HIV Testing & Risky Sexual Behavior

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Abstract

A puzzle in HIV prevention is that while HIV tests provide important information about a person's health status, it has little effect on risky sexual behavior. One explanation is that testing only affects people if it provides new information about their HIV status. Using data from a study that randomly assigns offers of HIV testing in two urban centers in East Africa, I examine the effects of testing when people's beliefs about their HIV status are taken into account. In order to objectively measure risky sexual behavior, gonorrhea and chlamydia infections that occurred during the study (sexually transmitted infections or "STIs") are used as proxies. I find that individuals who believed they were at low risk for HIV before testing, have a six-fold increase in contracting an STI following an HIV-positive test, indicating riskier sexual behavior. Individuals who believed they were at high risk for HIV have a 60% decrease in their likelihood of contracting an STI following an HIV-negative test, indicating safer sexual behavior. When HIV tests agree with a person's belief of HIV infection, there is no statistically significant change in contracting an STI. These findings suggest: 1) HIV tests only affect behavior if they provide new information and 2) risky sexual behavior is increasing in beliefs of HIV infection; as a person's likelihood of HIV infection increases, the benefit of choosing safe sexual behavior diminishes. I model the effects of HIV testing on risky sexual behavior using the distribution of beliefs of HIV infection, actual HIV status, and estimated behavioral change derived from this study. I find the overall number of HIV infections increase when people are tested compared to when they are unaware of their status - an unintended consequence of testing.

JEL Codes: D84, I18, O12

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1 Introduction

HIV Testing and Counseling is regarded as the gateway to prevention and treatment (WHO, 2009). Learning your HIV status is believed to lead to safer sexual behavior, while the provision of antiretrovirals (ARVs) requires first identifying infected individuals. Under this premise, universal access to HIV testing has been a key policy response to the HIV/AIDS epidemic. In nineteen countries in sub-Saharan Africa (SSA) with reliable data,[1] the number of people tested for HIV increased from 4.6 million in 2007, to 8.3 million by 2008 - a yearly growth rate of 80%, although the number tested in 2008 represents just 5.9% of the 142 million people who live in these countries (WHO, 2009).[2] Despite this emphasis, a major question remains: how does HIV testing affect risky sexual behavior? Since testing serves two purposes (prevention and access to treatment), it can be a desirable policy intervention if at a minimum testing does not increase the number of HIV infections. If testing leads some people to undertake riskier sexual behavior it will be at odds with prevention and may mitigate the effect that treatment has on the epidemic.

Most empirical studies show that HIV testing does not substantially affect the sexual behavior of people tested (Weinhard et al., 1999, Denison et al., 2008).[3] This is puzzling since HIV tests provide vital health information. What explains this? It may be that tests do not change people's beliefs about their HIV status. For example, if someone believed she was unlikely to be HIV infected, a negative test result will do little to change the person's beliefs. In this framework, only people who update their beliefs about their HIV status after testing (i.e. surprised by test results) will change their behavior (Boozer and Philpson, 2000, Delavande and Kohler, 2009a, de Paula et al., 2010).

I use data from the Voluntary Counseling & Testing (VCT) Efficacy study conducted in Kenya and Tanzania, which randomly assigned people into HIV testing and followed up with them 6 months later (Coates et al., 2000). I construct a measure of people's beliefs about their HIV status using questions on the baseline survey. This belief measure is correlated with HIV status and is strongly predictive of risky sexual behavior. To measure risky sexual behavior, I use biological

[1]The nineteen countries include: Benin, Botswana, Cape Verde, Central Africa Republic, Democratic Republic of Congo, Eritrea, Ethiopia, Gambia, Ghana, Guinea-Bissau, Lesotho, Mauritania, Niger, Sao Tome & Principe, Senegal, Sierra Leone, Somalia, Swaziland, and Uganda.

[2]The total population between the ages of 15-64 for the nineteen countries reporting HIV testing data is 142,167,064 (World Development Indicators). This is the relevant population as the WHO only reports on the number of people aged 15 or older who get tested. The percentage of people who got tested was determined by dividing the number of people tested (8,337,566) by the total population. This number is an upper bound since it does not take into account individuals who took multiple tests during the year.

[3]While HIV testing has some effect on those testing positive, it appears to have very little effect on those who test negative.

markers that are not susceptible to self-reporting bias. Data are collected on newly contracted infections of gonorrhea and chlamydia (henceforward known as "sexually transmitted infection" or "STI") that occur during the study. An STI only results from unprotected sex with someone who has an STI and serves as an objective measure of risky sexual behavior. The random assignment of testing enables me to identify the effect that HIV tests have on sexual behavior conditioned on prior beliefs of HIV infection.

I find that people who believed they were at low risk for HIV before testing increase their likelihood of contracting an STI by 12 percentage points after an HIV positive test. This effect is large and represents a six-fold increase in the probability of an STI versus a comparable control group[4] that doesn't receive an HIV test. People who believed they were at high risk for HIV decrease their likelihood of an STI by 4 percentage points after an HIV negative test. Again this effect is large and represents over a 60% decrease in the likelihood of contracting an STI compared to a comparable control group.[5] When HIV test results agree with a person's beliefs of HIV status, the effect of testing on STI likelihood is not statistically different from zero; the point estimate for an HIV negative test for the low risk group is virtually zero, although the same is not true for the estimates of an HIV positive test on the high risk group. These findings suggest that HIV tests have the largest effects on risky sexual behavior when test results provide new information to an individual.

In addition, these results provide evidence that when people make decisions about risky sexual behavior, self-interests dominate altruistic preferences. People who discover they are HIV positive no longer have any incentive to practice safe sex, while those who learn they are HIV negative face greater incentives to avoid risky behavior.

Using the results from this study, I estimate how risky sexual behavior changes as a result of testing. Using the distribution of beliefs of HIV infection and actual HIV status from the VCT Efficacy study data, I simulate the effect of rolling out HIV testing to a sample population of 10,000. In the base case where testing is not available, I estimate 15.4 new HIV infections are generated after 6 months. Under a testing case, where everyone is tested, the number of new HIV infections increases to 19.4. While testing reduces the number of new infections in the high risk/HIV negative group (a reduction of 3.26 HIV infections due to testing), the number of new infections generated by the low risk/HIV positive group is greater (an increase of 7.28 HIV infections due to testing).

[4]The comparable control group are all individuals who believe they are at low risk for HIV but are actually HIV positive and did not receive an HIV test during the baseline round of the study. The mean STI infection rate for the low risk group is 2.0%.

[5]The comparable control group are individuals who believe they are at high risk for HIV but are actually HIV negative and did not receive an HIV test at baseline. The mean STI infection rate for this group is 6.25%.

The overall effect is that using the distribution of preferences, beliefs, and HIV from this study sample, HIV testing leads to a 26% increase in the number of new HIV infections - an unintended consequence of testing.

This study makes several contributions. To the best of my knowledge, it is the first work to simultaneously resolve the selection and measurement error problems involved when identifying the effect that HIV testing has on sexual behavior. Most previous studies have relied on non-random variation in who is tested and self-reported sexual behavior which is subject to reporting bias (Weinhard et al., 1999, Denison et al., 2008).[6] Coates et al. (2000) is the first to successfully randomly allocate HIV tests in SSA, but uses self-reported sexual activity. More recently, Thornton (2008) uses random assignment of financial incentives to learn one's HIV status and improves on self-reported sexual behavior by using observed condom purchases as the outcome of interest. It is however difficult to interpret how changes in condom purchases correspond to changes in actual sexual behavior.[7] This study uses both random assignment into HIV testing and biological markers to measure risky sexual behavior to address both the selection and measurement challenges. Previous work has shown that HIV testing theoretically could lead to higher HIV prevalence (Philipson and Posner, 1993, Mechoulan, 2004). In this study I empirically show an adverse effect of HIV testing on sexual behavior: people who believed they were at low risk increase their risky sexual behavior following an HIV positive test. This finding has important policy implications. The current policy of promoting universal access to HIV testing may need to be modified to avoid adverse consequences.

