given zidovudine	56% of women always used condoms	343 (all MD)	Median 24 months	19 women
DeVincenzi et al., 1994 (8 European countries)	2.3/100 PY	NR	NR	NA	No	No	48.4% used condoms consistently	163 MD, 93 FD	Median duration 22 months	4 men, 8 women
Serwadda et al., 1995 (Uganda)	9.0/100 PY	8.7/100 PY	9.2/100 PY	No	No	No	17.1% in FD, 9.5% in MD	44 MD, 22 FD	0.98 years	2 men, 4 women
Hira et al., 1997 (Zambia)	8.7/100 PY	19.0/100 PY	5.0/100 PY	Yes[1]	No, But no sero-conversions among men reporting extramarital partners	No	78% of coital episodes, 1/3 of couples always used condoms	80 MD, 30 FD	Median 17.6 months	8 men, 6 women
Carpenter et al., 1999 (Uganda)	7.7/100 PY	5.2/100 PY	10.6/100 PY	borderline RR 2.0 p=0.07	No	No	NR	58 FD, 63 MD	445 PY	12 men, 22 women
Quinn et al., 2000 (Uganda)	11.8/100 PY	11.6/100 PY	12.0/100 PY	No	No	No	<15% ever used a condom in past 12 months	228 MD, 187 FD	Median 22.5 months	40 men, 50 women
Senkoro et al., 2000 (Tanzania)	6/100 PY	5.0/100 PY	8.3/100 PY	No	No	No	None	41 FD, 37 MD	2.5 years	4 men, 5 women
Ryder et al., 2000 (DRC)		6.8/100 PY	3.7/100 PY	NR	No	No	NR	92 MD, 86 FD	310 PY	10 men, 6 women
Roth et al., 2001 (Rwanda)	NA	No conversion observed	4.6/100 PY	NA	No	NR, couples were recruited through ANC	>60% of couples were 'regular condom users'	43 MD, 23 FD	1 year	0 men, 2 women
Hugonnet et al., 2002 (Tanzania)	7.5/100 PY	5.0/100 PY	10.0/100 PY	No	No	No	NR	22 MD, 21 FD	2 years	2 men, 4 women
Deschamps et al., 2004 (Haiti)	5.4/100 PY	7.6/100 PY	4.8/100 PY	No	Yes, by testing secondary sexual partners	No	23.7% always used condoms	143 MD, 34 FD	Median 27 months	5 men, 15 women
Fideli et al., 2004 (Rwanda)	7.7/100 PY	7.1/100 PY	8.3/100 PY	No	Yes, by molecular testing	No	80% of couples following VCT	535 MD, 487 FD	Median 15 months	61 men, 81 women
Mehendale et al., 2006 (India)	1.22/100 PY	2.90/100 PY	0.95/100 PY	No	No, and sero-conversions higher among those with multiple partners	NR	71%	394 MD, 63 FD	Median 12 months	2 men, 4 women
Donnell et al., 2010[2]	2.24/100 PY	NR	NR	NA	Yes, by molecular testing	Yes, if eligible, mean CD4+ at initiation of ART was 192	NR	1,097 MD, 2,284 FD	4,558 PY	103 (sex not reported)

NA = Not applicable
NR = Not reported
FD = Female Discordant (female member of couple HIV-positive, male HIV-negative)
MD = Male Discordant (male member of couple HIV-positive, female HIV-negative)
PY = Person-years
[1] Significance testing was published in Guthrie et al., 2007
[2] Data collection conducted in Botswana, Kenya, Rwanda, South Africa, Tanzania, Uganda, and Zambia

Nonetheless, HIV-negative individuals in discordant relationships remain an especially vulnerable population for acquiring the virus. One mathematical model for adults in urban Zambia and Rwanda predicts that 55.1 to 92.7 percent of new, heterosexually acquired HIV infections occur within cohabiting discordant couples (Dunkle et al., 2008). Table 3 shows the results of four studies that have compared rates of seroconversion among individuals with HIV-positive spouses to those with HIV-negative spouses. In Hugonnet et al. (2002), men with an HIV-positive partner were 11 times more likely and women were 58 times more likely to become infected with HIV than men and women in concordant negative couples. In Carpenter et al. (1999), men with an HIV-positive partner were 12 times more likely to become infected with HIV than men with an HIV-negative partner (rate ratio 11.6). Women were over 100 times more likely to become infected with HIV if their partner was HIV-positive than if he was HIV-negative (rate ratio 105.8). The available evidence uniformly supports the conclusion that having a spouse or partner who is infected with HIV greatly increases one's own risk of becoming infected with HIV compared with having a spouse or partner who is HIV-negative.

Table 3 Comparison of HIV seroconversion rates among individuals in discordant couples and in concordant negative couples

	Seroconversion rates of men				Seroconversion rates of women			
Study (Country)	In discordant couples	In concordant negative couples	Rate ratio	Number of couples	In discordant couples	In concordant negative couples	Rate ratio	Number of couples
Serwadda et al, 1995 (Uganda)	8.7/100 PY	0.94/100 PY	10.3*,[a]	323 men, 3 conversions	9.2/100 PY	0.82/100 PY	10.3*,[a]	375 women, 3 conversions
Carpenter et al., 1999 (Uganda)	5.2/100 PY	0.36/100 PY	11.6*	2,079 couples, 17 conversions	10.6/100 PY	0.15/100 PY	105.8*	2,079 couples, 8 conversions
Senkoro et al., 2000 (Tanzania)	5.0/100 PY	0.6/100 PY	NR	411 couples, 6 conversions	8.3/100 PY	0.9/100 PY	NR	411 couples, 6 conversions
Hugonnet et al., 2002 (Tanzania)	5.0/100 PY	0.45/100 PY	11.0*	1,663 men, 12 conversions	10.0/100 PY	0.17/100 PY	57.9*	1,740 women, 3 conversions

* Statistically significantly different from zero at the $p<0.05$ level
[a] Rate ratio reported is for both sexes combined: seroconversion rate in discordant couples compared with seroconversion rate in concordant couples
NR = Not reported
PY = Person years

Factors associated with serodiscordance

The transmission rates presented in the previous section are only average rates across the populations studied. The risk of transmission per coital act differs from couple to couple depending on their characteristics, and within a couple the risk of transmission can fluctuate over time. Evidence from the literature suggests there are several factors that influence the probability of HIV transmission within couples.

Sex of the HIV-positive partner

It is not clear from previous research whether or not the sex of the infected member of the couple affects the rate of transmission within the couple. Although some studies show a trend towards higher rates of male-to-female (MTF) transmission of HIV than female-to-male (FTM) transmission, none of these differences are statistically significant. Carpenter et al. (1999) found that women in discordant relationships had a seroconversion rate two times higher than that of men (10.6/100 person-years vs. 5.0/100 person-years), but this difference was of only marginal statistical significance (p=0.07). On the other hand, Hira et al. (1997), found a significantly higher seroconversion rate among men in discordant couples than among women (19.0/100 person-years vs. 5.0/100 person-years, p<0.05).

It is noteworthy that many of these studies are based on a low number of seroconversions, and most did not include controls to exclude seroconversions resulting from extramarital sexual partners, which could inflate the estimate of infection from within the couple. Exceptions to this rule include de Vincenzi et al. (1994), which excluded all women who had risk factors for HIV infection other than sexual activity with their HIV-positive spouse such as intravenous drug use and reports of additional sexual partners during the follow-up period, and Fideli et al. (2001); Allen et al. (2003); Wawer et al. (2005); and Donnell et al. (2010); which used genetic sequencing to identify transmissions that did not appear to come from the spouse. None of the studies that excluded potential seroconversions from outside the union found statistically significant differences between MTF and FTM transmission rates.

Viral load, stage of disease, and ARV use

HIV viral load of the HIV-positive member of a discordant couple has been found to be strongly associated with the risk of seroconversion in their HIV-negative partner. In two studies, by Quinn et al. (2000) and Fideli et al. (2001), the median viral load was significantly higher among HIV-positive individuals whose partners acquired HIV compared with HIV-positive individuals whose partners remained HIV-negative. Quinn et al. found a statistically significant dose-response relationship between viral load and HIV transmission within discordant couples. The rate of HIV seroconversion among partners of HIV-positive individuals with a viral load of less than 3,500 copies per mL was 2.2 per 100 person-years, compared with 23.0 per 100 person-years among partners of HIV-positive individuals with a viral load of 50,000 copies per mL or higher. No transmissions were observed among couples in which the HIV-positive partner had a viral load lower than 1,500 copies per mL. The dose-response effect was significant regardless of the sex of the HIV-positive partner. Fideli et al. also found a significant dose-response relationship between viral load and HIV transmission within discordant couples when the HIV-positive partner was female. However, the dose-response relationship was not significant when the HIV-positive partner was male. Based on their findings, Quinn and colleagues conclude that viral load is the chief predictor of the risk of heterosexual transmission of HIV.

Use of antiretroviral therapy (ART) by the HIV-positive partner is associated with reductions in both viral load and the risk of HIV transmission to the HIV-negative partner. A meta-analysis of 11 cohorts found a 92 percent reduction in the risk of HIV transmission from 5.64 to 0.46 transmissions per 100 person-years associated with the use of ART (Attia et al., 2009). A trial in seven African countries in which HIV-positive members of discordant couples began ART use in accordance with country guidelines found a similar result: the seroconversion rate ratio of couples who had not initiated ART compared with those who had initiated ART was 0.08 (95% CI 0.00-0.57, p=0.004) (Donnell et al., 2010). In this trial, the largest decrease in the risk of transmission occurred in couples in which the HIV-positive partner's CD4 cell count was below 200 cells per µL. Unprotected sex also significantly decreased after HIV-positive partners began receiving ART (adjusted odds ratio 0.63, 95% CI 0.41-0.96, p=0.03), so some of the observed risk reduction could be due to the added protection of condom use.

Stage of disease also appears to be associated with risk of HIV transmission within discordant couples independent of viral load. One study compared three groups of couples: couples who enrolled as concordant negative couples with one partner seroconverting during follow-up (incident index couples), those who enrolled as discordant couples (prevalent index couples) with no death during follow-up, and couples in which the first partner to be infected with HIV (the index partner) was infected prior to enrollment and died during follow-up (late-stage index couples) (Wawer et al., 2005). Even after controlling for viral load, transmission rates were highest soon after the first partner became infected with HIV and shortly before their death. The transmission rate of HIV among incident index couples was 7.25 times higher than among prevalent index couples (95% CI 3.05-17.25). The transmission rate among late-stage index couples was also higher than that of prevalent couples and similar to that of incident index couples (rate ratio 5.81, 95% CI 3.00-11.35). The incidence of transmission was highest during the first five months after infection of the index partner, and the authors note that this is a time during which few people know that they have HIV and is not a time when individuals are eligible for ART. Currently in Mozambique, HIV-positive individuals become eligible for ART when their CD4 cell count drops below 250 cells per µL (MISAU, 2010).

Sexually transmitted infections (STIs)

Several biological mechanisms may account for the link between HIV infection and the presence of other sexually transmitted infections (STIs), including increased shedding of the HIV virus in genital secretions and semen and presence of the virus in genital ulcers that can come into contact with mucosa during sex, thus facilitating transmission (CDC, 1998). Evidence from a longitudinal trial in Rakai, Uganda, confirms this biological link. Self-reported symptoms of STIs in HIV-positive and HIV-negative individuals were associated with about 20 percent of HIV acquisitions or transmissions (Gray et al., 1999).

Within discordant couples, however, evidence of a link between STIs and transmission of HIV is inconsistent. Researchers have approached this question a number of different ways depending on their study design. In longitudinal studies it is possible to look at the relationship between STIs in the person who transmitted HIV (the index partner) and in the person who acquired HIV (Quinn et al., 2000; Deschamps et al., 1996); however, most studies have chosen to look at STIs in the index partner only. In cross-sectional studies, on the other hand, because the index partner is not known in concordant positive couples, it is only possible to compare the proportion of discordant positive couples in which either member has a history of STIs to the same proportion among concordant positive couples.

History of genital ulcer disease (GUD) in the index partner has been associated with a significantly higher risk of HIV transmission in discordant couples: adjusted rate ratio 2.58, 95% CI 1.03-5.69 (Gray et al., 2001), adjusted rate ratio 2.04, 95% CI 1.04-3.99 (Wawer et al., 2005). In addition, de Vincenzi et al. (1994) found that 40.0 percent of discordant couples in which the index partner had a history of GUD converted to concordant positive in the two year follow-up period compared with 12.8 percent of couples in which the index partners reported no genital infections, $p<0.04$). Hira et al. (1997) found that having sexual intercourse while the index partner had genital ulcers was associated with a seven-fold increase in the risk of transmission (rate ratio 7.45, $p<0.01$). On the other hand, a history of genital ulcers in either the HIV-positive or the HIV-negative partner was not associated with risk of transmission in an investigation undertaken by Quinn et al. (2000).

Most studies testing for syphilis have not found a significant association with risk of HIV transmission within discordant couples (Gray et al., 2001; Wawer et al., 2005; Quinn et al., 2000). By contrast, Deschamps et al. (1996) found syphilis in both the index and non-index partners to be associated with increased risk of transmission, and Fideli et al. (2001) found that women who were HIV-positive and tested positive for syphilis were more likely to transmit HIV to their partners than women who did not test positive for syphilis ($p=0.03$).

Quinn et al. (2000) found that genital discharge or dysuria in the index partner was associated with a nearly two-fold increase in the risk of HIV transmission in univariate analysis ($p<0.05$). However, neither discharge nor dysuria in the non-index partner was associated with HIV infection in this partner. The associations between discharge and dysuria in the index partner and HIV transmission were not statistically significant in the multivariate analysis. Deschamps et al. (1996) found the opposite: a history of discharge in the non-index partner, but not in the index partner, was associated with increased risk of transmission. No significant association between genital discharge and risk of HIV transmission was found by Gray et al. (2001) or Wawer et al. (2005).

A reported history of STIs or STI symptoms without reference to type of infection has also been associated with increased risk of HIV transmission in discordant couples. Padian et al. (1997) found that female index partners reporting history of an STI were more likely to have transmitted HIV to their partners than women with no reported history of STIs (adjusted odds ratio 2.6, 95% CI 1.4-5.1). There were too few cases of MTF transmission in their study to assess risk factors. In another study, FTM transmission of HIV was associated with a reported history of STIs among female index partners ($p<0.04$), while history of reported STIs among male index partners was not associated with increased risk of MTF transmission (Fideli et al., 2001). Finally, according to results published by Malamba et al. (2005), women with a history of an STI were more likely to be in concordant-positive than in discordant relationships, even after controlling for viral load (adjusted odds ratio 1.9, 95% CI 0.9-4.5, $p=0.09$).

It is interesting to note that some studies have found statistically significant associations between HIV transmission and reported symptoms of STIs when they did not find statistically significant associations between HIV transmission and laboratory diagnoses of infections that cause these symptoms. For example, Gray et al. (2001) and Wawer et al. (2005) both found a statistically significant association between reported history of GUD and HIV transmission, but no statistically significant association between HIV transmission and laboratory diagnoses of syphilis or genital Herpes Simplex Virus (HSV-2), two common causes of genital ulcers. Quinn et al. (2000) found a statistically significant association between both genital discharge and dysuria in the HIV-positive member of the discordant couple and risk of HIV-transmission to the uninfected partner. However, laboratory diagnoses of infections known to cause one or both of these symptoms, including chlamydia, gonorrhea, and trichomonas vaginalis, in the HIV-positive partner were not significantly associated with risk of transmission.

STI and HIV coinfection and STI screening and treatment in Mozambique

In most surveys, such as the 2009 Mozambique INSIDA, STIs are measured only through self-reported symptoms. In a clinical setting, on the other hand, STIs can either be diagnosed based on laboratory tests or syndromically, i.e., by using predefined algorithms based on signs and symptoms. In Mozambique, with the exception of syphilis, which is screened for using rapid tests, STIs are identified and treated using syndromic management in primary care settings.

Limited clinical data are available on STI incidence and STI and HIV coinfection in Mozambique. In antenatal care (ANC) sentinel surveillance, median syphilis prevalence was 5.6 percent in 2009 (INS 2010). In 2007, median syphilis prevalence was 6.8 percent, and pregnant women were more likely to have a positive syphilis test if they were HIV-positive compared with women who were HIV-negative when controlling for age, parity, and region (MISAU, 2008). In a cross-sectional study conducted in 2007 among HIV-positive patients in two outpatient care and treatment clinics in southern Mozambique (Mavalane Hospital, Maputo City, and Xai-Xai health center, Gaza Province), 20.5 percent of men and 63.5 percent of women reported STI symptoms (n=498) at their first visit to the clinic. Upon examination, more urethral discharge, genital ulcers or blisters, and genital warts were identified by providers on male genital exam than were reported by men, and more vaginal discharge and genital warts were identified by providers on female genital exam than were reported by women. Serological evidence of HSV-2[7] infection was present in 91.0 percent of all patients, and 15.2 percent of patients were positive for syphilis[8]. Many STIs were found to be as common among patients with symptoms as among patients without symptoms (MISAU, 2009). The high prevalence of incurable viral STIs and the low sensitivity of symptoms may limit the usefulness of syndromic management of STIs in HIV-positive patients (Bunnell et al., 2006b).

HIV treatment guidelines in Mozambique highly recommend screening patients initiating ART for syphilis, in particular, and for STIs, in general, through syndromic management, though they recommend no specific timeline for routine, repeat screening (MISAU, 2010). The reporting system does not currently allow disaggregation of STI syndromic case reporting by HIV status, so it is not possible to monitor STIs among HIV-positive individuals through the routine monitoring and evaluation system.

Condom use

Different studies have found a widely varying prevalence of condom use among couples and inconsistent results on the association between condom use and risk of HIV transmission in discordant couples; however, studies with higher rates of condom use tend to show a stronger association with decreased HIV transmission. Statistically significant reductions in the risk of HIV transmission in discordant couples associated with condom use have been found by Allen et al. (2003), Sarocco et al. (1993), Deschamps et al. (1996), and Padian et al. (1997). The first three studies compared couples who used condoms consistently to those who used condoms inconsistently or never. In the fourth study, never use was compared with ever use. In a cross-sectional study by Malamba et al. (2005), not using a condom at last sex was found to significantly increase a woman's probability of being in a concordant positive couple versus being in a male discordant couple (odds ratio 2.4, 95% CI 1.1-5.1) at a univariate level, but this association lost significance in multivariate analysis. Among male partners, condom use at last sex did not affect their likelihood of being in a concordant positive couple relative to being in a female discordant couple.

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[7] Case definition for HSV-2 was positive serology and/or positive polymerase chain reaction (PCR) for HSV on a genital ulcer swab specimen

[8] Case definition for syphilis was positive rapid plasma reagin (RPR) confirmed by *Treponema pallidum* hemagglutination (TPHA) and/or positive PCR for *T. pallidum* from a genital ulcer swab specimen.

Other studies have found a trend towards lower risk of HIV transmission among couples using condoms but no significant difference (Nicolosi et al., 1994; de Vincenzi et al., 1994; Hira et al., 1997). Two studies in Rakai, Uganda, involving relatively lower use of condoms by enrolled couples have reported no association between condom use and risk of HIV transmission in discordant couples (Quinn et al., 2000; Wawer et al., 2005). These studies did not report how frequently condoms were used by couples who reported condom use. The limited impact of condom use on HIV transmission found in these studies may indicate the challenges of increasing long-term condom use between discordant stable partners.

Male circumcision

Male circumcision has been found effective in reducing a man's risk of becoming infected with HIV (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007). However, investigations searching for a direct protective effect of male circumcision in HIV-positive men for their HIV-negative female partners have found no such link (Weiss et al., 2009). It is associated with a reduced risk of FTM transmission within couples but not MTF transmission. A study looking at factors associated with MTF transmission and FTM transmission in discordant couples separately supports this hypothesis. No seroconversions were observed among circumcised men in female discordant couples compared with an incidence rate of 16.7 per 100 person-years ($p<0.001$) among uncircumcised HIV-negative men in female discordant couples. The transmission rate among female partners of circumcised men in male discordant couples was 5.2 per 100 person-years compared with 13.2 per 100 person-years among the female partners of uncircumcised men, but this difference was not statistically significant (Quinn et al., 2000).

In two cross-sectional studies, the proportion of men who were uncircumcised was significantly higher among concordant positive couples than discordant couples (Freeman and Glynn, 2004; Malamba et al., 2005). However, in one of these (Freeman and Glynn, 2004), the significance of the association disappeared in multivariate analysis controlling for duration of marriage, coital frequency, types of sexual acts, and presence of STIs. In the study by Malamba et al. (2005), the significance of the association between circumcision status and couple's HIV status remained significant even after controlling for viral load (adjusted odds ratio 4.5, 95% CI 1.1-18.8, $p<0.05$). Uncircumcised male partners of HIV-positive women were also significantly more likely to have HIV themselves (adjusted odds ratio 6.5, 95% CI 1.6-26.4, $p<0.01$).

No association was found between circumcision status of male index partners and transmission of HIV to their uninfected female partners in two studies looking at viral load and HIV transmission (Fideli et al., 2001; Wawer et al., 2005). Neither study assessed the relationship between circumcision status of men in female discordant couples and men's own risk of acquiring HIV.

Other factors

A few other factors have been associated with risk of transmission of HIV in discordant partners in isolated studies. Several studies have found younger age to be significantly associated with higher transmission of HIV within couples (Fideli et al., 2001; Hugonnet et al., 2002; Wawer et al., 2005; Gray et al., 2001; Quinn et al., 2000). For example, Gray et al. (2001) found individuals in discordant couples age 30-59 roughly two-thirds less likely than those age 15-19 either to transmit or to acquire HIV infection. Pregnancy has also been associated with increased risk of transmission for women. In one study, the incidence of HIV among pregnant women was 2.16 times higher than among nonpregnant, nonbreastfeeding women (95% CI 1.39-3.37) (Gray et al., 2005). Evidence of associations between duration of relationship or coital frequency and HIV transmission is weak (Fideli et al., 2001; Saracco et al., 1993; Nicolosi et al., 1994; de Gourville et al., 1998).