This work also contributes to the emerging literature on the role that information and beliefs play on an individual's behavior in developing countries (Delavande et al., 2010). Dupas (2010) finds that providing teenage girls in Kenya with the relative risk of HIV infection by age leads to a decrease in unprotected sex.[8] Both Jensen (2010) and Nguyen (2008) provide evidence that providing information on the returns to schooling leads to increases in years of schooling (Jensen) and improvements in test scores (Nguyen) - both authors attribute this behavioral response to low perceived returns of schooling before information is provided. In a related work to this paper,

[6]The reliability of self reported responses to sexual activity is suspect. Several studies have found females under report their level of sexual activity (Gersovitz et al., 1998, Nnko et al., 2004, Allen et al., 2003). The method of eliciting responses to questions about sexual behavior can produce different results (Plummer et al., 2004).

[7]Thornton notes that "condom purchases may not reflect the true demand for safe sex. If knowledge of HIV status increases abstinence, the demand for condoms could fall in response to obtaining test results." Thornton does find that those who receive HIV positive test results purchase more subsidized condoms than HIV positive individual's who did not receive their results, implying that those who learn they are HIV positive incur a a small private cost to protect their sexual partners. Overall, she does not detect a large behavioral response to HIV testing.

[8]Dupas uses pregnancy rates as a biomarker to measure unprotected sex.

de Paula et al. (2010) find that beliefs of HIV infection are an important determinant for married men in Malawi to engage in extramarital affairs.[9]

The paper is structured as follows. Section 2 outlines a simple model which shows that theoretically HIV testing has ambiguous effects on behavior. Section 3 describes the features of the data. Section 4 provides the empirical strategy and results, and, Section 5 does a simple simulation showing the effects of testing on new HIV infections.

2 Model

An individual chooses a level of risky sexual behavior j to maximize utility $U(j)$

$$U(j) = u(j)A(\pi) - [\pi + (1-\pi)j\lambda(\beta, W)]c$$

where c is the personal disutilty of HIV infection, and π is the belief of being infected with HIV. Altruism is modeled as $A(\pi) \in [0,1]$ where $A'(\pi) < 0$ or that as beliefs increase a greater discount will be applied to utility. The function $\lambda(\beta, W)$ determines the probability of becoming infected and is a function of β (HIV transmission rate) and W (prevalence). One can think of j as being the number of sexual partners, and $u(j)$ is increasing in j and is concave. Note that the choice of j is a function of π (beliefs of HIV infection). The first-order condition is:

$$u'(j)A(\pi) - (1-\pi)\lambda(\beta, W)c = 0$$

The comparative statics show the effect of changing beliefs π, on risky sexual behavior or $\partial j/\partial\pi$. Using the implicit function theorem we get:

$$\frac{\partial j}{\partial \pi} = -\left(\frac{u'(j)A'(\pi) + \lambda(B, W)c}{u''(j)}\right)$$

Since by concavity, $u''(j) < 0$, and given a non-zero HIV transmission rate ($\lambda(\beta, W) > 0$), the sign of $\frac{\partial j}{\partial \pi}$ depends on $u'(j)A'(\pi) + \lambda(B, W)c$. When altruism has a large effect on people's behavior, $u'(j)A'(\pi) + \lambda(B, W)c < 0$ and risky sexual behavior decreases as beliefs about HIV infection increases ($\partial j/\partial\pi < 0$). When altruism has a small effect on people's behavior then

[9]de Paula et al. (2009) find that decreases in beliefs of HIV infection lead to increases in the likelihood of a self-reported extramarital affair, while increases in beliefs of HIV infection lead to a decrease likelihood of an affair.This paper presents findings that show the opposite effect: when beliefs of HIV infection increase, risky sexual behavior increases. However, differences in the preferences (i.e. the level of altruism) between the populations of interest in both papers may explain the differences in outcomes.

$u'(j)A'(\pi) + \lambda(B, W)c > 0$ and people increase their risky sexual behavior as their beliefs increase ($\partial j/\partial\pi > 0$).

In the context of HIV testing, testing affects risky sexual behavior by changing beliefs of HIV infection. If people have low beliefs about HIV infection, an HIV+ test will increase beliefs, while those with high beliefs of HIV infection will decrease their beliefs when receiving an HIV- test. If HIV tests agree with beliefs of HIV infection, then there should be no change in beliefs and hence, no change in sexual behavior.

3 Data

The data is from the HIV Voluntary Counseling and Testing Efficacy study conducted in 1995-1998 (Coates et al., 2000). The study was designed to assess whether HIV testing and counseling is effective at reducing risky sexual behavior. My analysis uses data from the study sites in Nairobi, Kenya and Dar Es Salaam, Tanzania.[10] In both places, a single study site was placed in/near a health center. These sites enrolled, surveyed, and tested participants. A combination of media (flyers, radio and TV advertisements) and recruiters were used to recruit study participants; those participating in the study did not represent a random sample from their communities. In a later section, a comparison of demographic characteristics is made between study participants and a random sample from Nairobi and Dar es Salaam using data from the Demographic Health Surveys.[11] Recruitment and enrollment at both study sites occurred from June 1995 to March 1996. Individuals who previously tested positive for HIV were ineligible for the study. Over 90% of participants reported never receiving an HIV test before the study. The initial sample consists of approximately 2,900 people who were seeking HIV-related services, with 1/3 of them enrolling as a couple. (see Kamenga et al.(2000) for an in-depth description of the study's design and methods.)

Figure 1 presents the study design. A baseline survey was conducted and urine samples were taken of all individuals.[12] Study participants were then classified as either individuals or couples. They were then randomly assigned either to receive VCT services (treatment arm) or health education (control arm). People assigned into the VCT arm got counseling and were offered an HIV test, of which 93% accepted the test.[13] Test results were available 2 weeks after testing; 78%

[10] Port of Spain, Trinidad was the third study side and is excluded from this analysis because of low HIV prevalence. Estimates of HIV prevalence in Kenya and Tanzania were 14 and 11% respectively, while in Trinidad it was 3% [CAPS, 2000].

[11] DHS surveys are available for Nairobi, Kenya and Dar es Salaam in 1996.

[12] Urine samples at baseline were not tested for any STIs and kept frozen at the study sites.

[13] Of the 1477 in the VCT treatment arm, 1385 opted to take an HIV test.

of those in the treatment arm returned to the clinic to receive their HIV test results. Participants enrolled as a couple were strongly encouraged to share their HIV test results with each other. People in the control arm watched a video which described ways to prevent HIV infection and had a question and answer session with a health information officer.[14]

Six months after the baseline survey, a follow up survey was given. At this time, everyone was resurveyed and gave a urine sample. The urine sample was tested for two sexually transmitted infections (STIs): gonorrhea and chlamydia. For people who tested positive for an STI, their urine samples from the baseline survey were also tested. By doing this, we are able to determine which STI cases were new (infections between baseline and 6 months), and which preexisted before the study. Those in the health information control arm were offered VCT services, and 84% accepted an HIV test.[15] The difference and implications of HIV test acceptance rates between the treatment (93%) and control arms (84%) are discussed in the "HIV Status" section.

Baseline summary statistics for the treatment and control group are in table 2. Demographic data is presented in rows 1-9, and relationship status is in rows 10-14; the average age is 28, and 40% of study participants are married. Under the HIV/AIDS section (rows15-18), we see that awareness of how HIV is transmitted is high (row 15),[16] but few have been tested (row 17). Self-reported sexual activity during the 2 months prior to the baseline survey is reported in rows 19-28. Slightly over 20% of participants had two or more partners (row 19), and about 12% have had a commercial sex partner.[17] A high proportion in both the treatment and control groups report having symptoms of a sexually transmitted disease (STD) over the past 6 months (row 28). Overall the treatment and control groups are balanced across most covariates.