Couples counseling and testing interventions

Couples counseling and testing: evidence of effectiveness

Couples HIV counseling and testing (CHCT) holds potential for enabling discordant couples to learn their status and adopt behaviors to reduce the risk of HIV transmission within the couple. Although couples HIV counseling and testing may be delivered in varied settings, the terminology generally refers to joint counseling and joint disclosure of test results to both members of a couple. It may also include ongoing counseling for HIV-negative or discordant couples to help them maintain their status (CDC, 2007). Although such programs are still relatively uncommon, several trials have looked at their effectiveness in promoting risk reduction behaviors.

The primary outcome of interest in evaluating couples counseling and testing interventions is a reduction in unprotected sex within the couple through increased use of condoms. The first evidence of the effectiveness of couples counseling and testing on the promotion of condom use comes from two studies in the early 1990s. In a study in the former country of Zaire, less than 5 percent of couples receiving HIV counseling and testing had ever used a condom. After 18 months, during which couples continued to receive counseling, 77 percent of couples reported use of condoms during all episodes of sexual intercourse (Kamenga et al., 1991). In Rwanda, male partners of women attending antenatal counseling were asked to volunteer for HIV counseling and testing, and couples were encouraged to receive their test results together. Among couples found to be discordant, the percentage using condoms increased from 4 percent at baseline to 57 percent after one year of follow-up (Allen et al., 1992). Condom use was higher among couples in which the man was the HIV-positive member. The majority of couples reported at least one episode of unprotected sex during the follow-up period.

Similar results were found among couples receiving HIV counseling and testing in Lusaka, Zambia. In this study, participants were asked to keep a diary of their sexual exposures, thus reducing the chance of recall errors, and biomarkers were collected to attempt to validate participant reports (Allen et al., 2003). Prior to voluntary counseling and testing, only three percent of couples reported they were currently using condoms. Twelve months following testing, the percentage of sexual contacts in which members of a discordant couple used a condom had increased to more than 80 percent. However, only 23 percent of couples reported no unprotected intercourse. Some of these couples, though, had sperm detected on vaginal smears collected at quarterly follow-up visits, indicating that there was some underreporting of unprotected sex.

A trial conducted in Kenya, Tanzania, and Trinidad randomized couples into two groups: one receiving CHCT and one receiving only health information. Couples assigned to voluntary counseling and testing significantly reduced unprotected intercourse with each other compared with couples assigned to the health information group. Decreases in unprotected sexual intercourse were greater among couples in which one or both members had HIV than among couples in which both members were HIV-negative (Voluntary HIV-1 Counseling and Testing Efficacy Study Group, 2000). Finally, condom use was also found to increase among couples in Uganda in which HIV-positive individuals initiating a home-based antiretroviral therapy (ART) program were offered couples counseling and testing (Bunnell et al., 2006a). After six months of treatment, condom use at last sex had increased from 65 percent to 85 percent with partners who were HIV-negative or whose status was unknown, and the number of unprotected sexual acts with a partner of negative or unknown HIV status had decreased by 70 percent. The observed decrease was higher among men enrolled in the home-based ART program than among women in the program.

Group-based sessions for discordant couples have also been used as a means to reduce risk behaviors. One such intervention conducted in India, Thailand, and Uganda included four sessions and focused on communication and negotiation skills. Participants reported condom use with 100 percent of sexual contacts at follow-up (McGrath et al., 2007). Another such intervention in Zambia focused on sexual behavior skills training for discordant couples and was associated with increased condom use. Women whose partners attended four sessions reported higher rates of condom use following the intervention than those whose partners attended one session (Jones et al., 2005). A male-focused counseling program for discordant couples in Rwanda that consisted of an educational video followed by group discussion was also found to increase involvement of men. Rates of condom use increased at follow-up, even among couples who had been tested previously and knew their discordant status before the intervention began (Roth et al., 2001).

Challenges to implementing couples counseling and testing

In several studies, couples counseling and testing services have received only limited acceptance, and demand for this service by couples has been low. In programs for prevention of mother-to-child transmission (PMTCT) that encourage involvement of male partners in counseling and testing, the percentage of husbands or partners who participated in voluntary counseling and testing has been low, ranging from 9 to 15 percent (Semau et al., 2005; Msuya et al., 2008; Farquar et al., 2004). A program in Rwanda and Zambia used influential community members to conduct outreach activities to invite couples to participate in CHCT. Only 14 percent of invited couples chose to receive the service (Allen et al., 2007). An earlier promotion effort for couples counseling and testing in Zambia involved radio and newspaper advertisements as well as community workers. The door-to-door approach using community workers was effective at increasing service utilization, but the model was found to be labor intensive and unsustainable. Attendance for CHCT decreased after the community workers stopped conducting outreach, even though the mass media campaign was still in effect (Chomba et al., 2008).

Misunderstandings around couple discordance and fear of stigma and adverse outcomes including separation or violence are two factors that may pose significant barriers to the uptake of CHCT. A qualitative study in Uganda found that both VCT counselors and clients had difficulty explaining how a couple can be discordant (Bunnell et al., 2005). Both counselors and clients appeared to believe that the efficiency of HIV transmission is much higher than scientific estimates. Explanations provided by clients for discordance included the following: (1) the negative partner is actually infected, but the virus was not detected by the blood test, (2) the HIV-negative member has "strong blood" or is immune to HIV, (3) HIV transmission can be prevented by having "gentle sex," and (4) the HIV-negative member is protected by God. Bunnell et al. emphasize the need to properly train counselors on how to explain discordance to clients. Research conducted by PSI indicates that understanding about couple discordance is also low in Mozambique, and some of these same misconceptions may be prevalent (Chissano and Wheeler, 2009).

One concern about the provision of CHCT is negative consequences for the members of the couples and for HIV-positive women in discordant relationships in particular. The VCT trial in Kenya, Tanzania, and Trinidad looked at negative events following couples' participation in counseling and testing, including break-up of a marriage, break-up of a sexual relationship, physical abuse by a sexual partner, neglect by family, and being disowned by family (Grinstead et al., 2001). Couple members who were assigned to the VCT group were more likely than couple members assigned to the health information group to report being neglected or disowned by their families, although the overall level was low (3 percent versus 1 percent, $p<0.01$). When couples were compared by HIV status, participants in female discordant couples were most likely to report the break-up of a sexual relationship (20 percent versus 7 percent or less for the other groups of couples). Other outcomes such as physical abuse or neglect were too infrequent for results to be compared by HIV status of the couple. Break-up of marriage was compared for concordant couples (both positive and negative) versus discordant couples, and discordant couples had higher levels of divorce, although this result only approached statistical significance ($p<0.09$).

A study of PMTCT clients also assessed adverse social events for clients who received couples counseling, those who received individual counseling and disclosed their test result, and those who were tested and did not disclose their results. The events assessed included verbal or physical abuse from partner, separation or divorce, being forced to leave home, violence from others, and threats or intimidation (Semrau et al., 2005). Overall, the study found that the likelihood of experiencing any adverse event during the six months after the birth of the baby was not significantly different among the three groups. Adverse events were experienced by 31 percent of women who received couple counseling, 27 percent of women who received individual counseling and disclosed their test result, and 28 percent of women who did not disclose their test result. Women in couples counseling did not experience significantly more physical violence from their partners than women who did not disclose their HIV test result. By HIV status of the couple, there were no differences between concordant and discordant couples in reported verbal or physical abuse, or violence from others, but there was a trend towards higher levels of divorce among discordant couples.

Box 2 **Summary of evidence on HIV discordance among couples**

- HIV discordance (when one member of a couple is HIV-positive and the other is HIV-negative) is common, and in most countries discordant couples outnumber concordant positive couples.
- HIV does not spread as easily within a couple as commonly thought, but HIV-negative members in discordant couples are still one of the groups of people most at risk for new HIV infection.
- Viral load is one of the strongest risk factors for HIV transmission within a couple, and ART use can reduce the risk of transmission.
- Symptoms of STIs, both ulcerative and non-ulcerative, have been found to be a risk factor for transmission of HIV in discordant couples in several studies.
- Consistent condom use by discordant couples has been shown to reduce the risk of HIV transmission within the couple. Many studies show little benefit of inconsistent condom use over no condom use, but the evidence is inconclusive.
- Male circumcision reduces the risk of transmission to HIV-negative men in discordant relationships, but in male discordant couples male circumcision does not appear to reduce the risk of transmission to the female partner.
- Younger age and pregnancy have been found to be risk factors for HIV transmission in discordant couples in isolated studies; however, there is little evidence of an association between HIV transmission in discordant couples and duration of relationship or coital frequency.
- Evidence shows that couples HIV counseling and testing (CHCT) can decrease unprotected sex among discordant couples. Low uptake of services, difficulty in correctly explaining couple discordance, and risks of negative consequences to HIV-positive members in discordant couples pose challenges to effective and safe implementation of CHCT.

Prevention activities with HIV-positive people in Mozambique

A broader class of prevention interventions which are particularly relevant to discordant couples are often termed prevention among positives or positive prevention (PP). Unlike couples counseling, which is generally directed at couples in which neither partner knows their HIV status, positive prevention is specifically directed at HIV-positive individuals (see box 3).

Box 3 **Prevention activities with HIV-positive people in Mozambique**

In Mozambique, PP aims to provide services for people living with HIV and AIDS to address their HIV care and prevention needs, to provide them with social support and improve their quality of life, and, ultimately, to decrease HIV transmission risk behavior. The intervention includes a training for providers covering (a) sensitization, skills building, and training on how to assess risk and motivate behavior change; (b) brief prevention messages to be used by trained staff (e.g., reduce risk behaviors, encourage partners to test for HIV, adhere to HIV treatment including medications if prescribed, disclose status when possible, decrease number of partners, decrease alcohol intake especially during sex, adopt family planning to prevent unwanted pregnancies, and utilize services to prevent transmission of HIV to children for desired pregnancy); and (c) continuation of prevention during subsequent visits/interactions (Mozambique Positive Prevention Project, 2009).

PP is in an initial scale-up phase in Mozambique, having been piloted at two sites in Maputo Province (Namaacha Health Center and Esperanca-Beluluane Testing and Counseling Center) in 2008. The project was expanded to Sofala Province (Munhava and Mafambisse Health Centers) in 2009, and since 2010 the project is operating in health centers in the district of Nicoadala and in the city of Quelimane in Zambezia Province. A feasibility and acceptability study in all three provinces was conducted in 2010, with results forthcoming.

The national reporting system does not currently capture data on PP interventions. Many discordant couples can be reached through PP services once the HIV-positive partner enters the health care system.

III. DESCRIPTION OF THE SAMPLE

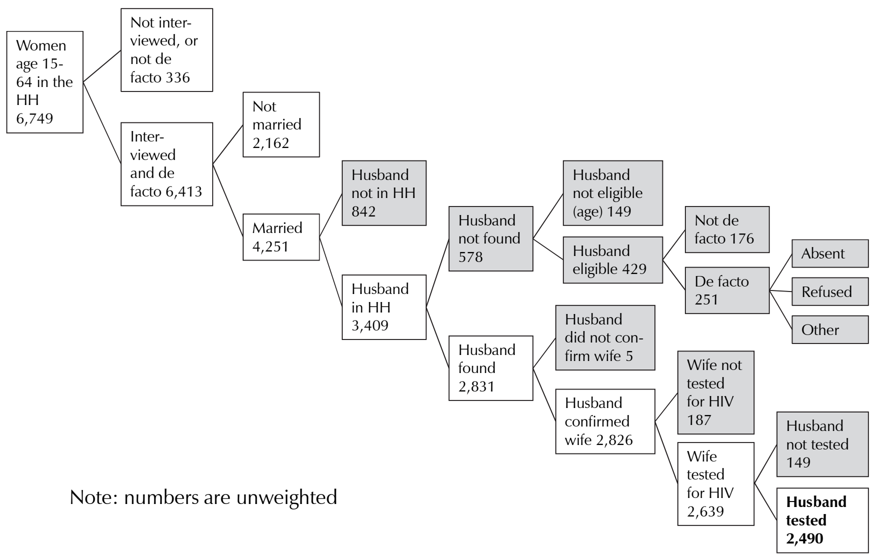
In the Mozambique 2009 INSIDA, a Household Questionnaire was administered to every household. This questionnaire included a complete list of persons in the household and their ages. Each individual listed in the household questionnaire was assigned a unique number within their household called the household line number. Men and women age 15-64 years were eligible to participate in an individual interview and to provide a blood sample for the survey HIV test. During the individual interviews, respondents were asked if they were married, and if so, who their spouse was. If the spouse was named in the Household Questionnaire, the interviewer recorded the household line number of the spouse in the individual's questionnaire.

To determine the HIV status of couples interviewed in the 2009 Mozambique INSIDA, it was first necessary to create from the database of individual respondents age 15-64 a separate file that matched individuals to their spouses. Matching of couples was conducted by identifying women who were married and subsequently identifying their husbands because each woman can be uniquely matched with one man. Some women said that their husbands did not live with them. These couples could not be included in the couples file because the survey lacked information about the husband.

For each married woman in the database who lived with her husband, an attempt was made to match her with her husband using his household line number. A confirmation was then made by checking the man's interview information to see if he named the woman he had been matched with as a wife. If a man is polygynous, he may appear in the database multiple times, once for each wife. Because the unit of analysis is the couple, there is no concern over some men appearing in multiple couples because each wife appears only once and thus every couple is unique. Matched couples in which either the husband or wife did not participate in the HIV test were excluded from the analysis.

Among 3,409 women who lived with their husbands, 2,826 (83 percent) were successfully matched with their husband (see Figure 2). Women who were not successfully matched with their husbands included four groups of women: (1) women whose husbands were not in the eligible age range for the interview (i.e., younger than 15 or older than 64 years of age) (4 percent), (2) women whose husbands did not spend the night before the interview in the household (5 percent), (3) women whose husbands refused to be interviewed, were absent during all follow up visits to the household, or who were not interviewed for some other reason (7 percent), and (4) women whose husbands did not name them as their wife (this was less than 1 percent and could have been due to mistakes by interviewers in recording household line numbers.

Figure 2: Composition of the Couples File



Three-hundred, thirty-six couples were excluded because either the husband or wife did not participate in the HIV test (12 percent of the 2,826 confirmed matched couples). The final analysis included 2,490 unweighted couples (2,648 weighted couples). This represents 73 percent of the 3,409 cohabiting couples and 59 percent of the 4,251 married women from the INSIDA survey. Because this is a relatively low percentage, it is important to examine differences between individuals in the couples file and married individuals in the main database for bias (Table 4).

Table 4 Comparison of all currently married men and women age 15-64 with the subsample of men and women age 15-64 who are in the couples file and were tested for HIV, Mozambique 2009

	Currently married women						Currently married men					
	All	95% CI lower	95% CI upper	In couples file and tested for HIV	95% CI lower	95% CI upper	All	95% CI lower	95% CI upper	In couples file and tested for HIV	95% CI lower	95% CI upper
Age												
Mean age	32.5	32.0	32.9	31.5	30.9	32.0	37.4	36.9	38.0	37.5	36.8	38.1
Type of union												
Percent polygynous	20.6	18.5	22.9**	15.1	13.0	17.6	12.4	10.5	14.6	15.2	12.9	17.9
Don't know/missing	4.1	3.1	5.4	3.3	2.2	4.8	0.7	0.5	1.1	0.5	0.3	1.0
Number of unions												
Percent married more than once	30.4	27.7	33.3	29.7	26.7	32.9	41.1	38.3	44.0	43.2	40.3	46.0
Missing	1.5	0.8	2.8	1.8	0.9	3.6	1.7	1.2	2.3	1.5	1.0	2.3
Cohabitation[a]												
Among those in monogamous union, percent living with spouse	88.3	86.5	90.0**	100.0	na	na	95.7	94.7	96.6**	100.0	na	na
Among those in polygynous union, percent living with:[1]												
All spouses	69.0	63.7	73.8**	100.0	na	na	18.5	13.3	25.2	28.3	20.5	37.7
Some, but not all spouses	na	na	na	na	na	na	79.8	72.8	85.3	71.7	62.3	79.5
No spouses	31.0	26.2	36.3**	0.0	na	na	1.7	0.7	3.8**	0.0	na	na
Living children												
Mean number	3.2	3.1	3.3	3.2	3.1	3.3	3.9	3.7	4.0	3.9	3.8	4.0
Education												
No education	35.8	32.0	39.7	35.7	31.4	40.3	14.3	11.9	17.1	14.1	11.7	17.0
Primary	56.6	52.9	60.2	56.6	52.3	60.8	68.7	65.6	71.6	69.8	66.3	73.0
Secondary +	7.7	6.3	9.3	7.6	5.9	9.9	17.0	14.2	20.2	16.1	13.0	19.8
Wealth quintile												
Mean wealth quintile	2.9	2.8	3.1	2.9	2.7	3.0	2.9	2.8	3.1	2.9	2.7	3.0
Place of residence												
Percent urban	26.5	22.8	30.1	27.4	22.7	32.0	28.0	24.1	32.0	27.4	22.7	32.0
Region												
North	35.8	31.6	40.3	37.6	32.3	43.1	38.8	34.3	43.5	37.6	32.3	43.1
Central	42.8	38.2	47.4	43.8	38.1	49.5	42.4	37.6	47.4	43.8	38.1	49.5
South	21.5	18.3	24.9	18.7	15.4	22.5	18.8	15.8	22.2	18.7	15.4	22.5
Province												
Niassa	5.7	4.0	8.2	6.5	4.8	8.8	6.7	4.8	9.1	6.5	4.8	8.8
Cabo Delgado	8.6	7.0	10.5	8.3	6.5	10.7	8.7	7.2	10.5	8.3	6.5	10.7
Nampula	21.5	17.7	25.8	22.7	17.9	28.4	23.4	19.4	28.0	22.7	17.9	28.4
Zambezia	18.9	15.0	23.5	19.4	14.3	25.7	18.9	14.6	24.0	19.4	14.3	25.7
Tete	8.9	7.0	11.2	9.5	7.3	12.2	9.2	7.2	11.7	9.5	7.3	12.2
Manica	6.9	5.7	8.5	6.8	5.4	8.6	6.7	5.4	8.1	6.8	5.4	8.6
Sofala	8.1	5.5	11.8	8.1	5.1	12.6	7.7	5.0	11.7	8.1	5.1	12.6
Inhambane	6.4	4.5	9.1	4.7	3.0	7.4	4.9	3.1	7.4	4.7	3.0	7.4
Gaza	5.6	4.4	7.1	4.3	2.8	6.3	4.1	3.0	5.6	4.3	2.8	6.3
Maputo Provincia	5.0	3.3	7.6	5.2	3.4	7.7	5.1	3.4	7.6	5.2	3.4	7.7
Maputo Cidade	4.4	3.7	5.2	4.5	3.7	5.6	4.8	3.9	5.8	4.5	3.7	5.6
HIV prevalence[2]	10.4	9.0	11.7	10.0	8.5	11.5	9.8	8.3	11.3	9.9	8.3	11.6
Coverage of INSIDA HIV test												
Not tested/missing[b]	7.6	5.8	9.8**	0.0	na	na	7.7	6.3	9.5**	0.0	na	na
Total number of respondents	**4,550**			**2,648**			**3,278**			**2,648**		

Note: Weights used in this table are as follows: individual sampling weight used for the "All" columns, except for the HIV prevalence row which uses the HIV weight. The "couple" columns use the men's HIV weight for all rows.
na = Not applicable
[1] The polygynous union category includes those with missing or "don't know" responses to type of union. Polygynous men are considered to be cohabitating with all spouses only if all wives are recorded as living in the same household with him. Women in polygynous unions are either living with their husband (all spouses) or not (no spouses). The "Some, but not all spouses" category does not apply to women because they have only one husband.
[2] Among those with a valid HIV test result.
[a] Cohabitation is a criterion for inclusion in the couples file.
[b] Valid test results from the INSIDA HIV test are a criterion for inclusion in the couples file.
** Indicates that the estimates for the full sample and the couples sample are statistically significantly different at the p<0.05 level based on lack of overlap in the 95% confidence intervals.

For the majority of demographic variables, married men and women in the main INSIDA database and those in the couples file are statistically similar with respect to age, number of living children, education, wealth, urban/rural residence, and their geographic distribution by region and province. There are significant differences in the proportions of couples who live together. Compared with 100 percent of women and men in the couples file, 88 percent of married women and 96 percent of married men in the main database live with their partners. Among women in polygynous unions in the main database, 31 percent do not live in the same household with their husband most of the time. Therefore, nearly one-third of women who are in polygynous unions are not eligible for inclusion in the couples file. As a result, the proportion of women who are in polygynous unions in the couples file is significantly lower than in the main dataset (15 percent versus 21 percent, $p<0.05$).

There is no significant difference in HIV prevalence between the main database and the couples file, despite the differences in the proportions of married men and women who live together, and in the proportions who are in polygynous unions.

IV. HIV DISCORDANCE AMONG COUPLES: KNOWLEDGE OF STATUS, NUMBER OF DISCORDANT COUPLES, AND CONDOM USE

This section first presents the proportion of HIV-positive individuals who are married to an HIV-negative spouse. Switching to the couple as the unit of analysis, the next part of the section describes the proportion of couples who are discordant. The section then summarizes couples' experiences with HIV counseling and testing prior to their participation in the 2009 INSIDA. This provides an understanding of the proportion of HIV-affected couples who may be aware that one or both of them are HIV-positive. This analysis lays the groundwork for the calculation of the absolute number of discordant couples in Mozambique and the number of discordant couples who cannot know they are discordant. Section IV concludes with an assessment of condom use among couples by the INSIDA HIV test result and testing history of the couple prior to the INSIDA survey.

The percentages shown in Section IV are derived from bivariate crosstabulations. The p-values for the significance of associations were calculated using chi-square statistics, accounting for the INSIDA sample design using the SPSS Complex Samples module. Comparisons are made only when the difference is significant at the $p<0.05$ level unless the lack of statistical significance is explicitly noted.

Summary of HIV discordance among couples in Mozambique

What proportion of HIV-positive Mozambicans have an HIV-negative partner?

Table 5 shows a percent distribution of all HIV-positive adults age 15-64 in the INSIDA main database by current marital status. According to the 2009 INSIDA, 64 percent of HIV-positive adults age 15-64 in Mozambique are currently in union (Table 5). Data from the couples file shows that among all HIV-positive people in union, 49 percent are married to someone who is also HIV-positive, and 51 percent are married to someone who is HIV-negative (data not shown). By applying the percentage of HIV-positive individuals who are married to an HIV-negative individual from the couples file (49 percent), to the percentage of HIV-positive individuals who are currently married from the main INSIDA database (64 percent), it is concluded that 33 percent of all HIV-positive individuals age 15-64 are married to someone who is uninfected.

Table 5 Percent distribution of HIV-positive men and women age 15-64 by marital status, Mozambique 2009

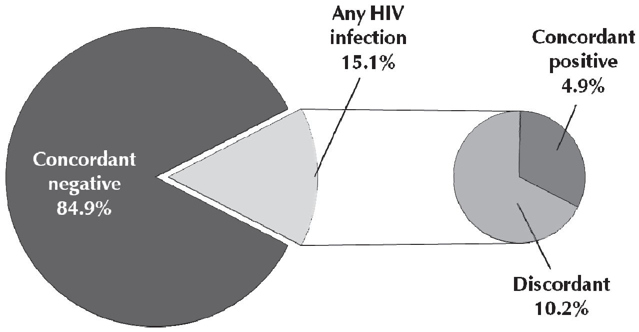
Marital status	HIV positive
Never married	9.3
Never had sex	1.1
Ever had sex	8.2
Currently married	63.6
Divorced/separated	16.6
Widowed	10.6
Total	100.0
Number	**1,145**

Note: Table uses individual HIV weights

Summary of HIV status of couples

Moving from looking at the HIV-positive individual as the unit of analysis to the couple as the unit of analysis, Figure 3 shows the distribution of couples in Mozambique by HIV status. A large majority of couples (85 percent) are concordant negative. Among the remaining 15 percent of couples, referred to as HIV-affected couples, one or both members are HIV-positive. Among HIV-affected couples, twice as many couples are discordant as are concordant positive (see Figure 3). In other words, for every 20 couples in Mozambique, 17 are concordant negative, one is concordant positive, and two are discordant. The discordant couples are fairly evenly divided into male discordant and female discordant couples. Among all couples, 5.1 percent are male discordant, and 5.2 percent are female discordant.

Figure 3: HIV Status of Couples in Mozambique



HIV status and history of HIV testing in couples

To best understand utilization of and demand for HIV counseling and testing services, it is helpful to know what percentage of married people know their HIV status and that of their spouse. The 2009 Mozambique INSIDA asked respondents whether or not they had ever been tested for HIV and received the test result (prior to participating in the survey). Respondents who answered yes were asked when they were last tested and whether they had received the result of the last test. Respondents were not asked to disclose the result of their HIV test to the interviewer; nor were respondents asked if they had disclosed their test result to their spouse.

From the INSIDA data, it is possible to construct a variable that specifies whether an individual has ever been tested for HIV and received the results of the last such test. Throughout the rest of this report, this variable is used as a proxy for knowledge of current HIV status. It should be interpreted as the maximum proportion or number of people who could potentially correctly know their current HIV status, assuming that all individuals who have been tested revealed this information during the interview. The proportion or number of people who correctly know their current status could be far lower, particularly if individuals seroconverted between their last HIV test and the INSIDA interview. The likelihood of such seroconversions is greater the longer ago the individual was last tested for HIV. Even if both members of the couple “know their HIV status” (according to the proxy variable), the members of the couple must take the additional step of disclosing their status to each other in order to know whether or not they are discordant. For this analysis, couples who cannot know that they are discordant are those in which neither member in the couple, or only one member in the couple, has ever been tested for HIV and received the results. Couples in which the positive member cannot know his or her status are discordant couples in which the HIV-positive member has never been tested for HIV and received the results. Included are couples in which neither member has been tested and received the result and those in which only the HIV-negative member has received an HIV test and the result. These couples have no knowledge that either of them is infected with HIV.

Data from the 2009 Mozambique INSIDA show that few discordant couples are likely to know their HIV status. Based on results of the couples file, only 31 percent of married women (95% CI: 27.3, 35.0) and 16 percent of married men (95% CI: 13.6, 18.7) have ever been tested for HIV and received the results of their most recent test (Table 6). In nearly two-thirds of the couples (64 percent), neither member has ever been tested and received the results, while both members have been tested and received their results in only 11 percent of couples. Having been tested for HIV and received the test results is clearly associated with HIV status. For example, both members have ever been tested and received the results in 22 percent of concordant positive couples compared with only 10 percent of concordant negative couples.

Looking at HIV testing among discordant couples, in only 15 percent of discordant couples have both husband and wife ever been tested and received their results (Table 6). Because, as noted previously, the 2009 Mozambique INSIDA did not ask respondents whether they disclosed their test results to others, and each partner's HIV status may have changed since his or her last negative test, this finding does not mean that 15 percent of discordant couples know they are discordant. In over half of discordant couples (51 percent), neither the husband nor wife has ever been tested for HIV and received the results. No more than 31 percent of discordant couples can know that at least one of the members has HIV. Disaggregating these results by sex, 38 percent of HIV-positive women in discordant couples have ever been tested for HIV and received the results compared with 25 percent of HIV-positive men in discordant couples.

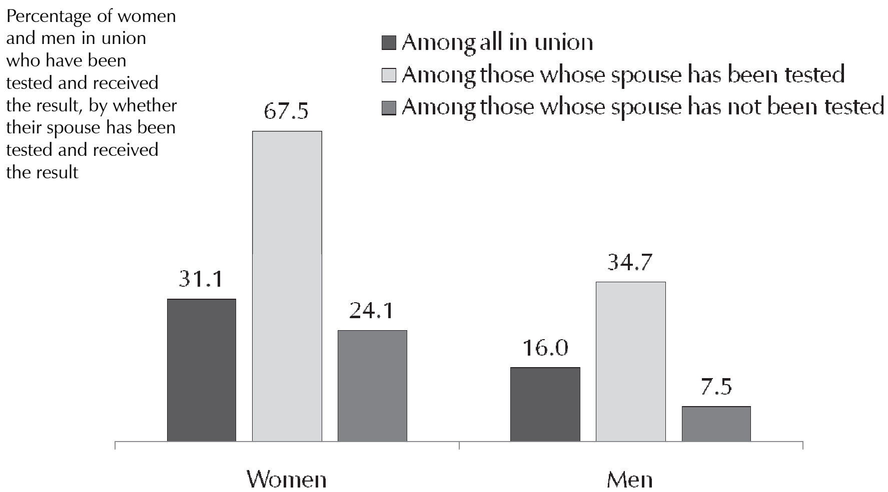
Table 6 Percent distribution of couples by testing status and percentage of women and men in the couples who have been tested and received the results of their last test, according to HIV status of the couple, Mozambique 2009

	Couple testing status						Testing status of men and women in the couples		
HIV status of the couple	Both husband and wife tested	Husband tested but not wife	Wife tested but not husband	Neither tested	Total	At least the positive member has been tested	Woman tested	Man tested	Number total
Both positive	22.1	8.1	24.2	45.6	100.0	22.1	46.3	30.2	129
Man positive, woman negative	14.7	10.1	23.1	52.1	100.0	24.7	37.8	24.7	134
Man negative, woman positive	14.4	12.4	23.4	49.8	100.0	37.8	37.8	26.8	136
Both negative	9.7	4.3	19.7	66.3	100.0	na	29.4	14.0	2,249
Couples with either or both members infected	17.0	10.2	23.6	49.2	100.0	28.3	40.6	27.2	400
All discordant couples	14.6	11.2	23.3	51.0	100.0	31.3	37.8	25.8	271
Total	**10.8**	**5.2**	**20.3**	**63.8**	**100.0**	**na**	**31.1**	**16.0**	**2,648**

na = Not applicable

The data show evidence of a "couples effect" for HIV testing; that is, testing of one member of a couple is related to whether or not their spouse has been tested. A married individual is 6.5 times more likely to have ever been tested and have received the test result if their spouse has done the same (95% CI, 4.8-8.8). This relationship is illustrated in Figure 4. The first bar in the figure shows the overall percentage of women in the couples file who have ever been tested for HIV and received the result. The second bar shows the percentage of women who have been tested for HIV among those whose husbands have also been tested (68 percent), and the third bar shows the percentage of women who have been tested for HIV if their husbands have never been tested (24 percent). A similar pattern is seen among men. Figure 5 looks at testing history among wives and husbands of individuals who may know that they are HIV-positive, that is, individuals who were HIV-positive in the test given as part of the INSIDA and who have ever been tested for HIV in the past and received the results. Only 43 percent of husbands of women who may know they are HIV-positive and 67 percent of wives of men who may know they are HIV-positive have ever been tested for HIV and received the results.

Figure 4: Testing Among Couples



There is a clear "couple effect" of HIV testing. Men and women whose partners have been tested are 6.5 times more likely to have been tested themselves.

Figure 5: HIV Testing Among Partners of Individuals Who Know They Have HIV

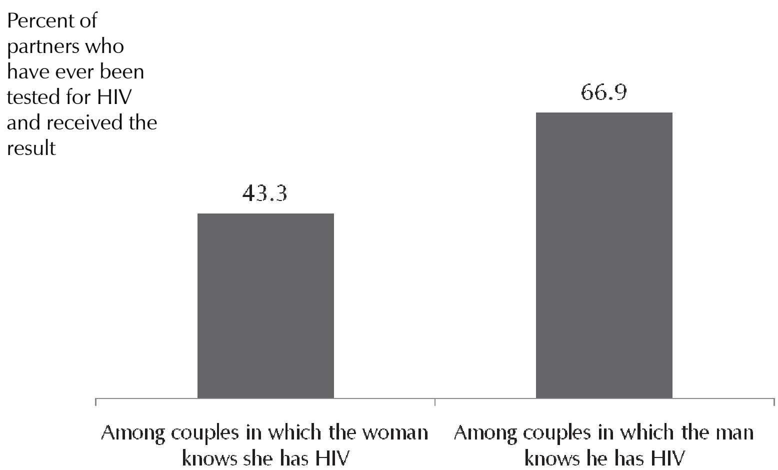


Table 7 presents variations in the percentage of couples who are discordant and in the proportion of discordant couples by knowledge of status, according to residence and region. The percentage of couples that are discordant across urban and rural areas and the three regions varies in accordance with the HIV prevalence in these areas. Areas with higher HIV prevalence tend to have higher percentages of discordant couples. Overall, 85 percent of discordant couples cannot know that they are discordant. (This is the inverse of the 15 percent of discordant couples in which both the husband and wife have been tested for HIV and have received the results, shown in Table 6). This percentage is 91 percent in rural areas and 78 percent in urban areas. By region, the percentage of discordant couples who cannot know they are discordant ranges from 77 percent in the southern region (Maputo City and Maputo, Gaza and Inhambane provinces) to 98 percent in the northern region

(Nampula, Cabo Delgado, and Niassa provinces). In 69 percent of discordant couples, the members of the couple cannot know that either of them has HIV. (This is the inverse of the 31 percent of discordant couples in which at least the HIV-positive member has been tested and has received the test results, shown in Table 6). Over three-quarters (77 percent) of discordant couples in rural areas and 57 percent of couples in urban areas cannot know that either of them has HIV. By region, the percentage of discordant couples who cannot know that either of them has HIV ranges from 56 percent in the southern region to around 75 percent in the northern and central regions. Table 7 shows the percentages that correspond to the absolute numbers of couples in Table 8.

Table 7 Percentage of couples that are discordant, percentage of discordant couples who cannot know that they are discordant, and percentage of discordant couples who cannot know that one of them has HIV, Mozambique 2009

Residence/ region	All couples		Discordant couples		
	Percentage that are discordant	Number of couples	Percentage that cannot know they are discordant[1]	Percentage in which the positive member cannot know his/her status	Number of discordant couples
Residence					
Urban	15.3	725	77.7	56.5	111
Rural	8.3	1,923	90.8	77.1	159
Region					
North	4.9	995	98.1	75.6	49
Central	11.8	1,159	86.4	74.0	137
South	17.2	494	76.7	56.1	85
Total	**10.2**	**2,648**	**85.4**	**68.7**	**271**

[1] Neither or only one member of the couple has ever been tested for HIV and received the results of the last test.

Estimated magnitude of couple discordance in Mozambique

To calculate the total number of discordant couples in Mozambique in 2009, it was first necessary to estimate the total number of couples in the country. The process began with data for the number of women age 15-64 determined by the 2007 Mozambique census and projected for 2009 (INE, 2009). The total number of married women age 15-64 in Mozambique was then calculated by applying an estimate for the percentage of women who are married from the INSIDA survey. The total number of married women can be considered as equal to the total number of couples because each married woman has exactly one husband (while men may have more than one wife). The estimate for the percentage of women age 15-64 who are married in Mozambique corresponds with the percentage of women who said that they were married or living with someone as if married during the INSIDA individual interview. This percentage was age-adjusted to account for any differences in age distribution between the census population and the INSIDA sample. The total number of couples in Mozambique was then multiplied by the percentage of couples who are discordant from the INSIDA couples file to produce the number of discordant couples. At each step, separate percentages and total numbers were calculated for urban and rural areas within each of the three geographic regions (northern, central, and southern Mozambique). This approach allows the numbers of discordant couples in urban and rural areas and in each of the three regions to sum to the same national total; however, it produces a greater standard error at the national level than simply calculating national-level percentages and numbers, resulting in a wider confidence interval for the number of discordant couples at the national level.

According to the analysis presented, there are approximately 4.1 million couples in Mozambique, of which around 433,000 are discordant (Table 8). Due to the sampling error for the estimate of the percentage of couples who are discordant from the 2009 Mozambique INSIDA, this estimate is imprecise. According to the 95% confidence interval, the actual number of discordant couples is between 365,000 and 500,000. By residence, roughly 178,000 discordant couples live in urban areas compared with 255,000 who live in rural areas. The northern region has the lowest number of discordant couples, estimated at roughly 72,000, followed by the southern region with 152,000 discordant couples and then the central region with about 209,000 discordant couples. In Mozambique as a whole, an estimated 368,000 discordant couples cannot know that they are discordant, and 295,000 discordant couples cannot know that either partner is infected with HIV.

Table 8 Estimated number of discordant couples and the upper and lower boundaries of the confidence interval, by residence and region, Mozambique 2009

Residence/ region	Total number of couples	Discordant couples: Number of discordant couples	95% confidence interval: Lower estimate	Upper estimate	Number who cannot know they are discordant	Number where the positive member cannot know he/she has HIV
Residence						
Urban	1,141,000	178,000	138,000	218,000	137,000	99,000
Rural	2,993,000	255,000	201,000	309,000	231,000	196,000
Region						
North	1,489,000	72,000	46,000	98,000	71,000	54,000
Central	1,763,000	209,000	157,000	261,000	181,000	155,000
South	882,000	152,000	117,000	186,000	117,000	86,000
Total	**4,134,000**	**433,000**	**365,000**	**500,000**	**368,000**	**295,000**

Note: The total number of couples is based on 2009 population projections for the number of women and the estimate for the percentage of women who are in union from the 2009 INSIDA. The numbers for the upper and lower estimates for urban and rural and the three regions do not sum to the upper and lower estimates for the total.

Knowledge of HIV status and condom use among couples

Use of condoms within couples is low in Mozambique. Overall, only 3 percent of couples reported using a condom the last time they had sexual intercourse with each other. Tables 9 and 10 assess how condom use varies according to the INSIDA HIV test result and testing history of the couple. These tables use the woman's report of condom use at her last episode of sexual intercourse with her husband[9]. It is important to note that HIV status, testing history, and condom use are all closely interrelated, so the bivariate associations presented in these tables must not be interpreted to indicate causality. The first panel in Table 9 shows the percentage of couples that used a condom the last time they had sex with each other by the HIV status of the couple. Condom use at last sex is higher among couples in which the woman is HIV-positive, regardless of the HIV status of the man. Eleven percent (95% CI 6.6, 16.8) of female discordant couples used a condom at last sex, followed by 9 percent (95% CI 5.1, 15.7) of concordant positive couples, 3 percent (95% CI 1.9, 3.4) of concordant negative couples, and 1 percent (95% CI 0.4, 4.5) of male discordant couples. History of ever having had an HIV test and having received the results, regardless of HIV status, is also significantly associated with condom use at last sex ($p < 0.001$). Among the majority of couples in which neither member has been tested for HIV and received the results, only 1 percent used a condom at last sex, compared with 5 percent of couples in which only the woman has been tested and 6 percent of couples in which only the man has been tested. Among couples in which both members have been tested for HIV and received the test results (the only couples with the potential of knowing whether or not they are discordant), 11 percent used a condom the last time they had sex with each other.

Table 9 Percentage of couples who used a condom the last time they had sexual intercourse with each other, by HIV status of the couple and whether each member of the couple has ever been tested for HIV and received the result of their last HIV test, Mozambique 2009

Characteristic	Condom use at last intercourse[1]	95% confidence interval	Number of couples
HIV status of the couple[2]			
Both positive	9.1	(5.1, 15.7)	129
Man positive, woman negative	1.3	(0.4, 4.5)	134
Man negative, woman positive	10.6	(6.6, 16.8)	136
Both negative	2.5	(1.9, 3.4)	2,249
Testing history of the couple[2]			
Both tested	11.1	(8.2, 15.0)	285
Man tested, woman no	6.4	(3.1, 12.7)	138
Woman tested, man no	4.7	(3.2, 6.9)	537
Neither tested	1.1	(0.6, 2.2)	1,688
Total	**3.2**	**(2.5, 4.0)**	**2,648**

[1] Last intercourse within the couple
[2] Based on Pearson chi-square, $p < 0.001$

[9] Women's rather than men's report of condom use at last sex with spouse is used because of polygyny. For men who have multiple wives, it is not possible to determine which wife he is referring to in his responses to the INSIDA questions about condom use at last sex.

Table 10 looks at the relationship between condom use at last sex, the INSIDA HIV test result, and prior individual HIV testing of female and male members of the couple. It would be desirable to examine condom use by knowledge of HIV infection; however, knowledge of current HIV status is not available from the INSIDA data. As noted previously, ever being tested for HIV plus receiving the results, combined with the individual's INSIDA HIV test result is only a proxy for knowledge of status. With these caveats in mind, the findings show that couples in which the woman has ever been tested for HIV and received the results (regardless of whether or not the husband has been tested) are more likely to have used a condom at last sex (7 percent) than couples in which the woman has never been tested and received the results (2 percent). Among couples in which the woman has ever been tested for HIV and received the results, those in which the woman is currently HIV-positive are more likely to have used a condom at last sex (17 percent) than those in which the woman is currently HIV-negative (5 percent). Couples in which the man has ever been tested for HIV and received the results are also more likely to have used a condom at last sex (10 percent) than those in which the man has never been tested and received the results (2 percent). However, it appears that among couples in which the man has ever been tested and received the results, those in which the man is currently HIV-positive are no more likely to have used a condom at last sex than those in which the man is currently HIV-negative (12 percent vs. 9 percent, difference not statistically significant).

Table 10 Percentage of couples who used a condom at last intercourse according to testing history and current HIV status of the male and female members in each couple, Mozambique 2009

Testing and HIV status	Used a condom at last intercourse[1]	95% confidence interval	Number of couples
According to testing and HIV status of the woman			
Woman ever tested	6.9	(5.3, 9.0)	822
Woman HIV positive	16.5	(10.2, 25.6)	111
Woman HIV negative	5.4	(4.0, 7.4)	711
Woman never tested	1.5	(0.9, 2.6)	1,826
According to testing and HIV status of the man			
Man ever tested	9.6	(7.4, 12.4)	423
Man HIV positive	11.7	(6.4, 20.3)	72
Man HIV negative	9.1	(6.7, 12.3)	351
Man never tested	2.0	(1.4, 2.8)	2,225
All couples	**3.2**	**(2.5, 4.0)**	**2,648**

[1] Last intercourse within the couple

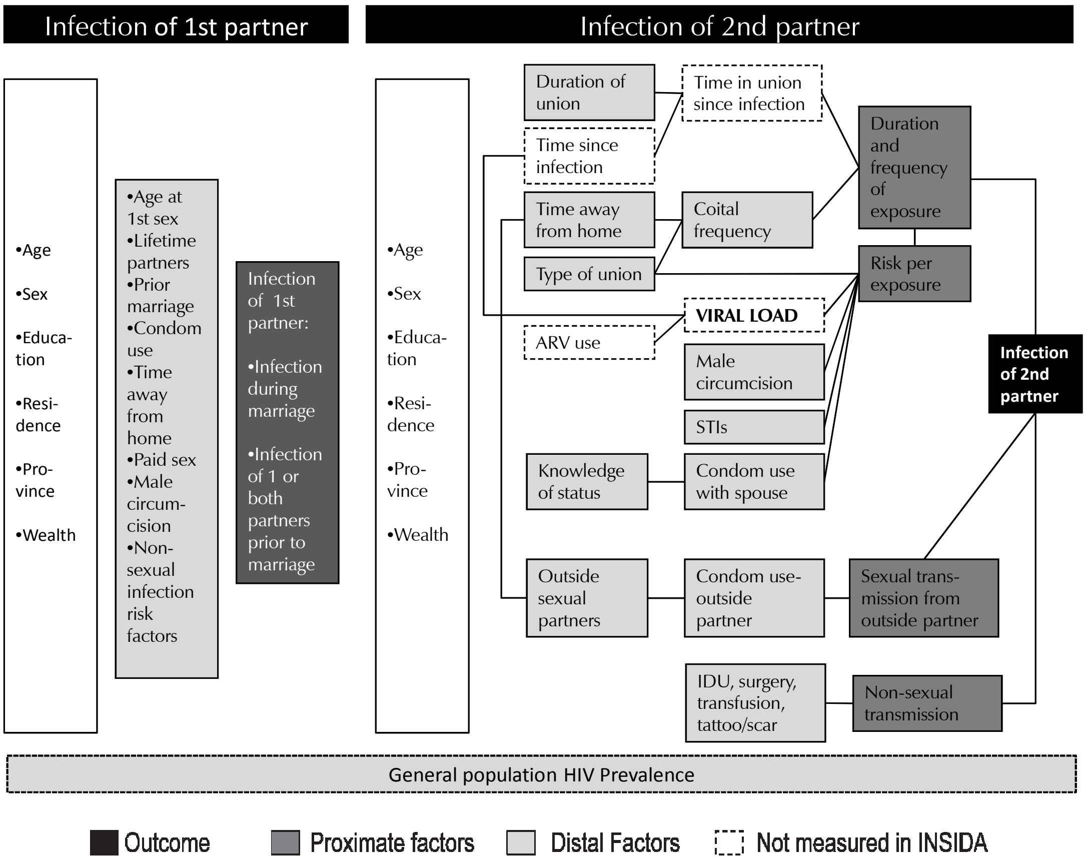
Box 4 Summary of findings on level of couple discordance, knowledge of status, and condom use

- One in ten couples in Mozambique, or 433,000 couples, is HIV discordant.
- One-third of all HIV-positive individuals age 15-64 have a spouse or partner who is HIV-negative.
- Knowledge of discordant status is low: both husband and wife have been tested for HIV and received the results in only 15 percent of discordant couples.
- Eleven percent of female discordant couples and 1 percent of male discordant couples used a condom the last time they had sex with each other.