Baseline HIV tests for the treatment group (Column 1, Row 18) reveal HIV prevalence to be at 20%, which is higher than estimated HIV prevalence in urban Kenya (13-14%) and Dar es Salaam, Tanzania (10-12%) (Balmer et al., 2000, Sangiwa et al., 2000). This suggest that those who selected to participate in the study are more sexually active and are a higher risk group than the general population. Given the main intervention (treatment) of the VCT Efficacy study is to

[14]Since the treatment and controls arms differ not only due to HIV testing, but different information interventions (counseling in the treatment arm and a video in the control arm), there may be differences between arms in what people learn about HIV. I compare changes in HIV/AIDS knowledge and awareness between the treatment and control arms during the study and find no differences (see appendix section 8.1).

[15]Of the 1223 in the control arm who returned for the 6 month follow up survey round, 1022 accepted an HIV test.

[16]The HIV/AIDS knowledge test asks participants 12 questions about how HIV is transmitted. Examples of questions include: "Can a person get AIDS or the AIDS virus from: working near someone, eating food cooked by someone who has the AIDS virus, using public toilets, having sexual intercourse without a condom with someone who has the AIDS virus?"(CAPS, 2000)

[17]Commercial sex partners are defined as when money is exchanged for sexual activity.

offer free HIV testing, the population of interest is sexually active individuals seeking HIV testing services. Since the policy of universal access to HIV testing is focused on expanding the number of sites where HIV tests can be obtained, this population is the relevant one to study when examining the effects of HIV testing on behavior.

Attrition in the study is both high and similar in the treatment and control arms (32% v. 34%) (Figure 2) The two main concerns of high attrition are its potential effects on external and internal validity. If those leaving the study are different from those that remain, then any estimated effects found for HIV testing might not apply to the population of interest (sexually active people seeking HIV tests). Table 3 presents summary statistics of those who remain in the study (columns 1 & 4) and those that leave (columns 2 & 5). Across most demographic and relationship variables there are no statistically significant differences (p-values in columns 3 & 6); a higher proportion of Muslims appear to have left the study (row 5), and those from wealthier households may have also left the study in greater numbers (rows 8,9). When examining HIV/AIDS and self-reported sexual activity (rows 15-29), there are no statistically significant differences with the exception of STD symptoms (row 29). Given the few statistically significant differences between those in the study and those that left, the sample that remains in the study should be relevant when making inferences about the population of interest (sexually active individuals seeking HIV testing).

In order to see if attrition affects internal validity,[18] I examine if there is evidence of differential attrition. In Table 3, column 7, the difference between those that left the treatment and those that left the control arm are calculated (p-values included in column 8). There are very few statistically significant differences across demographic, relationship, and HIV/AIDS variables (rows 1-18). Most importantly, there are no statistically significant differences in self-reported sexual activity with the exception of STD symptoms (row 29). The higher rate of STD symptoms in those leaving the treatment arm suggests that the treatment sample that remained in the study may engage in safer sexual activity. This potential bias to any estimation will be discussed in the results section. Overall, there isn't evidence of significant differential attrition between the treatment and control arms, and hence attrition should not threaten the internal validity of the research design.

I now discuss three important aspects of how I use the data: 1) Measuring Risky sexual behavior, 2) Identifying people's HIV status, and 3) measuring people's beliefs about HIV infection.

[18] For example, if people who engage in riskier sex left the treatment arm in greater proportions than the control arm, any decreases in risky sex attributable to assignment into the treatment arm may actually be due to differential attrition

3.1 Measuring Sexual Behavior

Sexual behavior is difficult to measure because it is unobserved and, due to its sensitive nature, self-reports of sexual behavior are subject to a high degree of social desirability bias (Fenton et al., 2001, Weinhardt et al., 1998). When survey participants are asked about their sexual behavior, they may misreport because of social norms, stigma, and to avoid criticism of their behavior (Turner et al., 2009). When biological markers (biomarkers) such as sexually transmitted infections are collected in a study, they typically provide evidence that self-reports underestimate actual sexual activity (Minnis et al., 2009, Gallo et al., 2006).

Given the bias present in self-reported behavior, recent research in measuring sexual behavior has incorporated biomarkers[19] as objective measures of sexual behavior (Mauck and Straten, 2008, Gallo et al., 2006, Minnis et al., 2009, Cleland et al., 2004). Biomarkers act as proxies for risky sexual behavior, as the likelihood of one is increasing in both acts of unprotected sex and number of partners.

In this paper, the incidence of gonorrhea and chlamydia infections are used as measures of risky sexual behavior. The primary means of transmission for both infections is unprotected sexual contact and nonsexual transmission is extremely rare (Neinstein et al., 1984). Both infections are sensitive to risky sexual activity: transmission rates are between .20 to .80 per unprotected sexual act with an infected individual (Kretzschmar et al., 1996, Chen et al., 2008).[20] [21] Going forward, STIs will refer specifically to gonorrhea and chlamydia infections (and not HIV).

Since the goal of using biomarkers is to measure risky sexual behavior during the course of the study I rely on the incidence of STIs instead of prevalence. What's the difference? Prevalence can be seen as a stock, or the number of STIs at any given point in time, where incidence is a flow and measures new infections over a time period. In the case of this study, incidence measures the number of new STI cases between baseline and the 6 month follow up.[22] Given that the duration

[19]Biomarkers range from sexually transmitted infections (gonorrhea, chlamydia, syphilis), residual semen or prostate-specific antigens, and pregnancy - all signs that unprotected sex took place (Fenton et al., 2001, Minnis et al., 2009).

[20]Transmission rates vary by gender. The likelihood of male to female transmission of gonorrhea is .5-.7 per sexual act, and somewhat lower for chlamydia at .5 per sexual act. The likelihood of female to male transmission of gonorrhea is .2-.3 per sexual act, and .25 for chlamydia (Kretzschmar et al., 1996).

[21]Gonorrhea and chlamydia infection rates contrast sharply to HIV transmission rates where are .003 to .001 per unprotected sexual act with an infected person (assuming the infected person is in his/her asymptomatic phase). HIV transmission rates jump to .05 per unprotected sexual act during the acute infection stage which is during the first three months of a new infection (Gray et al., 1999, Cohen and Pilcher, 2005).

[22]Incidence is therefore defined as having no STI at baseline and an STI at the 6 month follow up. Incidence was determined by testing frozen urine samples for STIs for everyone with a positive STI test at the 6 month follow up. This allows one to distinguish preexisting infections from new infections acquired during the study.

of gonorrhea and chlamydia is slightly over 6 months (Chen et al., 2008, Kretzschmar et al., 1996), using the incidence of STIs is a reasonable choice to avoid overestimating the level of risky sexual activity during the study (see appendix, section 8.2 for further details differentiating incidence from prevalence). However, incidence can underestimate risky sexual behavior since those who have an STI at baseline may continue to engage in risky sex during the study; thus I also estimate the effect of HIV testing on prevalence of STIs at 6 months and find results that are very similar to when using incidence as the main outcome.

3.2 HIV Status

The HIV status of everyone in the treatment arm that accepts an HIV test is known at baseline. However, the HIV status of those in the control group at baseline are unknown since they were not offered testing until the 6 month follow up. This is problematic, since I want to compare HIV positive (negative) individuals in the treatment arm to those in the control arm. In order to create a counter-factual group for testing I use the HIV test results from the 6 month follow up for the control group. For the control group, I assume that HIV test results at baseline would have been their same result as the 6 month follow up. Clearly those who are HIV negative at 6 months were also negative at baseline. For people who test HIV positive at 6 months, I assume that all of these individuals were positive at baseline. This assumption relies on evidence which suggests that HIV is not easily transmitted,[23] with estimated transmission rates of approximately .0015-.0007 per coital act when your partner has an established HIV infection(Wawer et al., 2005, Cohen and Pilcher, 2005).[24] There are two possible issues raised with using HIV tests at the 6 month follow up to infer HIV status at baseline: 1) differences between the treatment and control arm in who accepts an HIV test and 2) the effect of new HIV infections in the control arm between baseline and the 6 month follow up. I discuss both issues in detail below, and I provide evidence that issue 1 is not a concern, while issue 2 generates a possible bias in estimation that will be taken into account in the results section.