V. CONCEPTUAL FRAMEWORK AND DESCRIPTION OF VARIABLES

A conceptual framework delineating the primary factors hypothesized to be associated with couple discordance in this analysis is presented in Figure 6. The framework is based on the scientific literature that addresses factors associated with HIV transmission within discordant couples; this literature was summarized in Section II. To determine which couple characteristics are associated with some couples being discordant while other couples are concordant positive, the analysis focused on those factors hypothesized to be associated with the infection of the second partner,[10] shown under "Infection of 2nd partner" on the right side of Figure 6. The conceptual framework is comprehensive in that it includes factors expected to have an association with infection of the second partner in a couple even if there is no information available on that factor in the INSIDA survey. Boxes in white contain factors for which data are not available from the survey. Dark gray boxes indicate factors that are theorized to have a more proximal relationship to the outcome of interest. Light gray boxes are theorized to have a more distal relationship to the outcome of interest, as described below. Appendix Table C.1 includes further detail regarding the variables used in the multivariate analysis and how they relate to the conceptual framework.

Figure 6. Conceptual Framework



Once one member of a couple is HIV-positive, the second partner can become HIV-positive in one of three ways. First, the HIV-negative partner can acquire HIV from their HIV-positive spouse (the first or index

[10] This analysis focuses on the infection of the second partner because the regression models are limited only to couples in which one or both partners is HIV-positive, therefore at least one partner (the first or index partner) has already been infected. However, among concordant positive couples, it is not possible to determine which partner became HIV-positive first, i.e., which partner was the index partner and which partner was the second partner infected. It is also possible for concordant positive couples to comprise two HIV-positive individuals who acquired HIV independently prior to forming the union. However, with longer durations of the current union, the probability that HIV infection occurred during the union increases (de Walque, 2007).

partner) through sexual transmission. Second, the HIV-negative partner can acquire HIV from a sexual partner outside the marriage. Third, the HIV-negative partner can become HIV-positive through non-sexual means, i.e. through needle sharing, unsafe blood transfusions, or other blood-to-blood contact, possibly including tattoos or scarification.

The risk of HIV acquisition through sexual transmission within the couple is determined by two key factors: (1) the duration and frequency of sexual exposure within the couple and (2) the risk per exposure, or the likelihood that each sexual exposure will transmit HIV. Ideally, the first factor would be measured by how long the HIV-negative partner has been in a sexual relationship (or "in union") with the index partner *since the index partner became infected*. However, it is not possible to know from INSIDA data when someone first seroconverted. Because time in union since infection of the index partner is not available in the dataset, the duration of the sexual union, constructed from the woman's report of when she first had sex with her current spouse, is used instead. The time in union since infection may be shorter than the time in union, but it cannot be longer. Ten couples had no available information on duration of sexual union and were excluded from multivariate analysis. The time since last sex with spouse is used as a measure of frequency of sexual exposure, or coital frequency. Two other factors that may affect coital frequency are the time that one or both partners have been away from home and whether the marriage is monogamous or polygynous. Time away from home may also affect the likelihood that either member of the couple has had sexual partners outside the marriage. Whether the marriage is monogamous or polygynous may also directly affect the risk per exposure, particularly if polygyny represents a closed sexual network. A variable for "type of union" (i.e., polygynous or monogamous) is created by combining husband's and wife's reports of whether they are in a monogamous or polygynous marriage. In 6 percent of couples, one spouse reported the marriage as monogamous and the other spouse reported the same marriage as polygynous. This inconsistency in reporting of type of union has also been found in other couple studies (Coly et al., 2011). These couples are put into a "disagree" category for type of union. Whether the members of the couple have been married multiple times—a common occurrence in Mozambique—was also investigated.

The primary factor affecting the risk of HIV transmission per exposure is the viral load of the index partner, which may be mediated by use of antiretrovirals (Quinn et al., 2000; Wawer et al., 2005). However, neither viral load nor ARV use was collected in the 2009 INSIDA, so the absence of information is noted as an unavoidable limitation. Factors directly associated with the risk per exposure that were measured in the 2009 INSIDA include male circumcision, STIs, and condom use. As noted in Section II, male circumcision is protective against male acquisition of HIV, but there does not appear to be a protective effect for female partners of circumcised men. It is therefore anticipated that if the wife is the HIV-positive index partner in a couple, she will be less likely to transmit HIV to her husband if he is circumcised than if he is not; however, in couples in which the husband is the HIV-positive index partner, whether or not he is circumcised is not expected to affect the risk of HIV transmission to his wife. Male circumcision is measured by self-report of the male partner. STIs are also measured by self-report on three questions: whether the respondent has had an STI; had genital sores; or experienced abnormal genital discharge, all in the past 12 months. If a respondent said yes to any of these three questions, he or she is treated as having a history of STI symptoms. Condom use would also substantially lower, if not eliminate, the risk of HIV transmission per coital act. Because condom use for family planning is very low in Mozambique (less than 2 percent of women in the couples sample report currently using condoms for family planning; results not shown), condom use within the couple is considered to be primarily an attempt to prevent transmission of HIV or other STIs. As seen in Section IV, condom use within the couple varies significantly with HIV status. Behavioral changes due to knowledge of status appear to be operationalized through condom use (or abstinence, which is captured by the coital frequency variable in the model), and so condom use at last sex with spouse is the preferred variable for inclusion in the models.[11]

The second way the HIV-negative partner in a discordant couple can become HIV-positive is through sexual acquisition from outside the marriage. Simply having a nonspousal partner is the primary risk factor

[11] Condom use at last sex with spouse is included in the binomial logistic regression in Table 12. Couple ever tested for HIV and received results is substituted for condom use at last sex with spouse in the multinomial logistic regression in Table 13 because too few female discordant couples used a condom at last sex to permit inclusion of this variable in the model.

associated with this type of acquisition, and this risk can be mediated through condom use. Both of these factors are combined into one variable with three categories: condom used at last sex with nonspousal partner; no condom used at last sex with nonspousal partner; and no nonspousal sex in the past year. This variable includes paid sex for males. Because this information was only collected for sexual partners in the last 12 months, the analysis cannot account for nonspousal sexual transmission that may have occurred more than one year ago.

The third way for an HIV-negative partner in a discordant couple to become HIV-positive is through nonsexual transmission. HIV could be acquired through unsafe medical injections, surgery, blood transfusions, or tattoo or scarification procedures. Medical injections were by far the most common of these activities among respondents in the couples sample. No association was found between medical injections and HIV status in the sample. For this reason and also because of the potential for reverse causality—that HIV-positive people could be getting medical injections because of HIV-associated illnesses, rather than injections leading to HIV acquisition as noted in Mishra et al. (2008)—medical injections were excluded from consideration. One variable was created to reflect whether either member of the couple reported any activities other than medical injections that could lead to nonsexual acquisition: injection drug use, having received a blood transfusion, having had surgery, or having undergone scarification/tattooing.

Demographic factors that may be associated with couple discordance were also investigated: age, education, residence, province, and socioeconomic status of the couple. Age is measured with two variables: the mean age of the couple and the age difference between the two partners. The education variable used in the models combines the highest level of education attained by the couple (whether both members of the couple have no education, only primary education, or secondary education or higher) and the wife's educational attainment relative to that of her husband. Though percent distributions of HIV status of the couple are shown by urban/rural residence, region, and province in Table 11, province was unable to be used in the multivariate models due to low sample size,[12] and urban/rural residence and region were unable to be used due to collinearity. Socioeconomic status is measured using a "wealth index" of assets owned by the household. A wealth index score based on asset ownership is calculated through principle components analysis (see Rutstein and Johnson, 2004, for full details), placing each household on a wealth scale relative to all other households in the country. Couples are divided according to whether their household is ranked in the poorest 60 percent or the highest 40 percent of the population of Mozambique.

HIV prevalence in a couple's area as a factor associated with discordance

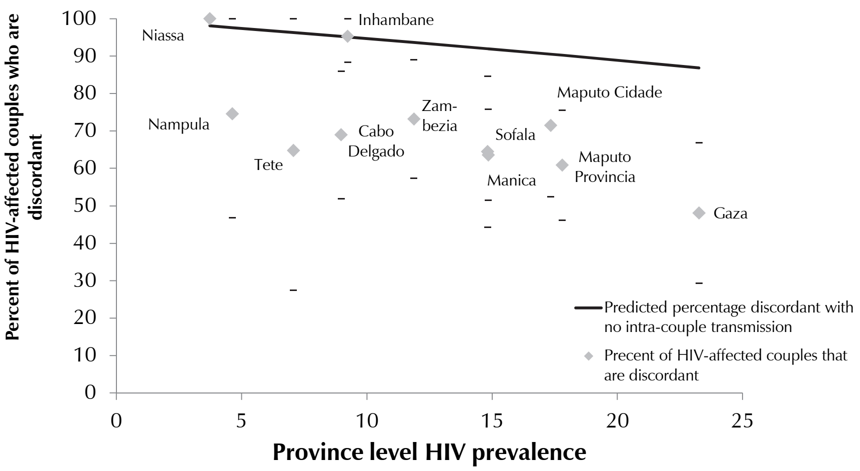
One additional factor that directly impacts levels of couple discordance and also could indirectly affect many of the variables in a multivariate model is the HIV prevalence in the general population of the area in which the couple resides. The proportion of couples who are concordant positive is expected to be higher in communities with high HIV prevalence than in those with low HIV prevalence; any exposure to risk of HIV transmission that either partner has in a high prevalence community is more likely to be with someone who is HIV-positive than in a low-prevalence community. In this analysis of couples in which one partner is already HIV-positive, higher HIV prevalence in the community enters into the conceptual framework primarily by increasing the risk of HIV transmission associated with sexual or other risk behaviors outside the marriage. HIV prevalence in the general population may also indirectly affect several of the variables in the conceptual framework such as knowledge of HIV status and condom use.

Bishop and Foreit (2010) employ mathematical probabilities to predict how general HIV prevalence is associated with HIV status among couples. According to their model, if there were no intracouple transmission of HIV, that is, if all individuals became infected through a means other than sexual intercourse with their spouse, then each member of the couple would have an independent chance of having HIV, and the probability that a couple would be discordant could be calculated as the probability that one member is infected (p) multiplied by the probability that the other member is not infected (1-p), where p is the HIV prevalence in their area.

[12] The sample included no concordant positive couples in Niassa province.

Figure 7 applies this principle to predict the percentage of couples who are discordant among HIV-affected couples as a function of HIV prevalence. The line in the figure presents the predicted prevalence of discordance, assuming that all infection comes from outside the marriage.[13] As HIV prevalence increases, the predicted percentage of HIV-affected couples that are discordant decreases. In other words, the percentage of these couples who are both infected with HIV increases. The points in the figure present the observed percentages of discordant couples among HIV-affected couples in each of the 11 provinces in Mozambique. The gap between the points and the line is statistically significant for 6 of the 11 provinces. This gap illustrates that the percentage of HIV-affected couples who are discordant in 6 provinces is significantly lower than predicted under the assumption that all HIV infection comes from outside the marriage. Said another way, the proportion of HIV-affected couples is higher than predicted, indicating two possibilities: (1) that transmission from one member of a couple to the other is an important source of infection and (2) that couples are more likely to be formed by people with similar risk-profiles, increasing the probability that two people enter into a relationship already infected with HIV from a previous exposure. Both of these possibilities may be contributing to the higher than expected percentage of concordant positive couples.

Figure 7: Observed and Predicted Percent of HIV-Affected Couples Who Are Discordant



Note : In Niassa, 100% of HIV-affected couples are discordant, so the estimated standard error is zero, and the confidence interval is (100%, 100%).

Figure 7 also illustrates another important point. Consistent with the overall trend for the predicted levels of discordance, the observed levels of discordance decrease with increasing HIV prevalence; however, some provinces with similar levels of HIV prevalence have different levels of discordance among infected couples. For example, Inhambane and Cabo Delgado both have a prevalence of HIV of around 9 percent. By contrast, the percentage of HIV-affected couples who are discordant is 95 percent (95% CI 88%, 100%) in Inhambane and 69 percent (95% CI 52%, 86%) in Cabo Delgado. This indicates that factors other than HIV prevalence in the general population influence the percentage of HIV-affected couples who are concordant positive.

For these reasons, HIV prevalence from the area in which the couple lives was included in the list of variables to consider for multivariate analysis. HIV prevalence was calculated among the general population of men and women age 15-64 in the community in which the couple resides at the lowest level at which the data

[13] The equation for the curve is y=2(1-x)/(2-x) where x is the HIV prevalence among adults age 15-64 in the couple's province. This equation is simplified from the equation for the probability of being discordant divided by the probability of being discordant plus the probability of being discordant positive, or $y=2x(1-x)/[2x(1-x)+x^2]$.

were representative in the INSIDA sample: the province. Couples were then categorized according to whether HIV prevalence in their province is less than 5 percent, 5 to 14.9 percent, or 15 percent or higher.

VI. Factors associated with HIV discordance among couples

This section investigates which factors are associated with HIV discordance among couples in Mozambique. Descriptive percent distributions are presented, followed by two multivariate models to examine the independent relationships between the variables described above and couple discordance, after controlling for all other variables in the model. In order to focus on factors associated with the HIV infection of the "2nd partner" as shown in the conceptual framework, the multivariate models are restricted to HIV-affected couples, that is, couples in which at least one member is already infected.

Bivariate associations

Table 11 provides information on HIV status of couples and the percentage of couples who are discordant by different characteristics. P-values of chi-square statistics for each of the crosstabulations are shown. Appendix Table D.1 shows the 95% confidence interval for each of these percentages. Appendix Table D.2 shows that the sample in the couples file is similar to all married individuals in the INSIDA main database in terms of risk factors for HIV transmission. The numbers in Table 11 can help describe which couples are more likely to be HIV-affected and which couples are more likely to be discordant. Overall, concordant negative couples constitute the largest group of couples for each characteristic, and the percentage of couples that are discordant does not exceed 22 percent in any category. The following variables are significantly associated with HIV status among couples at the $p<0.05$ level: mean age of the couple; woman's education; wealth; residence; region; STI in the past 12 months (in either or both partners); and HIV prevalence in the couple's province of residence.

In order to understand how the percentages of concordant positive and discordant couples vary by each characteristic, it is necessary to look at the individual percentages. Several characteristics with a significantly higher proportion of concordant positive couples also tend to have a higher proportion of discordant couples, including wealthier couples, those living in the central and southern regions, those with an uncircumcised male partner, those who used a condom at last sex, those in which either member has had an HIV test and received the results, and those who live in areas of higher HIV prevalence. However, the trends in concordant positivity by given background characteristics are not always the same as the trends in discordance by those same characteristics. For example, the proportion of couples who are discordant is significantly higher in urban areas than in rural areas, and is higher among couples who have been married less than five years than among couples married for 20 years or longer. However, the proportions of couples who are concordant positive by urban/rural residence or duration of union are not significantly different.

On the other hand, while there are significant differences in the proportion of couples who are concordant positive by education, number of unions, or history of STIs, the percentage of couples who are discordant does not differ by these variables (see Table 11). In addition, the percentage of all couples who are discordant is not associated in bivariate analysis with age, type of union, time since last sex between the couple, extramarital partners, time away from home, use of commercial sex workers by the male partner, or risk factors for nonsexual transmission.

Table 11 Percent distribution of couples by HIV status and percentage of couples who are discordant according to background characteristics, Mozambique 2009

Characteristic	HIV status of the couple: Both positive	Man+ woman-	Woman+ man-	Both negative	Total	*p-value*[1]	Percent of couples that are discordant	Number of couples
			Demographic factors					
Mean age of couple						*0.036*		
Under 30	4.1	4.7	6.1	85.1	100.0		10.8	1,029
30-39.9	6.3	6.8	5.3	81.5	100.0		12.1	839
40+	4.2	3.7	3.7	88.3	100.0		7.4	780
Age difference						*0.282*		
Woman older than man or couple same age	6.4	6.3	6.7	80.6	100.0		13.0	315
Man 1-4 years older	3.6	5.0	5.7	85.6	100.0		10.8	963
Man 5+ years older	5.4	4.8	4.4	85.4	100.0		9.2	1,370
Woman's education						*0.020*		
No education	3.5	4.3	3.8	88.4	100.0		8.1	947
Primary	5.4	5.5	5.6	83.6	100.0		11.1	1,499
Secondary +	7.8	5.8	7.9	78.5	100.0		13.7	202
Man's education						*0.079*		
No education	2.2	4.3	6.2	87.3	100.0		10.5	374
Primary	4.8	4.9	4.7	85.6	100.0		9.6	1,848
Secondary +	7.6	6.5	6.2	79.7	100.0		12.7	426
Couple's education level						*0.122*		
Both no education	1.6	4.0	4.7	89.7	100.0		8.7	295
Both primary	4.7	5.2	5.1	85.0	100.0		10.3	1,185
Both secondary+	6.1	6.1	6.7	81.1	100.0		12.8	162
Man more educated than woman	5.5	5.0	4.2	85.3	100.0		9.2	887
Woman more educated than man	7.9	5.3	12.0	74.7	100.0		17.4	119
Wealth quintile, grouped						*0.000*		
Wealthiest 40%	9.3	7.6	6.9	76.2	100.0		14.5	925
Poorest 60%	2.5	3.7	4.2	89.6	100.0		7.9	1,723
Residence						*0.000*		
Urban	7.4	7.1	8.2	77.2	100.0		15.3	725
Rural	3.9	4.3	4.0	87.8	100.0		8.3	1,923
Region						*0.000*		
North	1.5	2.3	2.6	93.6	100.0		4.9	995
Central	5.4	5.7	6.1	82.7	100.0		11.8	1,159
South	10.3	9.1	8.1	72.5	100.0		17.2	494
Province						*0.000*		
Niassa	<0.1	2.4	3.2	94.4	100.0		5.6	173
Cabo Delgado	3.6	5.2	2.8	88.4	100.0		8.0	221
Nampula	1.2	1.2	2.3	95.3	100.0		3.5	602
Zambezia	5.0	6.4	7.2	81.4	100.0		13.6	513
Tete	2.5	2.3	2.4	92.8	100.0		4.7	251
Manica	8.2	8.3	6.1	77.4	100.0		14.3	180
Sofala	7.6	6.0	7.8	78.6	100.0		13.8	214
Inhambane	0.5	6.1	3.8	89.6	100.0		9.9	125
Gaza	22.1	11.4	9.1	57.4	100.0		20.5	113
Maputo Provincia	10.8	9.4	7.4	72.4	100.0		16.8	136
Maputo Cidade	8.8	9.6	12.5	69.0	100.0		22.1	120
		Factors associated with sexual transmission within the couple						
Number of unions						*0.004*		
Both married only once	3.1	4.6	5.0	87.4	100.0		9.6	1,324
Man >1, woman once	5.7	6.8	3.0	84.5	100.0		9.8	554
Woman >1, man once	8.7	6.7	7.7	76.9	100.0		14.4	189
Both more than once	7.0	4.1	6.7	82.3	100.0		10.7	581
Duration of current union						*0.000*		
0-4	5.3	4.9	8.8	80.9	100.0		13.8	747
5-9	5.8	5.4	5.5	83.3	100.0		10.9	602
10-19	4.8	5.4	3.3	86.4	100.0		8.7	729
20+	2.8	3.5	2.5	91.3	100.0		6.0	496
Type of union						*0.900*		
Non-polygynous	4.6	5.3	5.1	85.0	100.0		10.4	2,161
Polygynous	6.4	4.9	4.8	83.9	100.0		9.7	333
Disagree	5.7	2.7	6.6	85.0	100.0		9.3	151
Time since last sex with spouse						*0.073*		
<1 month	4.9	5.1	5.4	84.6	100.0		10.5	2,047
1-5 months	7.2	5.4	5.7	81.7	100.0		11.0	299
6+ months	2.2	5.1	2.5	90.3	100.0		7.5	291
Male circumcision						*0.000*		
Man not circumcised	7.1	6.9	6.7	79.3	100.0		13.6	1,241
Man circumcised	2.9	3.5	3.8	89.8	100.0		7.3	1,402
Woman: STI or STI symptoms in past 12 months						*0.000*		
No	4.5	4.9	5.2	85.5	100.0		10.1	2,534
Yes	13.6	9.4	4.1	72.9	100.0		13.6	114
Man: STI or STI symptoms in past 12 months						*0.085*		
No	4.6	5.2	5.1	85.0	100.0		10.3	2,506
Yes	9.5	2.0	6.0	82.6	100.0		8.0	142
Couple: STI or STI symptoms in past 12 months						*0.000*		
No	4.2	5.0	5.2	85.6	100.0		10.2	2,408
Yes	11.8	5.5	5.0	77.7	100.0		10.5	240
Condom use at last sex with spouse/partner						*0.000*		
No	4.6	5.2	4.8	85.5	100.0		9.9	2,563
Yes	13.9	2.1	17.1	66.9	100.0		19.2	85
Couple ever tested for HIV and received result						*0.000*		
Both no	3.5	4.1	4.0	88.3	100.0		8.2	1,688
Either or both yes	7.3	6.7	7.1	78.9	100.0		13.8	960

Continued…

Table 11—*Continued*

Characteristic	HIV status of the couple: Both positive	Man+ woman-	Woman+ man-	Both negative	Total	*p-value*[1]	Percent of couples that are discordant	Number of couples
Factors associated with sexual transmission from outside the couple								
HIV prevalence in the couple's province (general population age 15-64)						*0.000*		
<5%	0.9	1.5	2.5	95.1	100.0		4.0	774
5-14%	4.8	5.7	5.4	84.1	100.0		11.1	1,504
15%+	13.6	10.1	9.6	66.7	100.0		19.7	369
Condom used at last sex with non-spousal partner						*0.513*		
Yes	7.8	7.2	5.6	79.4	100.0		12.9	157
No	5.6	5.8	4.7	83.9	100.0		10.5	364
No non-spousal sex in past 12 months	4.5	4.8	5.2	85.5	100.0		10.0	2,128
Non-sexual transmission factors								
Injection drug use, tattoos, surgery, blood transfusions						*0.396*		
Either or both yes	7.5	5.6	5.5	81.4	100.0		11.1	203
Neither	4.7	5.0	5.1	85.2	100.0		10.1	2,445
Total	**4.9**	**5.1**	**5.2**	**84.9**	**100.0**		**10.2**	**2,468**
Number of couples	**129**	**134**	**136**	**2,249**			**271**	**2,648**

Note: Table includes 74 couples with information missing on duration of union, 3 couples with information missing for type of union, 11 couples with information missing on time since last sex with spouse, and 5 couples with information missing for male circumcision.
[1] P-value based on Pearson chi-square

Multivariate modeling

This analysis includes two multivariate logistic regression models. The first model compares concordant positive couples with all discordant couples, regardless of whether the discordant couple is male discordant or female discordant. This model is a binomial (two-category) logistic regression because the outcome variable has two categories: concordant positive vs. discordant. The second model, a multinomial, or multiple-category, logistic regression compares concordant positive couples separately to male discordant and female discordant couples.