The intervention offered HIV tests to study participants - no one was mandated or coerced to take a test. The acceptance rate for HIV testings was 94% at baseline in the treatment arm, and 84% at the 6 month follow up in the control arm. Do differences in the test acceptance rate threaten the validity of the counterfacutal groups described above? If test takers in the treatment group have different preferences for risky sexual activity than test takers in the control group it

[23] Of the 750 individuals who tested HIV negative at baseline and retested at 6 months, only 12 became infected, an infection rate of 1.6%.

[24] Transmission rates are higher in early infection stages (.0082 per coital act).

could bias any estimations. To see if there is any evidence of this, a comparison along observables and self-reported activity is made between test takers in the treatment and control arms (Table 4). Column 1 presents all test takers in the treatment arm at baseline, while column 2 restricts the treatment sample to test takers who participate in the 6 month follow up. A t-test of the difference in means between treatment and controls arms is conducted, and p-values are in columns 4 and 5. Reassuringly, almost all demographic and relationship covariates (rows 1-14) are balanced across test takers in the treatment and control arms. More importantly, there are no differences in HIV/AIDS knowledge, testing, and HIV prevalence (rows 15-18). Self-reported sexual activity also appears virtually balanced between both arms. Thus, despite the differences in HIV testing acceptance rates, there is no evidence that test takers are different across treatment and control arms.

How do new HIV infections that occur between baseline and the 6 month follow up in the control group affect the estimates of HIV testing on behavior? Let Y be risky sexual behavior T indicate random assignment into testing, and HIV be HIV status. The average effect of an HIV-negative test on risky sexual behavior is:

$$\beta_{HIV-} = \mathbb{E}[Y_i|T_i = 1, HIV_i = 0] - \mathbb{E}[Y_i|T_i = 0, HIV_i = 0]$$

Since HIV status for the control group is not observed until the 6 month follow up, I estimate:

$$\beta^*_{HIV-} = \mathbb{E}[Y_i|T_i = 1, HIV_i = 0] - \mathbb{E}[Y_i|T_i = 0, (HIV_i = 0)^*]$$

where $(HIV = 0)^*$ is the HIV status at the 6 month follow up. If any individuals in the control group became HIV positive during the course of the study, they would not be included in the HIV negative control group, even though they were HIV negative at baseline. Thus the average risky sexual behavior of the true counter factual group will be greater than the behavior in the control arm:

$$\mathbb{E}[Y_i|T_i = 0, HIV_i = 0] \geq \mathbb{E}[Y_i|T_i = 0, (HIV_i = 0)^*]$$

which results in $\beta^*_{HIV-} \geq \beta_{HIV-}$ or that estimates of the effect of an HIV-negative test on risky sexual behavior will be biased upwards.

What is the effect of using HIV-positive tests at the 6 month follow up to infer baseline status? The average effect of an HIV-positive test on behavior is:

$$\beta_{HIV+} = \mathbb{E}[Y_i|T_i = 1, HIV_i = 1] - \mathbb{E}[Y_i|T_i = 0, HIV_i = 1]$$

Again, using test results at the 6 month follow up generates this effect:

$$\beta^*_{HIV+} = \mathbb{E}[Y_i|T_i = 1, HIV_i = 1] - \mathbb{E}[Y_i|T_i = 0, (HIV_i = 1)^*]$$

where $(HIV = 1)^*$indicates an HIV positive test result at the 6 month follow up. This group will consist of people who were HIV positive at baseline and those who became infected during the course of the study due to risky sexual behavior. The sexual behavior for this control group then will be on average more risky than the behavior for those who were HIV positive at baseline:

$$\mathbb{E}[Y_i|T_i = 0, (HIV = 1)^*] \geq \mathbb{E}[Y|T = 0, HIV = 1]$$

which results in $\beta^*_{HIV+} \leq \beta_{HIV+}$ or that the estimated effect of a HIV-positive test will be biased downwards.

To conclude, my estimates for the effects of HIV negative tests on risky sexual behavior will be biased upwards and biased downwards for HIV-positive tests. I discuss the implications of these biases for my findings in the results section.

3.3 Beliefs of HIV Infection

There are two major challenges faced when measuring beliefs of HIV infection: 1) questions regarding HIV status are extremely sensitive, and 2) actual beliefs cannot be directly verified. Measuring beliefs on HIV infection presents a specific challenge because of the social stigma associated with HIV infection. People who believe they are HIV positive face strong incentives to not reveal their true beliefs.[25] Direct questions about HIV status may therefore lead to biased responses. I generate a belief measure using both direct and indirect questions about HIV status that . In addition, while actual beliefs of HIV infection cannot be observed, I provide evidence that the belief measures used in this paper are valid following guidelines established by Manski (2004) and Delavande et al. (2010) on subjective expectations. If beliefs of HIV status are used by individuals when making decisions about sex, then a valid belief measure should predict this behavior.

A set of four questions that were all designed to measure perceived HIV risk[26] are used to

[25]Manski (2004) notes that "An absence of incentives (to honestly respond to survey questions) is a common feature of all survey research, not a specific attribute of expectations questions. (Manski) is aware of no empirical evidence that responses to expectations questions suffer more from incentive problems than do responses to other questions commonly asked in surveys." When considering questions about HIV status however, the incentive problem changes dramatically because of the costs involved of disclosing an HIV+ status.

[26]All four questions were included on the baseline survey but removed from the 6 month follow up survey. As noted in Grinstead et al. (2001), "Interviewers needed to be blinded to the baseline serostatus of participants during

measure beliefs of HIV infection. These questions were only asked at the baseline survey and are:

Question	Survey Question
A	What are the chances that you will get the AIDS virus?
B	What are the chances that you already have the AIDS virus?
C	How worried are you that you will get the AIDS virus?
D	How worried are you that you already have the AIDS virus?

The responses for the questions use the following Likert scale:

Response for A & B	Response for C & D	Value
Almost certainly will not happen	Not at all or hardly worried	1
It could happen	A little bit worried	2
It probably will happen	Quite a bit worried	3
It almost certainly will happen	Extremely worried	4

All four questions have been used by economists and demographers to measure beliefs of HIV status; Thornton (2008), Delavande and Kohler (2009), and de Paula et al. (2010) measures beliefs using similar language to questions A and B, while Smith and Watkins (2004), Kohler et al. (2007), and Boozer and Philpson (2000) use measures similar to questions C and D. Given that the responses use a Likert scale and are not subjective probabilities, interpersonal comparisons warrant caution.[27]

While question B is the most straightforward means of measuring beliefs of HIV infection, those who believe they are infected may bias their responses downward. The costs of revealing they are HIV positive, or likely to be, can be high. There are a number of cases documenting that those who reveal they are HIV positive are subject to employment discrimination, physical violence (including murder), and social stigma (Simbayi et al., 2007, Skinner and Mfecane, 2005, Brown et al., 2003, Kalichman and Simbayi, 2003).[28] Given the evidence that people misreport their sexual behavior (see section 3.1) due to social desirability bias, it should not be a surprise that people may also misreport their beliefs of HIV infection. The use of questions A,C, and D help resolve this problem. These additional questions are designed to measure perceived HIV risk (Lauby et al., 2006, Smith and Watkins, 2004), and slight changes in language may elicit more accurate responses.

the follow-up interview;".

[27]Two people may have identical beliefs about being HIV infected, but one may respond as "not at all or hardly worried" (1) while the other person may respond as "a little bit worried" (2).

[28]By extension, those who reveal that they believe they are likely to be infected with HIV face similar costs.