The first variables included in each model were the most proximate variables, or those most closely related to couple discordance. Proximate determinants are shown as those closest to the right side of the conceptual framework in Figure 6. Less proximate determinants that were hypothesized to be associated with discordance through other variables—for example, time away from home, which is hypothesized to operate through coital frequency–were not included in the models. All demographic factors were included in each model so that the adjusted odds ratios and relative risk ratios would be independent of the effects of factors such as age and wealth.

For some variables, several versions were considered to determine which formulations were most appropriate for the binomial vs. multinomial models. For example, because GUD appears to be the type of STI most closely associated with the risk of HIV transmission, experience of genital sores alone was first tested for an association with couple concordance. A second variable for STI symptoms indicating whether the respondent said yes to any of the three STI questions was also tested, and was found to be much more significantly related to increased couple concordance, suggesting that genital discharge or unspecified non-ulcerative STIs are also associated with increased HIV transmission among HIV-affected couples in Mozambique. This latter variable was included in the models as a couple-level variable in the binomial logistic model (either member of couple reported STI symptoms vs. neither), and as separate variables for males and females in the multinomial logistic model. Duration of sexual union was determined to be most relevant for the binomial model, while the variable on number of unions was more relevant for the multinomial model separating male discordance and female discordance. Several ways of estimating the impact of HIV prevalence in the general population on the level of couple discordance were also examined, but none of these variables were more strongly associated with couple discordance than the simple level of HIV prevalence in the general population in the province.[14] The variable

[14] Average HIV prevalence for men and women in the province was entered as a linear term; levels of male and female HIV prevalence in the province were multiplied; and quadratic terms were applied to approximate the simulations of Bishop and Foreit (2010) in which couple HIV status is defined as the probability of one member being infected multiplied by the probability that the second member is infected.

with three categories for low, medium, and high prevalence, as described above, was therefore used for ease of interpretation. To examine possible associations between pregnancy and HIV transmission, a variable was created to capture whether the woman in each couple had given birth during the duration of the union.[15] There was no association between having a recent pregnancy (ending in a live birth) and discordance in univariate or multivariate analysis, and it was not included in the models presented here.

All models were tested for collinearity (when two or more independent variables are highly correlated with each other), and collinear variables were excluded from the models. Because duration of union and number of unions were found to be collinear, the decision was made to include only one of these variables in each model. (As mentioned above, duration of union was included in the binomial model, and number of unions of each member in the couple was used in the multinomial model). Urban/rural residence and region were also found to be collinear with HIV prevalence in the province, and so the former two were excluded from the models. Results with a p-value of <0.05 are considered to be significantly associated with couple discordance; variables with a p-value of <0.10 are considered to have marginally significant association. Tables 12 and 13 note when p-values are <0.10 and <0.05.

Table 12 displays the results of the binomial logistic regression comparing concordant positive couples with discordant couples (including both male discordant and female discordant couples together). This model seeks to identify factors that may be associated with protecting the HIV-negative member of a discordant couple from becoming infected with HIV. In this model, an odds ratio of less than 1.0 means that a factor is associated with a lower likelihood of a couple being discordant and, conversely, a higher likelihood of a couple being concordant positive. Therefore, odds ratios of less than 1.0 indicate risk factors for seroconversion of the HIV-negative partner in a discordant couple. Although it is impossible to establish causality in a cross-sectional study (or even determine which came first, the factor or the outcome), odds ratios greater than 1.0 are consistent with protecting the HIV-negative status of the uninfected partner in a discordant couple.

Most of the variables in the model were not found to have a significant association with couple discordance. In the univariate model, couples in which the man had more education than the woman were less likely than couples in which both members had no education to be discordant, that is, they were marginally more likely to be concordant positive (p<0.10). No education variables were significant in the multivariate model. Couples in the wealthiest two quintiles were less likely to be discordant than couples in the poorest three quintiles (p<0.05); however, this association lost significance after controlling for the HIV prevalence of the couple's province and other factors. Age, although not significant in the univariate analysis, reached marginal significance (p<0.10) in the multivariate model. Older couples, specifically those with a mean age of 40 or older, were less likely to be discordant than the youngest couples, those with a mean age of less than 30 years. Couples in which either member reported having an STI or symptoms of an STI in the past 12 months were less likely to be discordant than couples with no STIs. This association was significant in both univariate and multivariate models (p<0.05). Therefore, STIs appear to be a risk factor for transmission of HIV within a couple. Notably, although the direction of the relationship between male circumcision and discordance suggests that couples may be more likely to be discordant if the man is circumcised (adjusted OR 1.41), making circumcision a protective factor, circumcision is not found to be significantly associated with discordance in either the univariate or multivariate binomial logistic model.

[15] There are several limitations to this approach, particularly that it is not possible to determine whether the father of the baby is the same as the woman's current spouse. Also there is no information on pregnancies that did not end in a live birth, so pregnancies that were miscarried (which may be more common among HIV-positive women who are likely to have decreased fecundity) or terminated cannot be accounted for.

Table 12 Logistic regression results of couple discordance (versus concordant positive status) among couples in which at least one partner is HIV-positive: unadjusted and adjusted odds ratios, Mozambique 2009

Odds of couple discordance (concordant positive = reference)	OR	Adjusted OR
Demographic factors		
Mean age of couple		
Under 30 (ref)	1.00	1.00
30-39.9	0.73	0.58
40+	0.68	0.38*
Age difference		
Woman older than man or couple same age (ref)	1.00	1.00
Man 1-4 years older	1.48	1.50
Man 5+ years older	0.84	0.94
Couple's education level		
Both no education (ref)	1.00	1.00
Both primary	0.40	0.48
Both secondary+	0.39	0.50
Man more educated than woman	0.31*	0.31
Woman more educated than man	0.41	0.43
Wealth quintile, grouped		
Wealthiest 40%	0.49**	0.60
Poorest 60% (ref)	1.00	1.00
Factors associated with sexual transmission within the couple		
Duration of current union		
0-4 (ref)	1.00	1.00
5-9	0.72	0.79
10-19	0.69	0.98
20+	0.83	1.86
Type of union		
Non-polygynous (ref)	1.00	1.00
Polygynous	0.66	1.35
Disagree	0.73	1.04
Time since last sex with spouse		
<1 month (ref)	1.00	1.00
1-5 months	0.72	0.79
6+ months	1.60	2.19
Male circumcision		
Man not circumcised (ref)	1.00	1.00
Man circumcised	1.30	1.41
Couple: STI or STI symptoms in past 12 months		
No (ref)	1.00	1.00
Yes	0.37**	0.40**
Condom use at last sex with spouse/partner		
No (ref)	1.00	1.00
Yes	0.64	0.88
Factors associated with sexual transmission from outside the couple		
HIV prevalence in the couple's province (general population 15-64)		
<5% (ref)	1.00	1.00
5-14%	0.54	0.52
15%+	0.34	0.50
Condom used at last sex with non-spousal partner		
No non-spousal sex in past 12 months (ref)	1.00	1.00
Yes	0.75	0.97
No	0.85	0.82
Non-sexual transmission factors		
Injection drug use, tattoos, surgery, blood transfusions		
Both no (ref)	1.00	1.00
Either or both members of couple	0.68	0.74
Number of couples	**400**	**384**

Note: Table includes 10 couples with information missing on duration of union, and 1 couple with information missing on time since last sex with spouse.
* Indicates that the odds ratio or adjusted odds ratio is statistically significantly different from the reference category at the p<0.10 level.
** Indicates that the odds ratio or adjusted odds ratio is statistically significantly different from the reference category at the p<0.05 level.

The results for the multinomial logistic regression model are found in Table 13. In this model, two separate comparisons are made. First, male discordant couples are compared with concordant positive couples. Second, female discordant couples are compared with concordant positive couples. The table includes both unadjusted relative risk ratios from the univariate models and adjusted relative risk ratios from the multivariate model. As in Table 12, a relative risk ratio of less than 1.0 indicates a possible risk factor for transmission. More factors were significantly associated with discordance in the multinomial model, which splits discordant couples into male discordant and female discordant categories, than in the binary logistic regression model presented in Table 12. This finding indicates that factors associated with FTM transmission may differ from factors associated with MTF transmission.

Table 13 Multinomial logistic regression results of couple status: 1) Man HIV+, woman HIV-; 2) Man HIV-, Woman HIV+; versus 3) Both HIV-positive among couples in which at least one partner is HIV-positive: unadjusted and adjusted relative risk ratios, Mozambique 2009

	Univariate		Multivariate	
	1) Man HIV+, Woman HIV- vs. 3) Both HIV+ (unadjusted)	2) Man HIV-, Woman HIV+ vs. 3) Both HIV+ (unadjusted)	1) Man HIV+, Woman HIV- vs. 3) Both HIV+ (adjusted)	2) Man HIV-, Woman HIV+ vs. 3) Both HIV+ (adjusted)
Characteristic	RRR	RRR	aRRR	aRRR
Demographic factors				
Mean age of couple				
Under 30 (ref)	1.00	1.00	1.00	1.00
30-39.9	0.94	0.57	1.21	0.50*
40+	0.77	0.60	1.08	0.54
Age difference				
Woman older than man or couple same age (ref)	1.00	1.00	1.00	1.00
Man 1-4 years older	1.42	1.53	1.39	1.38
Man 5+ years older	0.90	0.78	0.94	0.95
Couple's education level				
Both no education (ref)	1.00	1.00	1.00	1.00
Both primary	0.44	0.37*	0.67	0.45
Both secondary+	0.40	0.38	0.49	0.45
Man more educated than woman	0.36	0.26**	0.48	0.28*
Woman more educated than man	0.27	0.52	0.36	0.53
Wealth quintile, grouped				
Wealthiest 40%	0.55**	0.44**	0.63	0.42**
Poorest 60% (ref)	1.00	1.00	1.00	1.00
Factors associated with sexual transmission within the couple				
Number of unions				
Both married only once (ref)	1.00	1.00	1.00	1.00
Man >1, woman once	0.79	0.32**	1.12	0.36*
Woman >1, man once	0.52	0.54	0.57	0.76
Both more than once	0.39**	0.58	0.36**	0.60
Type of union				
Non-polygynous (ref)	1.00	1.00	1.00	1.00
Polygynous	0.66	0.67	0.92	1.72
Disagree	0.42	1.04	0.43	1.93
Time since last sex with spouse				
<1 month (ref)	1.00	1.00	1.00	1.00
1-5 months	0.73	0.72	0.78	0.92
6+ months	2.23	1.01	2.88*	1.45
Male circumcision				
Man not circumcised (ref)	1.00	1.00	1.00	1.00
Man circumcised	1.23	1.37	1.47	1.51
Woman: STI or STI symptoms in past 12 months				
No (ref)	1.00	1.00	1.00	1.00
Yes	0.64	0.26**	0.87	0.26**
Man: STI or STI symptoms in past 12 months				
No (ref)	1.00	1.00	1.00	1.00
Yes	0.18**	0.57	0.19**	0.75
Couple ever tested for HIV and received results				
Both no (ref)	1.00	1.00	1.00	1.00
Either or both yes	0.77	0.84	1.00	1.49
Factors associated with sexual transmission from outside the couple				
HIV prevalence in the couple's province (general population 15-64)				
<5% (ref)	1.00	1.00	1.00	1.00
5-14%	0.75	0.42	0.77	0.40
15%+	0.47	0.26*	0.54	0.47
Condom used at last sex with non-spousal partner				
Yes	0.88	0.63	1.31	0.84
No	0.98	0.73	1.00	0.76
No non-spousal sex in past 12 months (ref)	1.00	1.00	1.00	1.00
Non-sexual transmission factors				
Injection drug use, tattoos, surgery, blood transfusions				
Either or both members of couple	0.70	0.67	0.94	0.82
Neither (ref)	1.00	1.00	1.00	1.00
Number of couples	**400**	**400**	**398**	**398**

Note: Table includes 2 couples with information missing on time since last sex with spouse
* Indicates that the relative risk ratio or adjusted relative risk ratio is statistically significantly different from the reference category at the p<0.10 level.
** Indicates that the relative risk ratio or adjusted relative risk ratio is statistically significantly different from the reference category at the p<0.05 level.

Older age is marginally associated with lower discordance when comparing female discordant with concordant positive couples in the multivariate model. Specifically, couples with a mean age between 30 and 40 years are less likely to be female discordant than concordant positive compared with couples with mean age under 30 years ($p<0.10$). There is no significant association between age of the couple and the likelihood that a couple is male discordant versus concordant positive. After controlling for other factors, couples in which the man has a higher level of education than the woman are marginally less likely to be female discordant than concordant positive compared with couples in which neither member has any education ($p<0.10$). In univariate analysis, wealthier couples are less likely than poorer couples to be male discordant versus concordant positive. Wealthier couples are also less likely to be female discordant versus concordant positive. In the multivariate model, household wealth remains associated with increased risk of a couple being concordant positive as opposed to female discordant ($p<0.05$), but not of a couple being concordant positive as opposed to male discordant.

Couples in which the man has been married more than once but the woman has been married only once are less likely to be female discordant than concordant positive compared with couples in which both members have been married only once. That is, prior marriage for men in couples where the woman has been married only once appears to be associated with an increased risk of HIV-infection in the man ($p<0.05$ univariate, $p<0.10$ multivariate). On the other hand, couples in which both the man and the woman have been married more than once are less likely than couples in which both members have been married only once to be male discordant as opposed to concordant positive ($p<0.05$ in univariate and multivariate models). In these couples, prior marriage of both members appears to be associated with increased HIV infection in the woman. The model also assessed the likelihood of discordance among couples who had sexual intercourse with each other in the past month, those who had sex in the past six months but not in the past month, and those who did not have sex with each other in the past six months. Couples that had not had sex with each other in the past six months were marginally more likely than couples who had sex in the past month to be male discordant versus concordant positive ($p<0.10$). Time since last sex within the couple was not significantly associated with the likelihood of being female discordant versus concordant positive.

The multinomial model once again shows a significant association between STIs in a couple and the probability that a couple is concordant positive. Couples in which the woman had an STI or symptoms of an STI in the past 12 months were less likely than those in which the woman did not have an STI to be female discordant as opposed to concordant positive ($p<0.05$ in both univariate and multivariate models). This means, for couples in which the woman is HIV-positive, her husband is more likely to be HIV-positive if she reported an STI. Similarly, couples in which the man had an STI or symptoms of an STI were less likely than those in which the man did not have an STI to be male discordant versus concordant positive ($p<0.05$ in both univariate and multivariate models). For couples in which the man is HIV-positive, his wife is more likely to be HIV-positive if he reported an STI. In sum, the data show that an STI in the HIV-positive member may be associated with transmission of HIV within a couple. The data also show some evidence of an association between the HIV-negative partner having an STI and susceptibility to HIV acquisition, but the relative risk ratios are much closer to 1.0 (no association), and they are not statistically significant in either the univariate or multivariate models.

Finally, in univariate analysis higher HIV prevalence in the general population (15 percent or higher compared with less than 5 percent) is associated with a lower probability that a couple is male discordant than concordant positive, but the significance is weak ($p<0.10$), and disappears once controlling for other factors. As addressed above, HIV prevalence in the province was collinear with both urban/rural residence and region. Including one or the other instead of HIV prevalence in the province resulted in no significant differences in the binomial model. Neither residence nor region was significant in the multinomial model (included independently). Including urban/rural residence instead of HIV prevalence in the province resulted in one minor change: the p-value for “disagree” on type of marriage becomes marginally significant ($p<0.10$).

Box 5 Key multivariate findings

Comparing discordant couples with concordant positive couples:

- Younger couples (mean age < 30) are marginally more likely to be discordant than older couples (mean age 40 years or more). ($p<0.10$)
- Couples in which neither member has had an STI in the past year are more likely to be discordant than couples in which either member has had an STI. ($p<0.05$)

Comparing <u>male discordant</u> couples with concordant positive couples:

- Couples who have not had sex with each other in the past 6 months are marginally more likely to be male discordant than couples who have had sex in the past month. ($p<0.10$)
- Couples in which the man has not had an STI in the past 12 months are more likely to be male discordant than couples in which the man has had an STI. ($p<0.05$)

Comparing <u>female discordant</u> couples with concordant positive couples:

- Younger couples (mean age < 30) are marginally more likely to be female discordant than middle-aged couples (mean age 30-40). ($p<0.10$)
- Poorer couples are more likely to be female discordant than wealthier couples. ($p<0.05$)
- Couples in which the woman has not had an STI in the past year are more likely to be female discordant than couples in which the woman has had an STI. ($p<0.05$)

Overall the only consistent risk factor for couples being concordant positive rather than discordant is STIs. If either member of the couple has had an STI, they are more likely to both be positive vs. discordant; if the male partner had an STI, they are more likely to both be positive vs. male discordant; and if the female partner had an STI, they are more likely to both be positive vs. female discordant.

VII. CONCLUSIONS

There were approximately 433,000 discordant couples in Mozambique as of 2009, or around one in every ten couples. HIV testing among couples is relatively low: both members of the couple have been tested for HIV in 11 percent of all couples and in 15 percent of discordant couples. This means that there are at least 368,000 couples in Mozambique who are discordant but do not know it. According to the estimated rates of HIV transmission within discordant couples published in the scientific literature, this population is at high risk for new HIV infections. In addition, the Positive Prevention program should address the needs of the one-third of their target population who are married to or living with someone who is HIV-negative.

Women are much more likely than men to have ever been tested for HIV and received the results (31 percent of women versus 16 percent of men in the couples file), which may be related to the inclusion of HIV testing in ANC services. Condom use at last sex is higher among couples with exposure to HIV testing, but this does not prove that increased condom use was caused by having received an HIV test and the result. Another potential explanation could be that people who are willing to go for an HIV test may also be motivated to participate in other preventive behaviors. This report also shows that among men and women who have ever been tested for HIV, HIV-positive status among women but not men is associated with higher condom use by the couple. Qualitative research into decisions surrounding condom use in discordant couples could help identify the reasons for this finding.

According to the multivariate analysis, HIV discordance of couples in Mozambique does not appear to have a strong association with whether or not the couple is polygynous, the amount of time passed since the couple last had sexual intercourse with each other, or risk factors for non-sexual transmission of HIV. Although there are some differences in the HIV status of couples by characteristics of interest, as Bishop and Foreit (2010) found in their investigation of couple discordance across ten sub-Saharan African countries, the differences do not outline a profile that makes discordant couples easy to distinguish from the general population.

Results from the binomial and multinomial logistic regression models show that factors associated with transmission from women to men in a couple do differ from factors associated with transmission from men to women. The only factor that is consistently associated with discordance among couples is whether one or both partners reported an STI or STI symptoms in the past year. Findings from this analysis confirm that, although the cross-sectional nature of the data does not allow us to determine causality, STI symptoms in the HIV-positive partner are significantly associated with an increased risk of HIV transmission, even after controlling for all other factors. This association holds true regardless of whether the HIV-positive partner is male or female.

VIII. LIMITATIONS

Limitations due to the sample

The first limitation of this analysis is that the couples file does not include all men and women age 15-64 who were interviewed during the 2009 Mozambique INSIDA and who said that they were currently married or living together with someone as if married. The analysis excluded all couples who were not living together at the time of the survey, couples in which one or both members were outside of the 15-64 age range, and other couples for which information was missing for a variety of reasons covered in Section III. The requirement for inclusion in the couples file that spouses be cohabitating may systematically exclude polygynous couples and those whose partner is temporarily away—a particular concern for spouses of miners, who are considered to be at higher risk for HIV than the general population (CNCS, 2009). It is possible, therefore, that this analysis is not representative of all couples in Mozambique. However, a comparison of the samples included in the main INSIDA database and in the couples file indicated that the individuals in the couples file were not significantly different from those in the main database.

Couples analyzed in this report only include those in relatively stable, heterosexual, cohabitating partnerships. Excluded from this analysis are short-term or casual partnerships or long-term extra-marital partners that may be of particular interest to some prevention programs.[16]

The couples file included only 426 unweighted couples in which one or both members are HIV-positive. The power to detect statistically significant associations with this number of observations is low.

Limitations due to the information collected

Some information useful for this analysis was not collected directly by the questionnaire. The duration of the current sexual union was not collected for all respondents. Information for this variable had to be taken from one of two questions in the questionnaire, and some women were not eligible to answer either question.[17] For ethical reasons, INSIDA also did not ask if the respondents knew their HIV status, and so analyses of knowledge of status in this report rely on an imperfect proxy for knowledge of status, i.e., whether the respondent has ever been tested for HIV and received the result of the last test.

The INSIDA did not test respondents for STI infection, instead relying on self report rather than laboratory diagnosis, although as shown in Section II of this report, reported STI symptoms are sometimes found to have a stronger association with risk of HIV transmission than laboratory confirmed infections.

As noted in Section II, viral load appears to be a key factor in the risk of HIV transmission between couples. As the blood samples collected were not designed for viral load testing, and no information was collected on ARV use, which may decrease an individual's viral load, the information on factors associated with HIV transmission among HIV-affected couples is clearly incomplete.

[16] Information on the prevalence of these types of partnerships may be found in the 2009 INSIDA final report (INS, INE, and ICF Macro, 2010).

[17] Women provided information on time since first sex with their husband if they had sex with their husband in the past 12 months. If a woman did not have sex with her husband in the past 12 months, information is still available on duration of sexual union only if she has been married only once and began to have sexual intercourse when she got married. If neither of these conditions is true then the woman provided no information about the duration of her current sexual union, and the couple is assigned a value of missing on the duration of union variable.

Limitations due to study design

The data come from a cross-sectional survey, so in concordant positive couples it is impossible to know which partner was infected first. A cleaner, more powerful analysis would use longitudinal data to examine factors associated with discordant couples seroconverting to concordant positive couples. In such an analysis, it would be possible to compare HIV-positive men, for example, whose wives became HIV-positive over a certain period of time with HIV-positive men whose wives did not become infected. Characteristics of both the male index partners and their wives could be analyzed for factors associated with both transmission and acquisition of HIV within the couple. In this analysis, male discordant couples are not strictly comparable to concordant positive couples given that in male discordant couples, the man is the index infection in all of the couples, whereas in concordant positive couples, the index partner could have been either the man or the woman. The use of this comparison may have diluted some of the results of the analysis.

Results from the multivariate models show that couples in which either member has an STI are more likely to be concordant positive rather than discordant. Specifically, if the HIV-positive partner reported STI symptoms, they are more likely to be in a concordant positive rather than a discordant couple. This suggests that the HIV-positive partner's having an STI increased transmission of HIV to his or her spouse. However, because the data are cross-sectional, it is not possible to know whether the HIV infection or reported STI symptoms occurred first. Additionally, HIV-positive individuals are more likely to acquire STIs or candida infections, which can cause symptoms easily confused with an STI, than HIV-negative individuals. While these results do not prove that HIV-positive people who acquire an STI are then more likely to transmit HIV to their partner, the data are highly suggestive.

Another disadvantage of the cross-sectional study design is that it is not possible to determine whether HIV-positive members of the couples acquired their infection before or after the beginning of this marriage. Because time in union since the first partner was infected with HIV is unknown, duration of marriage was used as a substitute, but the duration of union in most cases will be longer than the duration of union since infection. Certainly different behaviors and risk factors are associated with becoming infected with HIV before versus during the current marriage.

IX. DISCUSSION AND RECOMMENDATIONS

The findings in this report illustrate several important areas for policy and programs to consider. First, one in ten couples, or over 400,000 couples in Mozambique have discordant HIV status. The majority of discordant couples are residing in the central and southern regions of the country, and in rural areas, and the majority of them do not know that they are discordant and that they must take measures to reduce the high risk of infection of the negative partner. Although condom use is higher among couples in which one or both members are infected than among concordant negative couples, condom use in male discordant couples is less than two percent. Discordant couples constitute an important risk group for new HIV cases, but they are impossible to recognize using basic characteristics. In addition, fully one-third of adults age 15-64 who are living with HIV in Mozambique are in stable sexual unions with HIV-negative individuals.

The presence of STIs in a discordant couple increases the risk of HIV transmission. While STI screening and treatment represents an opportunity both to identify HIV discordant couples and to reduce further transmission of HIV within discordant couples, it has several important limitations: data from the Ministry of Health show that, at least in southern Mozambique, viral (incurable) and asymptomatic STIs were more common than bacterial STIs in HIV-positive patients enrolling in care, limiting the potential benefits of treatment for the reduction of transmission (MISAU, forthcoming). Gray et al. (1999) found similar limitations on the effectiveness of STI screening and treatment for decreasing HIV transmission. Screening for HIV infection among patients diagnosed with STIs may still represent an important opportunity to identify HIV-positive patients. Screening for syphilis or other STIs in patients enrolled in HIV care and treatment services may provide a marker for continuing high-risk sexual behavior that can be used both to target PP interventions to patients who need them and to help assess the impact of PP programs on condom use.

Serodiscordant couples make up a very important population at risk for new HIV infection in Mozambique due both to the size of the population (over 400,000 couples) and to the high risk of infection (1.2 to 19.0 per 100 person-years). Further, the HIV-positive partners in some of these couples are already enrolled in the national care and treatment program and are thus accessible to the national health system during their routine visits to health facilities. Although experiences from other countries have demonstrated the difficulty both of convincing partners to get tested for HIV, and of improving condom use among discordant couples, the potential of such interventions to reduce new infections at a population level in Mozambique is high.

Recommendations

Recommendations are focused on three key areas: improving knowledge of HIV status through HIV testing—for individuals and couples, helping uninfected partners in discordant couples remain HIV-negative by increasing condom use, and improving screening and surveillance of STIs.

This report shows that HIV testing among men and women who are currently married is low, as is the potential for discordant couples to know their HIV status. In order to increase knowledge of HIV status among individuals and couples, the authors recommend:

1) Expanding HIV counseling and testing, especially in the northern region where few HIV-infected people know their HIV status.

2) Increasing disclosure of HIV infection to partners, by expanding partner notification and improving partner testing in settings where HIV testing occurs.

3) Improving access to couples' HIV counseling and testing, especially in the southern and central regions and in rural areas, where the majority of discordant couples live and where knowledge of discordance is particularly low.

The scientific literature on couple discordance and CHCT show that (1) there is low awareness of the fact that couples can remain discordant for some time with the HIV-negative partner still being at risk of infection and (2) CHCT programs can be effective at promoting preventive behaviors such as condom use among couples. The authors therefore recommend:

4) Raising the population's awareness of the issue of HIV discordance among couples.

5) Increasing the demand for couples HIV counseling and testing within the current *Aconselhamento e Testagem em Saúde*[18] (ATS) system, including community-based ATS, by educating couples that both members must be tested and disclose their results to know if they are a discordant couple.

6) Updating the existing ATS curricula to train counselors to provide VCT to couples including correct causes of discordance, and ways to explain it to clients.

7) Adapting specific interventions for discordant couples to help them maintain their discordant status by promoting preventive measures such as consistent condom use.

As this analysis found HIV status in the spouses of HIV-positive individuals to be associated with reports of STI symptoms in the previous year, and as presence of an STI is known to increase risk of HIV transmission, the authors recommend:

8) Clarifying and strengthening STI screening recommendations among HIV-positive individuals in the ART treatment guidelines, and HIV screening recommendations within the STI treatment guidelines.

9) Improving existing surveillance systems to allow capture of data on STI diagnoses among patients in HIV care and on HIV testing among STI patients.

[18] Counseling and Testing in Health

REFERENCES

Allen, S, J Tice, P Van de Perre, A Serufilira, E Hudes, F Nsengumuremyi, J Bogaerts, C Lindan, and S Hulley. 1992. Effect of serotesting with counseling on condom use and seroconversion among HIV discordant couples in Africa. British Medical Journal 304: 1605-1609.

Allen, S, J Meinzen-Derr, M Kautzman, I Zulu, S Trask, U Fideli, R Musonda, F Kasolo, F Gao, and A Haworth. 2003. Sexual behavior of HIV discordant couples after HIV counseling and testing. AIDS 17: 733-740.

Allen, S, E Karita, E Chomba, DL Roth, J Telfair, I Zulu, L Clark, N Kancheya, M Conkling, R Stephenson, B Bekan, K Kimbrell, S Dunham, F Henderson, M Sinkala, M Carael and A Haworth. 2007. BMC Public Health 7:349-358.

Attia, S, M Egger, M Muller, M Zwalhen, N Low. 2009. Sexual transmission of HIV according to viral load and antiretroviral therapy: systematic review and meta-analysis. AIDS 23: 1397-404.

Auvert, B, D Talijaard, E lagarde, J Sobngwi-Tambekou, R Sitta, et al. 2005. Randomized, controlled intervention trial of male circumcision for reduction of HIV infection risk: the ANRS 1265 Trial. PLoS Med 2: e298.

Bailey, RC, S Moses, CB Parker, K Agot, I Maclean, JN Krieger, CF Williams, RT Campbell, JO Ndinya-Achola. 2007. Male circumcision for HIV prevention in young men in Kisumu, Kenya: a randomized controlled trial. Lancet 369: 643-656.

Bishop, M, and K Foreit. 2010. Serodiscordant Couples in Sub-Saharan Africa: What Do Survey Data Tell Us? Washington, DC: Futures Group, Health Policy Initiative, Task Order 1.

Bunnell, RE, J Nassozi, E Marum, J Mubangizi, S Malamba, B Dillon, J Kalule, J Bahizi, N Musoke and JH Mermin. 2005. Living with discordance: knowledge, challenges, and prevention strategies of HIV-discordant couples in Uganda. AIDS Care 17: 999-1012.

Bunnell, R, JP Ekwaru, P Solberg, N Wamai, W Bikaako-Kajura, W Were, A Coutinho, C Liechty, E Madraa, G Rutherford and J Mermin. 2006a. Changes in sexual behavior and risk of HIV transmission after antiretroviral therapy and prevention interventions in rural Uganda. AIDS 20: 85-92.

Bunnell, R, J Mermin, and KMD Cock. 2006b. HIV prevention for a threatened continent: implementing positive prevention in Africa. Journal of the American Medical Association 296: 855--858.

Carpenter, LM, A Kamali, A Ruberantwari, SS Malamba and JA Whitworth. 1999. Rates of HIV-1 transmission within marriage in rural Uganda in relation to the HIV sero-status of the partners. AIDS 13: 1083-1089.

Centers for Disease Control and Prevention. 2007. Couples HIV Counseling and Testing Intervention and Curriculum, Module One: Background on Discordance. Accessed at http://www.cdc.gov/globalaids/Resources/prevention/chct.html, February28, 2011.

Centers for Disease Control and Prevention. 1998. HIV Prevention Through Early Detection and Treatment of Other Sexually Transmitted Diseases — United States. Morbidity and mortality weekly report 47 (No. RR-12):2.

Chissano, M and J Wheeler. 2009. Heroísmo e estigma: Motivações e barreiras á testagem em relação ao HIV no seio dos homens. Maputo, Mozambique: PSI.

Chomba, E, S Allen, W Kanweka, A Tichacek, G Cox, E Shutes, I Zulu, N Kancheya, M Sinkala, R Stephenson, A Haworth and the Rwanda Zambia HIV Research Group. 2008. Evolution of couples' voluntary counseling and testing for HIV in Lusaka, Zambia. Journal of Acquired Immune Deficiency Syndromes 47: 108-115.

Conselho Nacional de Combate ao SIDA (CNCS). 2009. Plano Estratégico Nacional de Resposta ao HIV e SIDA, 2010-2014. Maputo, Mozambique: CNCS.

de Gourville, EM, D Mabey, M Quigley, N Jack and B Mahabir. 1998. Risk factors for concordant HIV infection in heterosexual couples in Trinidad. International Journal of STE and AIDS 9:151-157.

de Vincenzi, I. 1994. A longitudinal study of human immunodeficiency virus transmission by heterosexual partners. European Study Group on Heterosexual Transmission of HIV. New England Journal of Medicine. 331: 341-346.

de Walque, D. 2007. Sero-discordant couples in five African Countries: Implications for Prevention Strategies. Population and Development Review 33: 501-523.

Deschamps, MM, JW Pape, A Hafner, WD Johnson, Jr. 1996. Heterosexual transmission of HIV in Haiti. Annals of Internal Medicine 125: 324-330.

Donnell, D, JF Baeten, J Kiarie, KK Thomas, W Stevens, CR Cohen, J McIntyre, JR Lingappa, C Celum, for the Partners in Prevention HSV/HIV Transmission Study Team. 2010. Heterosexual HIV-1 transmission after initiation of antiretroviral therapy: a prospective cohort analysis. The Lancet 375: 2092-2098.

Dunkle, KL, R Stephenson, E Karita, E Chomba, K Kayitenkore, C Vwalika, L Greenberg, S Allen. 2008. New heterosexually transmitted HIV infections in married or cohabiting couples in urban Zambia and Rwanda: an analysis of survey and clinical data. The Lancet 371: 2183-2191.

Ewayo, O, D de Walque, N Fort, G Gakii, RT Lester and EJ Mills. 2010. HIV status in discordant couples in sub-Saharan Africa: a systematic review and meta-analysis. The Lancet Infectious Diseases 10: 770-777.

Farquhar, C, JN Kiarie, BA Richardson, MN Kabura, FN John, RW Nduati, DA Mbori-Ngacha and GC John-Stewart. 2004. Antenatal couple counseling increases uptake of interventions to prevent HIV-1 transmission. Journal of the Acquired Immune Deficiency Syndromes 37: 1620-1626.

Fideli, US, SA Allen, R Musonda, S Trask, BH Hahn, H Weiss, J Mulenga, F Kasolo, SH Vermund, GM Aldrovandi. 2001. Virologic and immunologic determinants of heterosexual transmission of Human Immunodeficiency Virus Type 1 in Africa. AIDS Research and Human Retroviruses 17: 901-910.

Freeman, EE and JR Glynn. 2004. Factors affecting HIV concordancy in married couples in four African cities. AIDS 18: 1715-1721.

Gray, RH, MJ Wawer, NK Sewankanbo, D Serwadda, C Li, LH Moulton, T Lutalo, F Wabwire-Mangen, MP Meehan, S Ahmen, LY Paxton, N Kiwanuka, F Nalugoda, EL Korenromp, TC Quinn, and the Rakai Project Team. 1999. Relative risks and population attributable fraction of incident HIV associated with symptoms of sexually transmitted diseases and treatable symptomatic sexually transmitted diseases in Rakai District, Uganda. AIDS 13: 2113-2123.

Gray, RH, MJ Wawer, R Brookmeyer, NK Sewankambo, D Serwadda, F Wabwire-Mangen, T Lutalo, X Li, T vanCott, TC Quinn and the Rakai Project Team. 2001. Probability of HVI-1 transmission per coital act in monogamous, heterosexual, HIV-1-discordant couples in Rakai, Uganda. The Lancet 357: 1149-1153.

Gray, RH, X Li, G Kigozi, D Serwadda, H Brahmbhatt, F Wabwire-Mangen, F Nalugoda, M Kiddugavu, N Sewankambo, TC Quinn, SJ Reynolds, and MJ Wawer. 2005. Increased risk of indicent HIV during pregnancy in Rakai, Uganda: a prospective study. The Lancet 366: 1182-1188.

Gray, RH, G Kigozi, D Servadda, F Makumbi, S Warya, F Nalugoda, N Kiwanuka, LH Moulton, MA Chaudhary, MZ Chen, NK Sewankambo, F Wabwire-Mangen, MC Bacon, CF Williams, P Opendi, SJ Reynolds, O Laeyendecker, TC Quinn, MJ Wawer. 2007. Male circumcision for HIV prevention in men in Rakai, Uganda: a randomized trial. Lancet 369: 657-666.

Grinstead OA, SE Gregorich, KH CHoi, T Coates and the Voluntary HIV-1 Counseling and Testing Efficacy Study Group. 2001. Positive and negative life events after counseling and testing: the voluntary HIV-1 counseling and testing efficacy study. AIDS 15: 1045-1052.

Guthrie, BL, G de Bruyn, C Farquhar. 2007. HIV-1-discordant couples in sub-Sarahan Africa: explanations and implications for high rates of discordancy. Current HIV Research 5: 416-429.

Hira, SK, PJ Feldblum J Kamanga, G Mukelabai, SS Weir, and JC Weir. 1997. Concom and Nonoxynol-9 use and the incidence of HIV infection in serodiscordant couples in Zambia. International Journal of STD and AIDS 8: 243-250.

Hugonnet, S, F Mosha, J Todd, K Mugeye, A Klokke, L Ndeki, D Ross, H Grosskurth and R Hayes. 2002. Incidence of HIV infection in stable sexual partnerships: a retrospective cohort study of 1802 couples in Mwanza Region, Tanzania. Journal of Acquired Immune Deficiency Syndromes. 30: 73-80.

Instituto Nacional de Estatística (INE). 2009. Provincial Population Projections, Mozambique.

Instituto Nacional de Saúde (INS), Instituto Nacional de Estatística (INE), e ICF macro. 2010. Inquérito Nacional de Prevalência, Riscos Comportamentais e Informação sobre o HIV e SIDA em Moçambique 2009. Calverton, Maryland USA: INS, INE e ICF Macro.

Jones, D, D Ross, SM Weiss, G Bhat and N Chitalu. 2005. Influence of partner participation on sexual risk behavior reduction among HIV-positive Zambian women. Journal of Urban Health 82(3 Suppl 4): iv92-iv100.

Kamenga, C, RW Ryder, M Jingu, N Mbuyi, L Mbu, F Behets, C Brown and WL Heyward. 1991. 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 counseling center in Zaire. AIDS 5: 61-67.

Macro International, Inc. 2008. HIV Prevalence Estimates from the Demographic and Health Surveys. Calverton, Maryland: Macro International, Inc.

Malamba, SS, JF Mermin, R Bunnell, J Mubangizi, J Kalule, E Marum, DJ Hu, S Wangalwa, D Smith and R Downing. 2005. Couples at risk: HIV-1 concordance and discordance among sexual partners receiving voluntary counseling and testing in Uganda. Journal of Acquired Immune Deficiency Syndromes 39: 576-580.

McGrath, JW, DD Celentano and SE Chard. 2007. A group-based intervention to increase condom use among HIV serodiscordant couples in India, Thailand, and Uganda. AIDS Care 19: 418-424.

Mehendale SM, MV Ghate, B Kishore Kumar, S Sahay, TR Gamble, SV Godbole, MR Thakar, SS Kulkarni, A Gupta, RR Gangakhedkar, AD Divekar, AR Risbud, RS Paranjape and RC Bollinger. 2006. Low HIV-1 incidence among married serodiscordant couples in Pune, India. Journal of Acquired Immune Deficiency Syndromes 41: 371-373.

Ministry of Health (MISAU). 2008. Ronda de Vigilância Epidemiológica do HIV de 2007. Maputo, Mozambique: MISAU.

Ministry of Health (MISAU). Forthcoming. Integration of Sexually Transmitted Infection (STI) Prevention, Diagnosis, and Treatment into HIV Clinical Care in Mozambique. Ministry of Health, Mozambique.

Ministry of Health (MISAU). 2010. Guia de Tratamento Antiretroviral e Infecções Oportunistas no Adulto, Adolescente e Grávida. Maputo, Mozambique: MISAU.

Instituto Nacional de Saúde (INS). 2010. 'Resultados da Vigilância Epidemiológica do HIV e SIDA e o seu Impacto Demográfico em Moçambique: Actualização, Ronda 2009'. Maputo, Mozambique: MISAU. (Draft report).

Mishra, Vinod, Shane Khan, Li Liu, and Benny Kottiri. 2008. Medical Injection Use and HIV in Sub-Saharan Africa. DHS Comparative Reports No. 21. Calverton, Maryland, USA: Macro International Inc.

Mozambique Positive Prevention Project. 2009. Mozambique Positive Prevention Training Manual. San Francisco, California, USA: University of California San Francisco, School of Nursing; PEPFAR Mozambique; and the American International Health Alliance (AIHA) Twinning Center, available at http://positiveprevention.ucsf.edu/moz?page=moz-CU01PPTM.

Msuya, SE, EM Mbizvo, A Hussain, J Uriyo, NE Sam and B Stray-Pedersen. 2008. Low male partner participation in antenatal HIV counseling and testing in northern Tanzania: implications for preventive programs. AIDS Care 20: 700-709.

Multi-sectorial Technical Group for the Fight Against HIV/AIDS in Mozambique. 2008. Report on the Revision of the Data from HIV Epidemiological Surveillance—2007 Round. MISAU.

Nicolosi, A, M Musicco, A Saracco and A Lazzarin. 1994. Risk factors for woman-to-man sexual transmission of the human immunodeficiency virus. Italian Study Group on HIV Heterosexual Transmission. Journal of Acquired Immune Deficiency Syndromes 7: 296-300.

Padian, NS, SC Shiboski, SO Glass and E Vittinghoff. 1997. Heterosexual transmission of human immunodeficiency virus (HIV) in northern California: results from a ten-year study. American Journal of Epidemiology 146: 350-357.