In order to utilize the information from all four questions, I take the average response to questions A-D. The median of the average response is 2, which I use to divide the sample into a high and low belief group (Figure 3). Those with an average response of between 1 to 2 are classified as having low beliefs, while those with an average response of between 2-4 as having a high belief of HIV infection. In the robustness section I demonstrate that the results in this paper are not sensitive to this cut point for dividing the sample into low and high belief groups.

How can we be sure this belief measure is an accurate measure of true underlying beliefs of HIV infection? Both Manski (2004) and Delavande et al.(2010) note that it is impossible to know for sure since true beliefs are unobserved. However, if individuals take into account their beliefs of HIV infection when making decisions about sexual activity, then any belief measure should be a good predictor of this behavior. To test this, I examine whether the belief measure at baseline predicts incidents of STIs (the proxy for risky sexual behavior) at the 6 month follow up. I restrict this analysis to the control group since the HIV tests in the treatment arm would change baseline beliefs of HIV infection. The estimating equation is:

$$STI_{ij} = \alpha + \beta_1 High\,Belief_i + X_i'\delta_1 + \gamma_j + u_{ij} \tag{1}$$

where STI_{ij} is an indicator for STI incidence at the 6 month follow up for individual i in country j, $High\,Belief_i$ is an indicator if someone has high beliefs of HIV infection, X_i' is a vector of individual characteristics (i.e. gender, age, religion), and γ_j is a country fixed effect. Estimates are presented in table 5. Columns 1 and 2 present the correlation between the belief measure relying only on question B[29] (the most direct question), while columns 3 and 4 use the belief measure that takes the average response to questions A-D. The belief measure using all four questions is strongly associated with STI incidence and statistically significant at the 1% level, while the belief measure using question B is not. This suggests that the belief measure using responses from questions A-D are a better measure of underlying beliefs than relying on question B alone.

Another useful exercise is to examine whether beliefs of HIV infection are accurate. I estimate equation 1 but replace STI_{ij} with $HIV\,Status_{ij}$ which is an indicator for being HIV positive at baseline. The belief measure using all 4 questions has a slightly stronger correlation with HIV status (table 5; columns 7-8) than the belief measure using only question B (columns 5-6). Given that the transmission risk of HIV is very low (about 1/1000 per coital act)[30], it is not surprising that there is only a weak association between beliefs and actual HIV status.

[29]The $High\,Belief_i$ indicator using only question B takes a value of 1 if someone responds to question B with a "3" or "4" and a zero otherwise.

[30]See Cohen and Pilcher (2005) for more details.

It should be stressed that the results in this section should not be interpreted as casual. What this section does is provides evidence that the preferred belief measure (using all four questions) is a valid measure of beliefs of HIV infection.

4 Empirical Analysis

4.1 Identification Strategy

This paper has argued that risky sexual behavior is a function of beliefs of HIV infection, and HIV tests update beliefs only if test results are different from prior beliefs. Using the measures of prior beliefs described in the previous section, there are two groups where HIV tests should update beliefs: 1) low priors receiving HIV positive tests, and 2) high priors receiving HIV negative tests. In these two groups, HIV tests should also have an effect on risky sexual behavior. Testing should not change beliefs or behavior in the other two groups, 3) low priors receiving HIV negative tests, and 4) high priors receiving HIV positive tests. Table 1 presents the four groups and the predictions of the effects of testing in each group.

Table 1: Four Groups for Analysis: Effect of Testing in Each Group

	HIV-Negative	HIV-Positive
Low Prior Beliefs	Tests have no effect on beliefs or behavior	Tests increase beliefs => Change in behavior
High Prior Beliefs	Tests decrease beliefs => Change in behavior	Tests have no effect on beliefs or behavior

The goal is to identify the effect of HIV testing conditional on prior beliefs. The estimating equation is a linear probability model:

$$\begin{aligned} STI_{ij} &= \alpha + \beta_1 Test_i + \beta_2 High\,Priors_i + \beta_3 HIV_i + \beta_4 Couple_i + \beta_5 (Test_i \times High\,Priors_i) \\ &\quad + \beta_6 (Test_i \times HIV_i) + \beta_7 (Test_i \times High\,Priors_i \times HIV_i) + I_i' \omega_1 + X_i' \delta_1 + \gamma_j + u_{ij} \quad (2) \end{aligned}$$

where $STI_{ij} = 1$ if individual i in country j contracts an STI during the study, $Test_i$ indicates assignment into the HIV testing arm, $High\,Priors_i$ indicates if the individual has high prior beliefs, $HIV_i = 1$ for those who are HIV positive, and $Couple_i$ indicates if the individual enrolled in the study with his/her partner. The vector I_i includes all the interactions of $Test_i$, $High\,Priors_i$, HIV_i, $Couple_i$ that are not explicitly specified, X' is a vector of individual level characteristics, and γ_j is a country fixed effect.

Assignment into the testing arm is randomly assigned, however not everyone in the testing arm receives their test results (there is a delay between testing and availability of results). I therefore employ intent to treat estimators. The random assignment of testing implies that $\mathbb{E}(u_{ij}|Test_i) = 0$ allowing the OLS estimate of β_1 to be unbiased. Since prior beliefs were determined before testing occurred they are not affected by the intervention, and thus β_5 estimates the causal impact of testing conditioned on prior beliefs. As discussed in section 3.2, HIV status for the control group was estimated using test results at the 6 month follow up, therefore estimates of β_6 will be biased downward. Given that estimates of β_6 are positive (see below), estimates serve as a lower bound for the effect of an HIV positive test on the low prior group.

Using the predictions from table 1, we should expect $\beta_1 = 0$ (low priors receiving HIV- test), $\beta_1 + \beta_6 \neq 0$ (low priors receiving HIV+ test), $\beta_1 + \beta_5 \neq 0$ (high priors receiving HIV- test), and $\beta_1 + \beta_5 + \beta_6 + \beta_7 = 0$ (high priors receiving HIV+ test).

4.2 Results

Table 6 presents OLS estimates of equation 2. STI incidence across the whole sample is 3.91%. Column 1 includes each covariate of interest, while columns 2 and 3 include the full set of interactions. Column 3 also includes a set of controls such as gender, age, education, martial status, and a country fixed effect.

I estimate the effects of HIV-positive and HIV-negative tests by each prior belief group. Individuals with low prior beliefs who receive HIV negative tests have little change in STI incidence (row 8). The point estimate across both specifications is virtually zero, and standard errors are relatively small. This finding is consistent with a model where HIV negative tests don't provide any new information to those with low prior beliefs. If beliefs of HIV infection remain unchanged, then behavior will as well.

To examine the effect of an HIV positive test on individuals with low prior beliefs, I estimate the linear combination $Test + (Test \times HIV+)$ (row 9).[31] The effect is very large and statistically significant; those with low priors have about a 12 percentage point increase in STI incidence after receiving an HIV positive test.[32] Given that the STI incidence for the low prior control group is 2.0%, this represents a 6-fold increase in STI likelihood after an HIV positive test. The result is also consistent with a model where people with low prior beliefs update them after receiving an HIV positive test. The increase in beliefs in this case leads to an increase in risky sexual behavior.

[31] I exclude the HIV indicator because I compare HIV positive individuals with low prior beliefs who get tested vs. HIV positives with low prior beliefs who are not tested.

[32] This estimate is also a lower bound of the effect of HIV+ tests on those with low prior beliefs (see section 3.2).

This suggests that self-interests have a larger effect on sexual behavior than altruism; once people revise their beliefs upwards, they face far less incentive to engage in safe sex.