Quinn, TC, MJ Wawer, N Sewankambo, D Serwadda, C Li, F Wabwire-Mangen, MO Meehan, T Lutalo and RH Gray. 2000. Viral load and heterosexual transmission of human immunodeficiency virus type 1. Rakai Project Study Group. New England Journal of Medicine 342: 921-929.

Roth, DL, KE Stewart, OJ Clay, A van der Straten, E Karita and S Allen. 2001. Sexual practices of HIV discordant and concordant couples in Rwanda: effects of a testing and counseling program for men. International Journal of STD and AIDS 12: 181-188.

Rutstein, SO, and K Johnson. 2004. The DHS Wealth Index. DHS Comparative Reports No. 6. Calverton, Maryland: ORC Macro.Ryder, RW, C Kamenga, M Jingu, N Mbuyi, L Mbu and F Behets. 2000. Pregnancy and HIV-1 incidence in 178 married couples with discordant HIV-1 serostatus: additional experience at an HIV1 counseling centre in the Democratic Republic of the Congo. Tropical Medicine and International Health 5: 482-487.

Ryder, RW, C Kamenga, M Jingu, N Mbuyi, L Mbu, and F Behets. Pregnancy and HIV-1 incidence in 178 married couples with discordant HIV-1 serostatus: additional experience at an HIV-1 counselling centre in the Democratic Republic of the Congo. Tropical Medicine and International Health 5(7): 482-487.

Saracco, A, M Musicco, A Nicolosi, G Angarano, C Arici, G Gavazzeni, P Costigliola, S Gafa, C Gervasoni, R Luzzati, F Piccinino, F Puppo, B Salassa, A Sinicco, R Stellini, U Terelli, G Turbessi, GM Vigevani, G Visco, R Zerboni and A Lazzarin. 1993. Man-to-woman sexual transmission of HIV: longitudinal study of 343 steady partners of infected men. Journal of Acquired Immune Deficiency Syndromes 6: 497-502.

Semrau, K, L Kuhn, C Vwalika, P Kasonde, M Sinkala, C Kankasa, E Shutes, G Aldrovandi and DM Thea. 2005. Women in couples antenatal HIV counseling and testing are not more likely to report adverse social events. AIDS 2005 19:603-609.

Senkoro, KP, JT Boerma, AH Klokke, JZ Ng'weshemi, AS Muro, R Gabone, MW Borgdorff. 2000. HIV incidence and HIV associated mortality in a cohort of factory workers and their spouses in Tanzania, 1991 through 1996. Journal of Acquired Immune Deficiency Syndromes 23: 194 202.

Serwadda, D, RH Gray, MJ Wawer, RY Stallings, NK Sewankambo, JK Konde-Lule, B Lainjo, and R Kelly. 1995. The social dynamics of HIV transmission as reflected through discordant couples in rural Uganda. AIDS 9: 745-750.

Staveteig, S and S Wang. Forthcoming. HIV-1 Serodiscordance among Couples in Sub-Saharan Africa: Prevalence and Covariates. Calverton, Maryland, USA: ICF International.

The Voluntary HIV-1 counseling and testing efficacy study group. 2000. Efficacy of voluntary HIV-1 counseling and testing in individuals and couples in Kenya, Tanzania, and Trinidad: a randomized trial. Lancet 356: 103-112.

Wawer, MJ, RH Gray, NK Sewankambo, D Serwadda, X Li, F Nalugoda, F Wabwire-Mangen, MP Meehan, TC Quinn. 2005. Rates of HIV-1 transmission per coital act, by stage of HIV-1 infection in Rakai, Uganda. Journal of Infectious Diseases 191: 1403-1409.

Weiss, HA, CA Hankins and K Dickson. 2009. Male circumcision and risk of HIV infection in women: a systematic review and meta-analysis. The Lancet Infectious Diseases 9: 669-677.

APPENDIX A SAMPLE WEIGHTS

The allocation of the sample for the 2009 INSIDA to the different provinces and to their urban-rural areas was non-proportional.[19] This requires the use of sampling weights for any analysis using 2009 INSIDA data to ensure the actual representativeness of the sample at the national level as well as province level. Since the 2009 INSIDA sample is a two-stage stratified cluster sample, sampling weights were calculated based on sampling probabilities separately for each sampling stage and for each cluster. We use the following notations:

P_{1hi}: first-stage sampling probability of the i^{th} cluster in stratum h

P_{2hi}: second -stage sampling probability within the i^{th} cluster (households)

Let a_h be the number of clusters selected in stratum h, M_{hi} the number of households according to the sampling frame in the i^{th} cluster, and $\sum M_{hi}$ the total number of households in the stratum h. The probability of selecting the i^{th} cluster in the INSIDA sample is calculated as follows:

$$\frac{a_h \, M_{hi}}{\sum M_{hi}}$$

Let b_{hi} be the proportion of households in the selected segment compared to the total number of households in the cluster i in stratum h if the cluster is segmented, otherwise $b_{hi} = 1$. Then the probability of selecting cluster i in the sample is:

$$P_{1hi} = \frac{a_h \, M_{hi}}{\sum M_{hi}} \times b_{hi}$$

Let g_{hi} be the number of households selected in the cluster. The second stage's selection probability for each household in the cluster is calculated as follows:

$$P_{2hi} = \frac{g_{hi}}{M_{hi} b_{hi}}$$

The overall selection probability of each household in cluster i of stratum h is therefore the production of the selection probabilities:

$$P_{hi} = P_{1hi} \times P_{2hi}$$

The design weight for each household in cluster i of stratum h is the inverse of its selection probability:

$$W_{hi} = 1 / P_{hi}$$

A spreadsheet containing all sampling parameters and selection probabilities was constructed to facilitate the calculation of sampling weights. Household sampling weights and the individual sampling weights were obtained by adjusting the above calculated design weight to compensate for household non-response and individual non-response, respectively. Separate individual sample weights were calculated for men and women based on the male and female response rates. These weights were further normalized at the national level to achieve the number of un-weighted cases equal to the number of weighted cases for both households and individuals at the national level. The normalized weights are valid for estimating means, proportions, rates and

[19] For further information on the sample design of the 2009 INSIDA, see Appendix A of the 2009 INSIDA final report (INS, INE and ICF Macro, 2010).

ratios, but not valid for estimation of totals. The 2009 INSIDA included testing for HIV. In the survey, it was possible for a respondent to participate in the interview, but not participate in the HIV test. For this reason, it is necessary to calculate separate HIV weights. The HIV weights were calculated by using the individual sample weights with a further adjustment for non-response to the HIV test. As with individual sample weights, separate HIV weights are calculated by sex, but the normalization of the HIV weights was done for tested males and females together at the national level so that the HIV prevalence for the two sexes together can be calculated.

Most of the analysis in this report uses the couple as the unit of analysis; however couples were not a unit of selection in the sample. The survey did do not identify eligible couples in the household listing, only eligible individuals. Therefore, the number of couples eligible to participate in the survey is unknown, and it is not possible to calculate a true couples' weight. A proxy weight must be selected from either the men's individual sample weight or the women's individual sample weight. The base for both of these weights is the household weight, and where response rates differ little by sex, there is very little difference between these two weights.[20] Response rates to population-based surveys tend to be lower among men, so the practice of the DHS project is to use the men's sample weight for couples. HIV status is used in this analysis, so the men's HIV weight is the weight used in this document every time the unit of analysis is the couple.

[20] In the 2009 INSIDA, the women's response rate to the interview and HIV test was 88.5 percent, and the men's response rate to the interview and HIV test was 84.3 percent (INS, INE and ICF Macro, 2010).

APPENDIX B STATISTICAL TESTS

Table B.1 Methods used for significance testing

Table/Figure	Unit	Outcome	Significance testing	Weight
Section II. Background and rationale				
Table 1	Couple	HIV status	None	Men's HIV weight
Figure 1	Couple	HIV status	None	Men's HIV weight
Section III. Description of the sample				
Figure 2	Women	Inclusion in couples sample	None	None
Table 4, Table C.2	Individuals and couple members	Characteristics of the samples	No significance testing, only comparison of the 95% CIs	As described in the table footnote
Section IV. HIV discordance among couples				
Table 5	Individuals	Marital status	None	Women's and men's HIV weights
Figure 3	Couple	HIV status	None	Men's HIV weight
Table 6	Couple	HIV testing	None	Men's HIV weight
Figure 4	Women and men in the couples file	HIV testing	Univariate logistic regression for significance of the odds ratio	Men's HIV weight
Figure 5	Individuals in the couples file	HIV testing	None	Men's HIV weight
Table 7	Couple	HIV status and knowledge of HIV status	None	Men's HIV weight
Table 8	Couple	HIV status and knowledge of HIV status	None	Men's HIV weight
Table 9	Couple	Condom use	Pearson chi-square Each panel is a separate crosstabulation	Men's HIV weight
Table 10	Couple	Condom use	None	Men's HIV weight
Section V. Conceptual framework				
Figure 7	Couple	HIV status	No significance testing, only comparison of the 95% CIs with the value predicted by the mathematical model	Men's HIV weight
Section VI. Multivariate models				
Table 11, Table C.1	Couple	HIV status of couples	Pearson chi-square Each panel is a separate crosstabulation	Men's HIV weight
Table 12, Table C.3	Couple	Couple discordance	Binomial logistic regression	Men's HIV weight
Table 13, Table C.4	Couple	Couple discordance	Multinomial logistic regression	Men's HIV weight

CI = confidence interval

APPENDIX C LINKING THE CONCEPTUAL FRAMEWORK AND VARIABLES IN THE MULTIVARIATE MODELS

Table C.1 Variable definitions and position of variables within the conceptual framework (Figure 6)

Variables	Source of data	Corresponding factor in conceptual framework	Coding of the variable
Outcome variable			
HIV status of 'second' partner[1]	Direct observation through laboratory diagnosis	"HIV infection of the 2nd partner"	In Table 12: Two categories 1) 2nd couple member HIV+ (concordant positive) 2) 2nd couple member HIV- (discordant) In Table 13: Three categories 1) 2nd couple member HIV+ (concordant positive) 2) 2nd couple member HIV- and female (male discordant) 3) 2nd couple member HIV- and male (female discordant)
Variables measuring risk of sexual transmission within the couple			
Duration of union	Self-report of the wife	"Duration of union"	Taken from one of two questions: If the woman was married only once and reported initiating sexual activity when she married, then duration of current union equals time since first sex. If this condition is not true, and the woman had sex with her husband in the past 12 months, then duration of current union equals time since first sex with the partner listed as her husband. Otherwise, the variable is set to missing. Duration of union is coded into 4 categories for number of years: 0-4, 5-9, 10-19, 20+
Number of unions	Self-reports of the husband and wife	Collinear with "Duration of union"	Married respondents are asked if they have been married once or more than once. The variable combines information reported by the husband and the wife to create one variable with 4 categories: 1) Both married only once 2) Man married more than once, woman married once 3) Man married once, woman married more than once 4) Both married more than once Polygynous men are considered to have been married more than once.
Type of union	Self-reports of the husband and wife	"Type of union"	Men are asked how many wives they have; women are asked how many wives their husband has. If husband and wife both say 1 wife: Type of union = non-polygynous If husband and wife both say >1: Type of union= polygynous If husband says 1 wife, and wife says >1 wife, or vice versa: Type of union is set to 'disagree'
Time since last sex with spouse	Self-report of the wife	Proxy for "Coital frequency"	Taken from the wife's report of time since last sex with her husband. Recoded into three categories: 1) <1 month 2) 1-5 months 3) 6+ months
Male circumcision	Self-report of the husband	"Male circumcision"	Men are asked if they are circumcised. Yes = yes No, don't know or missing are coded as 'No'
STIs: 3 variables 1) Couple: STI or STI symptoms 2) Woman: STI or STI symptoms 3) Man: STI or STI symptoms	Self-reports of husband and wife	"STIs"	Men and women are asked three questions about STIs or symptoms of STIs in the past 12 months: 1) Did you have a disease which you got through sexual contact? 2) Did you have a bad-smelling or abnormal genital discharge? 3) Did you have a genital ulcer or sore? A yes on ANY of these three questions = 'Yes' on the STI variable. Table 12: A Couple STI variable is used with a value of 'No' if neither member of the couple answered yes to any of these 3 questions and 'Yes' if either the husband or wife answered yes to any of the 3 questions Table 13: 2 STI variables are used 1) Woman STI = 'Yes' if she answered yes to any of the 3 questions 2) Man STI = 'Yes' if he answered yes to any of the 3 questions
Condom use at last sex with spouse	Self-report of the wife	"Condom use with spouse"	Women are asked if they used a condom the last time they had sex with each of their 3 most recent sexual partners in the past 12 months. Condom use at last sex with spouse = 'Yes' if the woman reports that she used and condom the last time she had sex with her husband. Reporting that she did not use a condom with her spouse at last sex, missing responses, and women who did not have sex with their husband in the past 12 months are assigned a value of 'No'
Ever tested for HIV and received the result of the last test	Self-reports of husband and wife	Proxy for "Knowledge of status"	Men and women are asked whether they have ever been tested for HIV, and if so, whether they received the result of the last HIV test they received. Couple ever tested and received result = 'Yes' if both husband and wife have been tested and received the result of the last test that each of them took. All other couples are assigned a value of 'No'.

Continued…

Table C.1—*Continued...*

Variables	Source of data	Corresponding factor in conceptual framework	Coding of the variable
Variables measuring risk of sexual transmission from outside the couple			
HIV prevalence in the area	Direct observation through laboratory diagnosis	"General population HIV prevalence"	Defined as the HIV prevalence among women and men age 15-64 in the province in which the couple lives.
Condom use at last sex with non-spousal partner	Self-reports of the husband and wife	1 variable combining 2 factors: "Condom use, outside partner" and "Outside sexual partners"	The variable has 3 values: 1) 'Yes' if either the man or the woman had a non-marital partner in the past 12 months, and a condom was used a last sex by all members of the couple who had an outside partner 2) 'No' if either member of the couple had an outside sexual partner in the past 12 months and did not use a condom at last sex with that partner 3) 'No non-spousal sex in past 12 months' if neither member of the couple reported having a sexual partner other than the spouse in the past 12 months.
Variables measuring risk of non-sexual transmission			
Injection drug use, tattoos, surgery, blood transfusions	Self-reports of the husband and wife	"IDU, surgery, transfusion, tattoo/scar"	'Yes' if either member of the couple reported that they have ever used injection drugs or received traditional scarification or tattooing, or if either member of the couple received a blood transfusion or surgery in the past 12 months. 'No' for all other couples
Conceptual framework factors measured in the INSIDA but not included in the model			
Away from home for more than one month in the past year	Self-reports of the husband and wife	"Time away from home"	Husband and wife report for themselves whether they have been away from home for more than 12 months in the past year (yes/no).
Conceptual framework factors not measured in the 2009 INSIDA			
Time in union since infection	Not measured		
Time since infection of index partner	Not measured		
Viral load	Not measured		
ARV use	Not measured		

NA = not applicable
STI = sexually transmitted infection
[1] In concordant positive couples, it is not possible to determine which partner was infected first and which was infected second.

APPENDIX D ADDITIONAL TABLES

Table D.1 Percent distribution of couples by HIV status and percentage of couples who are discordant according to background characteristics with 95% confidence intervals, Mozambique 2009

Characteristic	HIV status of the couple													Percent of couples that are discordant			
	Both positive	95%CI lower	95%CI upper	**Man+ woman-**	95%CI lower	95%CI upper	**Woman+ man-**	95%CI lower	95%CI upper	**Both negative**	95%CI lower	95%CI upper	Total	Percent of couples that are discordant	95%CI lower	95%CI upper	Number of couples
Demographic factors																	
Mean age of couple																	
Under 30	4.1	2.8	6.0	4.7	3.3	6.7	6.1	4.1	8.9	85.1	81.2	88.2	100.0	10.8	8.1	14.2	1,029
30-39.9	6.3	4.4	9.1	6.8	5.0	9.0	5.3	3.8	7.5	81.5	77.9	84.7	100.0	12.1	9.6	15.2	839
40+	4.2	3.0	6.1	3.7	2.5	5.4	3.7	2.5	5.5	88.3	85.6	90.6	100.0	7.4	5.7	9.7	780
Age difference																	
Woman older than man or couple same age	6.4	3.6	11.1	6.3	3.8	10.4	6.7	4.2	10.5	80.6	74.3	85.6	100.0	13.0	9.6	17.4	315
Man 1-4 years older	3.6	2.4	5.4	5.0	3.7	6.9	5.7	3.9	8.4	85.6	81.9	88.7	100.0	10.8	8.1	14.3	963
Man 5+ years older	5.4	4.0	7.2	4.8	3.6	6.4	4.4	3.3	5.8	85.4	82.6	87.9	100.0	9.2	7.2	11.6	1,370
Woman's education																	
No education	3.5	2.2	5.4	4.3	3.0	6.2	3.8	2.5	5.8	88.4	85.6	90.8	100.0	8.1	6.1	10.7	947
Primary	5.4	4.1	7.1	5.5	4.2	7.0	5.6	4.3	7.2	83.6	80.8	86.0	100.0	11.1	9.1	13.4	1,499
Secondary +	7.8	4.5	13.4	5.8	3.3	9.9	7.9	4.9	12.5	78.5	70.3	84.9	100.0	13.7	9.1	20.1	202
Man's education																	
No education	2.2	1.1	4.4	4.3	2.1	8.6	6.2	3.8	10.0	87.3	81.6	91.5	100.0	10.5	6.5	16.6	374
Primary	4.8	3.5	6.5	4.9	3.8	6.3	4.7	3.6	6.1	85.6	82.9	88.0	100.0	9.6	7.9	11.7	1,848
Secondary +	7.6	4.8	11.8	6.5	4.4	9.5	6.2	4.0	9.4	79.7	73.9	84.4	100.0	12.7	9.1	17.4	426
Couple's education level																	
Both no education	1.6	0.7	3.7	4.0	1.8	8.7	4.7	2.2	9.5	89.7	82.5	94.2	100.0	8.7	4.4	16.4	295
Both primary	4.7	3.3	6.7	5.2	3.9	7.0	5.1	3.8	6.8	85.0	81.8	87.6	100.0	10.3	8.2	12.8	1,185
Both secondary+	6.1	2.9	12.3	6.1	3.2	11.4	6.7	3.7	11.9	81.1	72.1	87.7	100.0	12.8	8.3	19.3	162
Man more educated than woman	5.5	3.9	7.7	5.0	3.5	7.1	4.2	2.8	6.3	85.3	82.0	88.1	100.0	9.2	7.0	11.9	887
Woman more educated than man	7.9	3.5	16.9	5.3	2.0	13.5	12.0	6.4	21.4	74.7	64.9	82.6	100.0	17.4	10.4	27.5	119
Wealth quintile, grouped																	
Wealthiest 40%	9.3	6.9	12.3	7.6	5.8	9.9	6.9	5.1	9.3	76.2	71.5	80.4	100.0	14.5	11.4	18.2	925
Poorest 60%	2.5	1.7	3.6	3.7	2.7	5.0	4.2	3.1	5.7	89.6	87.3	91.5	100.0	7.9	6.2	10.1	1,723
Residence																	
Urban	7.4	5.5	10.0	7.1	5.2	9.8	8.2	6.0	11.0	77.2	72.0	81.7	100.0	15.3	11.7	19.9	725
Rural	3.9	2.7	5.5	4.3	3.2	5.6	4.0	3.0	5.4	87.8	85.4	89.9	100.0	8.3	6.6	10.4	1,923
Region																	
North	1.5	0.8	2.9	2.3	1.5	3.6	2.6	1.6	4.2	93.6	91.5	95.2	100.0	4.9	3.5	6.8	995
Central	5.4	3.8	7.7	5.7	4.2	7.8	6.1	4.5	8.2	82.7	78.8	86.0	100.0	11.8	9.1	15.3	1,159
South	10.3	7.2	14.6	9.1	6.7	12.2	8.1	5.8	11.3	72.5	67.7	76.8	100.0	17.2	13.7	21.4	494
Province																	
Niassa	<0.1	na	na	2.4	1.0	5.5	3.2	1.3	7.7	94.4	90.6	96.7	100.0	5.6	3.3	9.4	173
Cabo Delgado	3.6	1.8	7.1	5.2	3.2	8.3	2.8	1.4	5.4	88.4	83.9	91.8	100.0	8.0	5.5	11.4	221
Nampula	1.2	0.4	3.7	1.2	0.5	3.1	2.3	1.1	4.8	95.3	92.4	97.1	100.0	3.5	1.9	6.4	602
Zambezia	5.0	2.5	9.9	6.4	4.0	10.1	7.2	4.6	11.2	81.4	74.2	86.9	100.0	13.6	9.2	19.6	513
Tete	2.5	0.7	8.2	2.3	1.0	5.4	2.4	1.0	5.5	92.8	87.8	95.9	100.0	4.7	2.3	9.4	251
Manica	8.2	5.5	12.1	8.3	5.8	11.7	6.1	3.5	10.3	77.4	71.2	82.7	100.0	14.3	10.3	19.7	180
Sofala	7.6	5.0	11.3	6.0	2.3	14.6	7.8	4.3	13.8	78.6	67.4	86.8	100.0	13.8	6.6	26.5	214
Inhambane	0.5	0.1	1.9	6.1	2.1	16.6	3.8	1.9	7.4	89.6	78.2	95.4	100.0	9.9	4.2	21.7	125
Gaza	22.1	12.1	36.9	11.4	5.9	20.9	9.1	4.7	16.9	57.4	45.7	68.3	100.0	20.5	15.1	27.2	113
Maputo Provincia	10.8	7.6	15.2	9.4	5.4	16.0	7.4	4.1	13.0	72.4	63.3	80.0	100.0	16.8	10.4	26.0	136
Maputo Cidade	8.8	4.7	16.0	9.6	6.5	14.0	12.5	6.9	21.7	69.0	61.0	76.1	100.0	22.1	14.3	32.6	120

Continued...