Now I turn to the group with high prior beliefs of HIV infection. The effect of an HIV negative test for individuals with high priors is the linear combination $Test + (Test \times High)$ (row 10). STI incidence decreases by 4 percentage points after an HIV negative test.[33] The effect is statistically significant at the 5% level and the magnitude is large; the mean STI rate of the high prior belief control group is 6.47%, thus testing reduces STI incidence by 60%. Those who update their beliefs of HIV infection downward appear to be reducing their risky sexual behavior. This is consistent with people having greater incentives to protect themselves when they learn they are uninfected. Finally, the effect of HIV positive tests on high prior types is the linear combination $Test + (Test \times HIV) + (Test \times High) + (Test \times High \times HIV)$ (row 11). There is no statistically significant effect on STI incidence, as predicted, but given the wide confidence intervals, inference warrants caution.

The model presented in this paper predicts that HIV testing only affects behavior if it changes beliefs of HIV infection. A question that arises from this prediction is, "Do HIV+/HIV- tests have differential effects *within* and *between* low and high prior groups?" To examine if an HIV+ test has a differential effect to an HIV- test within the low prior group and high prior group, I test the following null hypotheses: for low priors $H_0^1 : (Test \times HIV) = 0$ (row 12),[34] and high priors $H_0^2 : (Test \times HIV) + (Test \times HIV \times High) = 0$ (row 13). For the low prior group, I reject the null (H_0^1) at the 1% confidence level (row 12; F-stat = 7.3, 6.5 with controls), and infer that HIV+/HIV- tests have differential effects within the low prior group. However, I cannot make the same claim for the high prior group since I am unable to reject the null (H_0^2) (row 13; F-stat<1). To examine differential effects between the low and high prior groups, two additional hypothesis are tested, $H_0^3 : (Test \times High) = 0$ for HIV- tests (row 14),[35] and $H_0^4 : (Test \times High) + (Test \times High \times HIV) = 0$ for HIV+ tests (row 15). In both cases, I reject the null, with H_0^3 rejected at the 10% level and H_0^4 rejected at the 1% level. Both of these tests provide evidence that HIV tests have differential effects between prior belief groups which is consistent with the model in this paper.

Overall, these results provide strong evidence that HIV testing only affects people's behavior

[33] This estimate represents an upper bound on the effect of HIV negatives tests on those with high prior beliefs (see section 3.2).

[34] For those with low priors, the effect of an HIV negative test is simply $Test$ and an HIV positive test is the linear combination $Test + (Test \times HIV)$ so to test whether there are differential effects, the null would be $H_0 : Test = Test + (Test \times HIV)$ which simplifies to $H_0 : (Test \times HIV) = 0$.

[35] For those with low priors, receiving an HIV- test is $Test$ and for those with high priors, receiving an HIV- test is $Test + (Test \times High)$ so to test whether an HIV- test has a differential effect between low vs. high prior groups, the null would be $H_0 : Test = Test + (Test \times High)$ which simplifies to $H_o : Test \times High = 0$.

if it changes beliefs about HIV infection. Is it possible to see how people actually change their behavior? There are a few types of behavior that are of interest. The first is how does risky sexual behavior change. Are the types with higher STI rates after testing (low prior beliefs/HIV+) having more partners or reducing condom use? Another behavioral change of interest is if there is assortative matching by HIV status (Dow and Philipson, 1996). If those who receive HIV positive tests are seeking out partners who are also HIV positive, this will mitigate the adverse effects of any increase in risky sexual behavior by these types.[36] Finally, another behavioral change might explain the STI results; those who are receiving HIV tests might changing the way they treat STIs. For example, those in the high prior belief group who receive HIV negative tests are less likely to have an STI; this result could be explained by these types seeking treatment for their STIs instead of any change in sexual behavior. To examine these various behavioral changes, I look at the self-reported behavior from the six month follow up survey.

I again estimate equation 2, but this time I replace the STI outcome with self-reported sexual behavior. Measures of sexual behavior in the 6 month follow up survey are: 1) an indicator for whether the person has had sex 2) an indicator if they had 2 or more sexual partners, 3) an indicator if they had unprotected sex with a non-primary partner, and 4) an indicator if they have a different sexual partner from baseline (Table 7; columns 1-4).[37] I focus the analysis on the two groups where there are changes in STI incidence: low prior beliefs/HIV+ test result and high prior beliefs/HIV- test result. Individuals with low prior beliefs who receive HIV+ tests have a 21% less likely to engaging in any sexual activity (row 9; column 1) and have no statistically significant changes in other types of sexual activity (row 9; columns 2-4). This result is puzzling, given these types are more likely to have an STI. What explains this? One explanation is that low prior types who receive HIV+ tests change their sexual behavior in a way that is not captured by any of these self-reported responses. A more likely explanation is that self-reported sexual behavior is inaccurate due to social desirability bias (Fenton et al., 2001). Individuals who learn they are HIV+ might simply be telling enumerators the "correct" sexual behavior that counselors have instructed them to do. This pattern is repeated with high prior types receiving HIV+ tests; these types are less likely to engage in unprotected sex (row 11, column 3), but there are no statistically significant decreases in STI incidence (table 6, row 11).

[36] Specifically, when HIV positive types increase their risky sexual behavior they make it more riskier for HIV negative types to engage in risky sexual behavior since they increase the likelihood that an HIV negative individual will match with an HIV positive individual.

[37] The questions on sexual behavior ask using a two month time frame (i.e. At the 6 month follow up survey, the questions ask about sexual behavior over the past two months). Indicators (2)-(4) of sexual behavior are conditioned on being sexually active.

Another behavioral change I examine is assortative matching by HIV status. It maybe that after individuals receive their HIV test results, they attempt to match with partners that have the same HIV status. This has important implications if HIV positive types match with partners who are also HIV positive; this type of behavior at the extreme will effectively shut down new HIV infections. While data does not exist for the HIV status of sexual partners that are not enrolled in the study, the 6 month follow up survey does ask study participants if their most recent sexual partners have been tested for HIV. If assortative matching on HIV status is occurring, then one expects those who tested for HIV will also have partners who have been tested. I create an indicator that takes the value of one if an individual's sexual partner has been tested for HIV. Equation 2 is estimated using this indicator as the dependent variable (table 7; column 5).[38] For those who receive HIV negative tests (rows 8,10), there appears to be an increase likelihood that their sexual partners have also been tested; the association is the opposite with the low prior belief group receiving HIV positive tests - individuals in this group are much less likely to match with a partner who has been tested. This suggests that there may be matching for HIV negative types but not for HIV positive types.

The final behavior examined is whether those who have a change in STI incidence are changing their treatment of STIs. An indicator takes the value of one if the person has sought treatment for an STI conditioned on being sexually active and having symptoms of an STI. Equation 2 is estimated with this indicator as the dependent variable (table 7, column 6). There are no statistically significant changes in STI treatment in any of the groups of interest.

Given the conflicting results between the biomarker outcomes and the self-reported sexual behavior, I rely on the STI outcomes as the basis of my inference. In Section 5, I use a simple model of STI & HIV transmission to estimate changes in risky sexual behavior based on the STI results. These estimated changes in sexual behavior will then be used to calculate the change in HIV infections as a result of testing.

4.3 Robustness

4.3.1 Are beliefs the channel through which HIV testing is affecting behavior?

While offers of HIV testing were randomly assigned, the research design did not stratify by prior beliefs and randomize within each belief group. There are two possible issues that could affect inference. The first issue concerns whether there are preexisting differences between treatment

[38]This specif cation is only estimated on individuals enrolled in the study. Couples enrolled in the study always have their sexual partners tested. This is why the number of observations is 916.

and control in each of the four groups analyzed, while the second issue is whether prior beliefs are correlated with other variables that might be driving the results.

Regarding the first issue of preexisting differences, if within each of the four groups analyzed: 1) Low Priors/HIV-, 2) Low Priors/HIV+, 3) High Priors/HIV-, and 4) High Priors/HIV+ (see table 1), there were differences between the treatment and control group before treatment assignment then the effect I am inferring from testing might be driven by preexisting differences. For example, for those with low priors who are HIV positive, if the treatment arm had a higher proportion of males and if males engage in riskier sex, than the testing effect I find for this group might be due to the higher proportion of males and not to HIV testing.

To show that preexisting differences between the treatment and control arms are not a concern, I present comparisons of baseline characteristics for the treatment and control arms in each of these four groups (table 8). The two groups that I focus on are the ones where testing has an effect. The first group, the low prior/HIV positive (testing increases risky sexual behavior), is present in columns 4-6. There are no statistically significant differences on any baseline demographics, although given the relative small size of this group (n=144), there may not be enough statistical power to detect small differences. Since individuals in this group increase their risky sexual behavior after an HIV test, I pay particular attention to any differences in self reported sexual activity. Again, across these variables, there are no statistically significant differences. It does appear that the control group may be a riskier group given that a higher proportion of them report having sex with two or more partners (.22 v .15; row 19) and engaging in sex with a commercial partner (.17 v. .08; row 21) compared to the treatment group. This provides additional support that the HIV positive control group engages in riskier sexual behavior (section 3.2) and that estimates of HIV testing in this group serve as a lower bound for the true effect. The second group where testing has an effect is the high prior/HIV- group (testing decreases risky sexual behavior), is presented in columns 7-9. There are no statistically significant differences on any demographics except for the number of children (row 13), and this difference is very small. Focusing on self reported sexual behavior, the control group has a lower proportion reporting sex with a non-primary partner (.23 v.30; row 22). This is consistent with the discussion in section 3.2 showing that the HIV negative control group engages in safer sexual behavior. Overall, across 112 tests of difference of means (4 groups X 28 variables), I find only 2 statistically significant differences at the 5% level. Based on these observed and self-reported characteristics, there doesn't appear to be major pre-testing differences between the treatment and control arms in each group. This provides evidence that the changes in risky sexual behavior are due to testing.

The second issue is whether prior beliefs are correlated with other individual characteristics.

Using a similar example as before, if there were more males in the low prior belief group and females in the high prior belief group, the effects of testing maybe due to differential responses in gender and not beliefs. To see which characteristics are correlated with beliefs, I compare baseline characteristics between the low and high prior belief group (table 9). There are differences in self-reported sexual behavior, which makes sense. The high prior group has a higher proportion of multiple partners and sex with commercial partners. There are also differences on other characteristics which may confound the inference of the results. For example, a larger portion of those with low priors are married when compared to the high prior group. (.45 v .34). It maybe the case that married types respond to HIV positive tests by increasing their sexual activity outside of marriage in order to protect their spouse. This could explain the increase in STI incidence for low prior types receiving HIV+ tests. There is also a difference in sexually transmitted disease (STD) symptoms. These symptoms include burning or itching in the genitalia area. Those with STD symptoms may seek medical treatment and take antibiotics. It could be the case that since those with low priors also have fewer STD symptoms that a smaller proportion of them are on antibiotics. If this is the case, it could explain the increase in STIs at the 6 month follow up.

To examine whether HIV tests are working through beliefs vs. an alternative channel, I estimate the main equation (2) and interact test and HIV status with the following variables: marriage, Christian, HIV/AIDS counseling, HIV testing, and STD symptoms. I present the results in table 10. Column 1 has demographic interactions (marriage, Christian), column 2 uses interactions of HIV/AIDS awareness (counseling and testing), column 3 includes interactions of STD symptoms, and finally column 4 includes all interactions. The estimated effects of HIV testing by prior belief groups remain stable. The effect of an HIV positive test on the low prior group (row 9) remains large and statistically significant, as does the effect of an HIV negative test on those with high priors (row 10). These results suggest that HIV testing is working through beliefs to affect sexual behavior and not through an alternative channel.

4.3.2 Are results sensitive to how belief groups are specified?

The low and high prior belief groups used in the main analysis were determined by taking the average response of four questions designed to measure HIV risk perception and dividing the sample by the median response. One potential concern is that the results are sensitive to using the median response as the cut point determining low and high priors. To examine how sensitive the results are to this cut point, I use six different cut points and estimate the effects of HIV testing for each new cut point. Figure 4 shows the distribution of responses, and the 6 alternative cut points used to determine the low and high prior belief groups. For example, with a cut point of

1.25, all responses below this will be grouped into low priors, while those equal or above the point will be grouped into high priors. Equation 2 is then estimated using this cut point. Results of each estimation using each cut point are in table 11. The results remain fairly stable across all six specifications. Those with low priors receiving an HIV+ test show an increase in risky sex that is statistically significant in four out of the six cut points (row 2). The attenuation of the effect also makes sense as the cut point increases; a high cut point implies that fewer people will be surprised by an HIV positive test. The same pattern is found with high priors receiving an HIV negative test (row 3). All cut points show a decrease in risky sex, with the effect becoming attenuated as the cut point decreases - again this makes sense as fewer people are surprised by an HIV- test with a lower cut point. Finally the estimates for HIV- tests for those with low priors (row 1) , and HIV+ tests for those with high priors (row 4) are not statically significant. Overall, the results in this paper do not appear to be sensitive to the cut point used to determine the low and high prior belief groups.

The four questions used to determined beliefs of HIV infection were given equal weight. It maybe that some questions are more accurate with HIV status or have more predictive power for risky sexual behavior. An alternative method of determining prior beliefs is to use weight each question by how accurate it is of HIV status or predictive of risky sexual behavior. I estimate the following equations

$$HIV\ Status_i = \alpha + \beta_1 A_i + \beta_2 B_i + \beta_3 C_i + \beta_4 D_i + u_i \tag{3}$$

$$STI_i = \alpha + \beta_1 A_i + \beta_2 B_i + \beta_3 C_i + \beta_4 D_i + u_i \tag{4}$$

where $HIV\ Status_i$ is baseline HIV status, and STI_i is an indicator for an STI for person i at the 6 month follow up only for the control group. Questions A-D enter each equation (A_i, B_i, C_i, D_i) following the parametrization described in section 3.3. For example, if someone answers question A with a "1" or "2" then $A_i = 0$ and a response of a "3" or "4" leads $A_i = 1$. I then determine each individual's predicted HIV status or STI incidence. Taking the median for each distribution, I split the sample into a low and high prior belief group. Equation 2 is then estimated, and the results are presented in table 11. Using either predicted HIV status or STI incidence to determine prior beliefs, I find the results are very similar to my main findings (columns 7-8).

Under a number of different specifications to determine prior beliefs of HIV infection, estimates of the effects of HIV testing conditioned on prior beliefs remain consistent. This provides strong evidence that the main results are not driven by how prior beliefs are specified, but that testing does have differential effects depending on priors.

5 Short-Term Effect of Testing on New HIV Infections

The effect of HIV testing on new HIV infections requires the following: 1) estimating how sexual behavior changes from testing using the results on STI outcomes (table 6), 2) comparing how HIV transmission rates change due to changes in sexual behavior from testing, and 3) estimating new HIV infections in a base case without testing and in a case where everyone is tested. The first two steps will use an epidemiological model, while the third step will rely on the distribution of prior beliefs and HIV in the population.

To estimate how HIV testing affects sexual behavior, the results using STI outcomes from section 4.2 need to be converted into sexual behavior. For example, if a group has increases in STI incidence after testing, what does this imply with regards to sexual activity? Decreased condom use? An increased number of partners? Since the self-reported sexual behavior conflicts with the biomarker outcomes, I employ an epidemiological model to estimate sexual behavior change. The same model will then use estimates of sexual behavior to determine HIV transmission rates amongst the four groups (low/high priors; HIV+/HIV-; Table 1).