Table D.1—*Continued*

Characteristic	**Both positive**	95%CI lower	95%CI upper	**Man+ woman-**	95%CI lower	95%CI upper	**Woman+ man-**	95%CI lower	95%CI upper	**Both negative**	95%CI lower	95%CI upper	Total	Percent of couples that are discordant	95%CI lower	95%CI upper	Number of couples
	HIV status of the couple																
Factors associated with sexual transmission within the couple																	
Number of unions																	
Both married only once	3.1	2.1	4.4	4.6	3.3	6.3	5.0	3.4	7.3	87.4	84.2	90.0	100.0	9.6	7.1	12.8	1,324
Man >1, woman once	5.7	3.5	9.1	6.8	4.5	10.0	3.0	1.8	4.9	84.5	80.1	88.1	100.0	9.8	7.1	13.3	554
Woman >1, man once	8.7	5.2	14.3	6.7	4.0	11.2	7.7	4.6	12.6	76.9	70.3	82.4	100.0	14.4	10.0	20.3	189
Both more than once	7.0	4.3	11.1	4.1	2.5	6.5	6.7	4.6	9.5	82.3	77.5	86.2	100.0	10.7	8.0	14.2	581
Duration of current union																	
0-4	5.3	3.8	7.3	4.9	3.3	7.2	8.8	6.1	12.5	80.9	76.5	84.7	100.0	13.8	10.5	17.9	747
5-9	5.8	3.8	8.8	5.4	3.5	8.0	5.5	3.8	8.0	83.3	79.5	86.4	100.0	10.9	8.3	14.2	602
10-19	4.8	3.3	7.0	5.4	3.8	7.5	3.3	2.2	5.0	86.4	83.0	89.3	100.0	8.7	6.7	11.3	729
20+	2.8	1.7	4.5	3.5	2.1	5.7	2.5	1.5	4.3	91.3	88.5	93.4	100.0	6.0	4.2	8.5	496
Type of union																	
Non-polygynous	4.6	3.6	5.8	5.3	4.2	6.6	5.1	4.0	6.5	85.0	82.6	87.2	100.0	10.4	8.5	12.7	2,161
Polygynous	6.4	3.3	12.3	4.9	2.6	9.0	4.8	2.8	8.1	83.9	77.1	88.9	100.0	9.7	6.6	14.0	333
Disagree	5.7	2.9	10.8	2.7	1.1	6.6	6.6	3.1	13.6	85.0	76.9	90.6	100.0	9.3	5.1	16.4	151
Time since last sex with spouse																	
<1 month	4.9	3.8	6.3	5.1	4.0	6.4	5.4	4.3	6.8	84.6	82.2	86.8	100.0	10.5	8.6	12.6	2,047
1-5 months	7.2	4.6	11.2	5.4	3.2	8.8	5.7	3.2	9.8	81.7	76.2	86.2	100.0	11.0	7.5	15.9	299
6+ months	2.2	1.0	5.0	5.1	2.8	9.0	2.5	1.2	5.2	90.3	85.8	93.4	100.0	7.5	4.8	11.7	291
Male circumcision																	
Man not circumcised	7.1	5.3	9.4	6.9	5.4	8.8	6.7	5.1	8.8	79.3	75.9	82.3	100.0	13.6	11.0	16.7	1,241
Man circumcised	2.9	2.0	4.1	3.5	2.4	5.1	3.8	2.8	5.1	89.8	87.3	91.9	100.0	7.3	5.5	9.5	1,402
Woman: STI or STI symptoms in past 12 months																	
No	4.5	3.5	5.7	4.9	3.9	6.1	5.2	4.2	6.5	85.5	83.2	87.4	100.0	10.1	8.4	12.0	2,534
Yes	13.6	7.5	23.4	9.4	5.0	17.1	4.1	1.7	9.7	72.9	62.4	81.3	100.0	13.6	8.2	21.5	114
Man: STI or STI symptoms in past 12 months																	
No	4.6	3.6	5.9	5.2	4.2	6.5	5.1	4.1	6.3	85.0	82.8	87.0	100.0	10.3	8.7	12.3	2,506
Yes	9.5	4.6	18.4	2.0	0.6	5.9	6.0	2.4	14.1	82.6	73.6	88.9	100.0	8.0	3.9	15.7	142
Couple: STI or STI symptoms in past 12 months																	
No	4.2	3.3	5.4	5.0	4.0	6.3	5.2	4.1	6.4	85.6	83.4	87.6	100.0	10.2	8.5	12.2	2,408
Yes	11.8	7.3	18.5	5.5	2.9	10.2	5.0	2.5	9.8	77.7	70.5	83.6	100.0	10.5	6.7	16.2	240
Condom use at last sex with spouse/partner																	
No	4.6	3.6	5.8	5.2	4.2	6.4	4.8	3.8	5.9	85.5	83.3	87.4	100.0	9.9	8.3	11.8	2,563
Yes	13.9	7.6	24.0	2.1	0.6	7.0	17.1	10.1	27.5	66.9	54.9	77.0	100.0	19.2	11.9	29.6	85
Couple ever tested for HIV and received result																	
Both no	3.5	2.4	4.9	4.1	3.1	5.6	4.0	2.9	5.5	88.3	85.9	90.4	100.0	8.2	6.5	10.3	1,688
Either or both yes	7.3	5.6	9.5	6.7	5.0	8.9	7.1	5.4	9.3	78.9	75.3	82.0	100.0	13.8	10.9	17.4	960
Factors associated with sexual transmission from outside the couple																	
HIV prevalence in the couple's province (general population 15-64)																	
<5%	0.9	0.3	2.9	1.5	0.7	2.9	2.5	1.4	4.6	95.1	92.7	96.7	100.0	4.0	2.5	6.3	774
5-14%	4.8	3.5	6.5	5.7	4.3	7.4	5.4	4.1	7.1	84.1	81.0	86.8	100.0	11.1	8.8	13.9	1,504
15%+	13.6	9.6	18.9	10.1	7.3	13.7	9.6	6.6	13.6	66.7	61.1	71.9	100.0	19.7	15.5	24.7	369
Condom used at last sex with non-spousal partner																	
Yes	7.8	4.2	14.1	7.2	4.2	12.1	5.6	2.7	11.1	79.4	70.9	85.9	100.0	12.9	8.4	19.2	157
No	5.6	3.3	9.4	5.8	3.6	9.3	4.7	2.7	7.9	83.9	78.9	87.9	100.0	10.5	7.2	14.9	364
No non-spousal sex in past 12 months	4.5	3.4	6.0	4.8	3.8	6.0	5.2	4.1	6.6	85.5	83.0	87.6	100.0	10.0	8.2	12.1	2,128

Continued...

Table D.1—*Continued*

Characteristic	HIV status of the couple													Percent of couples that are discordant			
	Both positive	95%CI lower	95%CI upper	**Man+ woman-**	95%CI lower	95%CI upper	**Woman+ man-**	95%CI lower	95%CI upper	**Both negative**	95%CI lower	95%CI upper	Total		95%CI lower	95%CI upper	Number of couples
	Non-sexual transmission factors																
Injection drug use, tattoos, surgery, blood transfusions																	
Either or both yes	7.5	4.2	12.9	5.6	3.0	10.3	5.5	3.0	9.7	81.4	73.4	87.5	100.0	11.1	6.7	17.9	203
Neither	4.7	3.6	6.0	5.0	4.0	6.2	5.1	4.1	6.4	85.2	83.0	87.2	100.0	10.1	8.5	12.1	2,445
Total	4.9	3.8	6.2	5.1	4.1	6.3	5.2	4.2	6.4	84.9	82.7	86.9	100.0	10.2	8.6	12.1	2,468
Number of couples	**129**			**134**			**136**			**2,249**				**271**			**2,648**

Note: Table includes 10 couples with information missing on duration of union, and 1 couple with information missing on time since last sex with spouse.
na = Not applicable

Table D.2 Comparison of all currently married men and women age 15-64 with the subsample of men and women age 15-64 who are in the couples file and were tested for HIV in the INSIDA by risk factors for HIV transmission and prior HIV testing, Mozambique 2009

	Currently married women						Currently married men					
	All	95%CI lower	95%CI upper	In couples file and tested for HIV	95%CI lower	95%CI upper	All	95%CI lower	95%CI upper	In couples file and tested for HIV	95%CI lower	95%CI upper
Prior HIV testing												
Percent tested and received results in past 12 months	15.9	14.0	17.8	16.1	13.8	18.4	8.4	6.9	9.8	7.8	6.2	9.4
Multiple partners												
Percent reported >1 partner in past 12 months	2.8	2.2	3.5	2.2	1.5	2.8	16.8	14.4	19.3	16.0	13.5	18.5
Male circumcision												
Percent of men circumcised	na			na			54.5	50.0	59.1	53.0	47.8	58.1
Time away from home												
Percent away from home for >1 month in past year	10.5	8.9	12.1	9.2	7.3	11.2	17.4	15.1	19.8	16.6	14.1	19.1
Sexually transmitted infections												
Percent reported an STI in past 12 months	2.7	2.0	3.6	2.4	1.8	3.1	3.8	2.7	5.3	3.7	2.4	5.5
Don't know/missing	2.6	2.0	3.5	3.0	2.2	4.2	5.1	4.0	6.4	5.2	4.0	6.6
Percent reported a genital sore in past 12 months	2.1	1.5	2.8	1.6	1.1	2.3	2.2	1.6	3.1	2.0	1.3	3.1
Don't know/missing	2.4	1.8	3.2	2.4	1.7	3.4	1.7	1.3	2.4	1.9	1.4	2.7
Paid sex												
Percent paid for sex in past 12 months	na			na			7.0	5.5	8.8	7.2	5.6	9.1
Missing	na			na			0.9	0.6	1.4	0.8	0.5	1.3
Non-sexual risk factors for HIV infection												
Either or both members of couple	3.3	2.5	4.2	3.3	2.4	4.5	4.6	3.7	5.7	4.8	3.7	6.2
Total number of respondents	**4,550**			**2,648**			**3,278**			**2,648**		

Note: None of the associations in this table reached significance at the p<0.05 level based on review of the 95% confidence intervals. Weights used in this table are as follows: individual sampling weight used for the "All" columns, except for the HIV prevalence row which uses the HIV weight. The "couple" columns use the men's HIV weight for all rows.
na = Not applicable

Table D.3 Logistic regression results of couple discordance (versus concordant positive status) among couples in which at least one partner is HIV-positive: unadjusted and adjusted odds ratios, with 95% confidence intervals and p-values, Mozambique 2009

Odds of couple discordance (concordant positive = reference)	Univariate OR	Univariate 95%CI Lower	Univariate 95%CI Upper	Univariate *p-value*	Multivariate OR	Multivariate 95%CI Lower	Multivariate 95%CI Upper	Multivariate *p-value*
Demographic factors								
Mean age of couple								
Under 30 (ref)	1.00				1.00			
30-39.9	0.73	0.40	1.33	*0.305*	0.58	0.27	1.26	*0.170*
40+	0.68	0.37	1.24	*0.202*	0.38	0.15	1.00	*0.050*
Age difference								
Woman older than man or couple same age (ref)	1.00				1.00			
Man 1-4 years older	1.48	0.68	3.21	*0.325*	1.50	0.66	3.39	*0.327*
Man 5+ years older	0.84	0.44	1.60	*0.590*	0.94	0.42	2.08	*0.874*
Couple's education level								
Both no education (ref)	1.00				1.00			
Both primary	0.40	0.12	1.30	*0.127*	0.48	0.13	1.74	*0.261*
Both secondary+	0.39	0.10	1.47	*0.161*	0.50	0.11	2.16	*0.347*
Man more educated than woman	0.31	0.09	1.07	*0.065*	0.31	0.08	1.17	*0.083*
Woman more educated than man	0.41	0.09	1.87	*0.245*	0.43	0.08	2.49	*0.346*
Wealth quintile, grouped								
Wealthiest 40%	0.49	0.28	0.85	*0.012*	0.60	0.33	1.12	*0.106*
Poorest 60% (ref)	1.00				1.00			
Factors associated with sexual transmission within the couple								
Duration of current union								
0-4 (ref)	1.00				1.00			
5-9	0.72	0.38	1.36	*0.308*	0.79	0.38	1.65	*0.531*
10-19	0.69	0.39	1.24	*0.219*	0.98	0.47	2.05	*0.952*
20+	0.83	0.42	1.66	*0.603*	1.86	0.64	5.36	*0.250*
Type of union								
Non-polygynous (ref)	1.00				1.00			
Polygynous	0.66	0.30	1.45	*0.304*	1.35	0.45	4.02	*0.586*
Disagree	0.73	0.28	1.85	*0.500*	1.04	0.36	2.99	*0.948*
Time since last sex with spouse								
<1 month (ref)	1.00				1.00			
1-5 months	0.72	0.37	1.41	*0.335*	0.79	0.38	1.66	*0.533*
6+ months	1.60	0.62	4.12	*0.327*	2.19	0.76	6.29	*0.146*
Male circumcision								
Man not circumcised (ref)	1.00				1.00			
Man circumcised	1.30	0.76	2.24	*0.342*	1.41	0.81	2.46	*0.227*
Couple: STI or STI symptoms in past 12 months								
No (ref)	1.00				1.00			
Yes	0.37	0.18	0.77	*0.008*	0.40	0.18	0.89	*0.026*
Condom use at last sex with spouse/partner								
No (ref)	1.00				1.00			
Yes	0.64	0.29	1.38	*0.253*	0.88	0.33	2.34	*0.790*
Factors associated with sexual transmission from outside the couple								
HIV prevalence in the couple's province (general population 15-64)								
<5% (ref)	1.00				1.00			
5-14%	0.54	0.13	2.24	*0.397*	0.52	0.14	1.94	*0.330*
15%+	0.34	0.08	1.42	*0.137*	0.50	0.12	2.09	*0.338*
Condom used at last sex with non-spousal partner								
No non-spousal sex in past 12 months (ref)	1.00				1.00			
Yes	0.75	0.33	1.71	*0.492*	0.97	0.33	2.81	*0.953*
No	0.85	0.41	1.76	*0.658*	0.82	0.37	1.84	*0.633*
Non-sexual transmission factors								
Injection drug use, tattoos, surgery, blood transfusions								
Neither (ref)	1.00				1.00			
Either or both members of couple	0.68	0.30	1.54	*0.358*	0.74	0.28	1.96	*0.539*
Number of couples	**400**				**384**			

Note: Table includes 10 couples with information missing on duration of union, and 1 couple with information missing on time since last sex with spouse.

Table D.4 Multinomial logistic regression results of couple status: 1) Man HIV+, woman HIV-; 2) Man HIV-, Woman HIV+; versus 3) Both HIV-positive among couples in which at least one partner is HIV-positive: unadjusted and adjusted relative risk ratios, with 95% confidence intervals and p-values, Mozambique 2009

	Univariate								Multivariate							
	1) Man HIV+, Woman HIV - vs. 3) Both HIV+ (unadjusted)				2) Man HIV-, Woman HIV+ vs. 3) Both HIV+ (unadjusted)				1) Man HIV+, Woman HIV- vs. 3) Both HIV+ (adjusted)				2) Man HIV-, Woman HIV+ vs. 3) Both HIV+ (adjusted)			
	RRR	95%CI Lower	95%CI Upper	*p-value*	RRR	95%CI Lower	95%CI Upper	*p-value*	aRRR	95%CI Lower	95%CI Upper	*p-value*	aRRR	95%CI Lower	95%CI Upper	*p-value*
Demographic factors																
Mean age of couple																
Under 30 (ref)	1.00				1.00				1.00				1.00			
30-39.9	0.94	0.46	1.90	*0.858*	0.57	0.28	1.17	*0.127*	1.21	0.57	2.57	*0.617*	0.50	0.22	1.13	*0.095*
40+	0.77	0.39	1.53	*0.454*	0.60	0.29	1.26	*0.176*	1.08	0.53	2.19	*0.827*	0.54	0.25	1.14	*0.104*
Age difference																
Woman older than man or couple same age (ref)	1.00				1.00				1.00				1.00			
Man 1-4 years older	1.42	0.62	3.27	*0.409*	1.53	0.60	3.89	*0.370*	1.39	0.61	3.14	*0.432*	1.38	0.58	3.29	*0.464*
Man 5+ years older	0.90	0.43	1.87	*0.772*	0.78	0.34	1.77	*0.550*	0.94	0.42	2.09	*0.879*	0.95	0.43	2.09	*0.892*
Couple's education level																
Both no education (ref)	1.00				1.00				1.00				1.00			
Both primary	0.44	0.11	1.76	*0.246*	0.37	0.12	1.13	*0.080*	0.67	0.18	2.51	*0.547*	0.45	0.11	1.79	*0.258*
Both secondary+	0.40	0.08	2.01	*0.264*	0.38	0.10	1.36	*0.136*	0.49	0.10	2.44	*0.384*	0.45	0.09	2.31	*0.337*
Man more educated than woman	0.36	0.09	1.44	*0.148*	0.26	0.07	0.96	*0.043*	0.48	0.14	1.72	*0.261*	0.28	0.06	1.24	*0.093*
Woman more educated than man	0.27	0.04	1.66	*0.157*	0.52	0.11	2.44	*0.405*	0.36	0.05	2.40	*0.288*	0.53	0.08	3.31	*0.491*
Wealth quintile, grouped																
Wealthiest 40%	0.55	0.31	0.98	*0.044*	0.44	0.24	0.81	*0.009*	0.63	0.32	1.22	*0.170*	0.42	0.20	0.88	*0.022*
Poorest 60% (ref)	1.00				1.00				1.00				1.00			
Factors associated with sexual transmission within the couple																
Number of unions																
Both married only once (ref)	1.00				1.00				1.00				1.00			
Man >1, woman once	0.79	0.37	1.71	*0.555*	0.32	0.13	0.80	*0.016*	1.12	0.48	2.61	*0.791*	0.36	0.13	1.06	*0.064*
Woman >1, man once	0.52	0.19	1.45	*0.208*	0.54	0.20	1.46	*0.220*	0.57	0.20	1.66	*0.301*	0.76	0.27	2.09	*0.588*
Both more than once	0.39	0.16	0.96	*0.039*	0.58	0.26	1.31	*0.189*	0.36	0.14	0.90	*0.029*	0.60	0.25	1.44	*0.252*
Type of union																
Non-polygynous (ref)	1.00				1.00				1.00				1.00			
Polygynous	0.66	0.28	1.57	*0.345*	0.67	0.25	1.75	*0.407*	0.92	0.31	2.76	*0.878*	1.72	0.59	5.05	*0.318*
Disagree	0.42	0.14	1.30	*0.130*	1.04	0.35	3.06	*0.942*	0.43	0.14	1.32	*0.139*	1.93	0.62	6.04	*0.257*
Time since last sex with spouse																
<1 month (ref)	1.00				1.00				1.00				1.00			
1-5 months	0.73	0.34	1.53	*0.396*	0.72	0.32	1.60	*0.413*	0.78	0.33	1.88	*0.584*	0.92	0.43	2.01	*0.840*
6+ months	2.23	0.80	6.26	*0.126*	1.01	0.33	3.10	*0.985*	2.88	0.91	9.20	*0.073*	1.45	0.41	5.17	*0.562*
Male circumcision																
Man not circumcised (ref)	1.00				1.00				1.00				1.00			
Man circumcised	1.23	0.70	2.16	*0.467*	1.37	0.72	2.61	*0.337*	1.47	0.79	2.73	*0.220*	1.51	0.77	2.97	*0.229*
Woman: STI or STI symptoms in past 12 months																
No (ref)	1.00				1.00				1.00				1.00			
Yes	0.64	0.26	1.59	*0.334*	0.26	0.08	0.83	*0.024*	0.87	0.30	2.55	*0.800*	0.26	0.08	0.89	*0.032*
Man: STI or STI symptoms in past 12 months																
No (ref)	1.00				1.00				1.00				1.00			
Yes	0.18	0.05	0.71	*0.014*	0.57	0.17	1.98	*0.377*	0.19	0.05	0.83	*0.027*	0.75	0.18	3.09	*0.694*
Couple ever tested for HIV and received results																
Both no (ref)	1.00				1.00				1.00				1.00			
Either or both yes	0.77	0.42	1.41	*0.395*	0.84	0.44	1.62	*0.609*	1.00	0.51	1.97	*0.999*	1.49	0.75	2.98	*0.252*
Factors associated with sexual transmission from outside the couple																
HIV prevalence in the couple's province (general population 15-64)																
<5% (ref)	1.00				1.00				1.00				1.00			
5-14%	0.75	0.18	3.10	*0.692*	0.42	0.09	1.95	*0.268*	0.77	0.22	2.68	*0.678*	0.40	0.11	1.50	*0.172*
15%+	0.47	0.11	1.96	*0.296*	0.26	0.05	1.27	*0.095*	0.54	0.13	2.23	*0.389*	0.47	0.11	2.04	*0.311*
Condom used at last sex with non-spousal partner																
Yes	0.88	0.38	2.03	*0.768*	0.63	0.21	1.91	*0.410*	1.31	0.48	3.59	*0.602*	0.84	0.25	2.84	*0.783*
No	0.98	0.44	2.19	*0.956*	0.73	0.32	1.65	*0.448*	1.00	0.41	2.41	*0.997*	0.76	0.28	2.04	*0.587*
No non-spousal sex in past 12 months (ref)	1.00				1.00				1.00				1.00			
Non-sexual transmission factors																
Injection drug use, tattoos, surgery, blood transfusions																
Either or both members of couple	0.70	0.30	1.65	*0.416*	0.67	0.26	1.68	*0.39*	0.94	0.35	2.51	*0.906*	0.82	0.29	2.31	*0.708*
Neither (ref)	1.00				1.00				1.00				1.00			
Number of couples	**400**				**400**				**398**				**398**			

Note: Table includes 2 couples with information missing on time since last sex with spouse.