The AVERT model (Rehle et al., 1998) is used to estimate both changes in sexual behavior and HIV transmission rates. The simple model predicts the likelihood of infection from HIV or an STI, and is driven by the probability of matching with someone who is already infected, and conditional on this match, the probability of becoming infected. The model is defined as

$$\mathbb{P}(Infection) = 1 - \left\{P[1 - R(1 - FE))^N + (1 - P)\right\}^M \tag{5}$$

where $\mathbb{P}(Infection)$ is the likelihood of becoming infected with either HIV or an STI, $P =$prevalence, $R =$infectivity or the probability of infection per unprotected sexual act, $F =$fraction of sex acts where a condom is used, $E =$ effectiveness of condoms, $N =$Number of sex acts per partner, and $M =$number of sexual partners. Parameter estimates for condom effectiveness (E) and infectivity (R) come from epidemiological research (Kretzschmar et al., 1996, Sweat et al., 2000, Gray et al., 2001), while sexual acts per partner N and prevalence of STIs (P) comes from the study (table 12; column 1)

For step 1, estimating the change in sexual behavior from testing, I focus on M or the number of sexual partners.[39] Solving equation 5 for M results in:

$$M = \frac{log(1 - \mathbb{P}(\text{STI}))}{log(P[1 - R(1 - FE))^N + (1 - P))} \tag{6}$$

Using the parameter values from table 12, and applying the STI outcomes from table 6 for $\mathbb{P}$(STI), changes in sexual behavior M are generated (table 13). For example, in the first cell are low priors who are HIV+. The control arm has an STI incidence of 2.0% which generates an estimated number of partners at .19. This can be interpreted as the rate of partner turnover, so approximately 1 in 5 from this group changed partners during the 6 month study. The STI incidence in the testing arm is 14% (.02 + .12), which translates into 2.67 partners during the study period. In the high prior X HIV positive and low prior X HIV negative cell I assume no changes in sexual behavior from testing.

Step 2 converts the sexual behavior (M) into HIV transmission probabilities for HIV positive types (P(Transmitting), and HIV infection probabilities for HIV negative types (P(Infection)). The probability of infection simply uses equation 5, using parameter values from table (12; column 2) and sexual behavior estimates from step 1. To calculate the probability of transmitting HIV to another individual requires a trivial modification of equation 5:

$$\mathbb{P}(HIV\,Transmission) = 1 - [P + (1 - P)(1 - R(1 - FE))^N]^{M^*} \tag{7}$$

where M^* are the estimates of sexual behavior from step 1. Transmission and infection likelihoods are presented in the final column of each cell in table 13.

The final step is to apply these HIV transmission rates to a sample population segmented by priors and HIV status (table 14). I use the same distribution of priors and HIV as the baseline data. For example, 37% of the individuals in the data have low priors and are HIV negative. I simulate the effects of HIV testing on a hypothetical population of 10,000; the "N" for each cell is simply the mass multiplied by 10,000. In each cell, the number of new HIV infections is determined by multiplying either the transmission rates or infection likelihoods from table 13 by the number of individuals in each cell. A base case (no testing) and testing case are compared, with differences between each case shown for each group. Testing reduces the number of new infections for those with high priors who are HIV negative as these types reduce their risky sexual behavior. Testing however increases the number of new infections for those with low priors who are HIV positive.

[39] The choice of focusing on number of sexual partners and not condom use is not arbitrary. Given the high rates of infectivity for gonorrhea or chlamydia, the most important factor determining likelihood of either of these STIs is the number of partners you have.

The combined effect is that there are 15.4 new HIV infections in the base case which increases to 19.4 new HIV infections in the testing case. Thus, using the distribution and preferences from this sample, HIV testing leads to a 26% increase in HIV infections.

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6 Conclusion

HIV tests provide critical information about a person's health status. If testing provides no new information than there should be no subsequent change in behavior. However, if tests do provide new information, beliefs about HIV infection should update and this drives changes in risky sexual behavior.

These results raise concern that HIV testing under some instances may increase the number of new HIV infections. The behavioral response of those with low priors who receive HIV positive test results is consistent with rational behavior; if there is no longer any benefit of safe sex then individuals no longer need to practice it ("nothing to lose").

Additional research is needed to understand the incentives that HIV positive individuals face when making decisions about sexual behavior. Policymakers may also need to take into account people's beliefs and awareness about their HIV risk so that increased access to HIV testing does not lead to unintended outcomes.

References

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

D. Balmer, O.A. Grinstead, F. Kihuho, S. Gergorich, M. Sweat, M.C. Kamenga, F.A. Plummer, K.R. O'Reilly, S. Kalibala, E.V. Praag, and T. Coates. Characteristics of individuals and couples seeking hiv-1 prevention services in nairobi, kenya: The voluntary hiv-1 counseling and testing efficacy study. *AIDS and Behavior*, 4(1):15–23, 2000.

M. Boozer and T. J. Philpson. The impact of public testing for immunodeficiency virus. *Journal of Human Resources*, 35:419–446, 2000.

L. Brown, K. Macintyre, and L. Trujillo. Interventions to reduce HIV/AIDS stigma: What have we learned? *AIDS Education and Prevention*, 15(1):49–69, 2003.

CAPS. The voluntary hiv counseling and testing efficacy study. 2000. URL `http://www.caps.ucsf.edu/projects/VCT/index.php`.

M. I. Chen, A.C. Ghani, and J. Edmunds. Mind the gap: The role of time between sex with two consecutive partners on the transmission dynamics of gonorrhea. *Sexually Transmitted Diseases*, 35:435–444, 2008.

J. Cleland, J.T. Boerma, M. Cara, and S.S. Weir. Monitoring sexual behaviour in general populations: a synthesis of lessons of the past decade. *Sexually Transmitted Infections*, 80(suppl 2), 2004.

T. Coates, Grinstead O., Gregorich S., W. Wolf D. Heilbron, K.H. Choi, P. Scheirer, A. van der Straten, M.C. Kamenga, M. Sweat, I. De Zoysa, G. Dallabetta, K.R. O'Reilly, E.V. Praag, E. Michael, M. m Ruiz, S. Kalibala, B. Nkowane, D. Balmer, F. Kihuho, S. Moses, F. Plummer, G. Sangiwa, M. Hogan, J. Killewo, Mwakigile, and C. FUrlonge. Efficacy of voluntary hiv-1 counselling and testing in individuals and couples in kenya, tanzania, and trinidad: a randomised trial. *The Lancet*, 356:103–12, 2000.

M.S. Cohen and C.D. Pilcher. Amplified hiv transmission and new approaches to hiv prevention. *Journal of Infection Diseases*, 191:1391–3, 2005.

A. de Paula, G. Shapira, and P.E. Todd. How beliefs about hiv status affect risky behaviors: Evidence from malawi. *Working Paper*, 2010.

A. Delavande and H.P. Kohler. The impact of hiv testing on subjective expectations and risky behavior in malawi. *Working Paper*, 2009a.

A. Delavande and H.P. Kohler. Subjective expectations in the context of hiv/aids in malawi. *Demographic Research*, 20(31):817–874, 2009b.

A. Delavande, X. Gine, and D. McKenzie. Measuring subjective expectations in developing countires: A critical review and new evidence. *Journal of Development Economics*, 2010.

J.A. Denison, K.R. O'Reilly, G.P. Schmid, C.E. Kennedy, and M.D. Sweat. Hiv voluntary counseling and testing and behavioral risk reduction in developing countries. *AIDS Behavior*, 12: 363–737, 2008.

W. Dow and T. Philipson. An emperical examination of the implications of assortative matching on the incidence of hiv. *Journal of Health Economics*, 15:735–749, 1996.

P. Dupas. Do teenagers respond to hiv risk information? evidence from a field experiment in kenya. *American Economic Journal: Applied Economics*, 2010.

K. A. Fenton, A.M. Johnson, S. McManus, and B. Erens. Measuring sexual behaviour: methodological challenges in survey research. *Sexually Transmitted Infections*, 77:84–92, 2001.

M.F. Gallo, F.M. Behets, M.J. Steiner, M.M. Hobbs, T.H. Hoke, K. Van Damme, L. Ralimamonjy, L. Raharimalala, and M.S. Cohen. Prostate-specific antigen to ascertain reliability of self-reported coital exposure to semen. *Sexually transmitted diseases*, 33(8):476, 2006.

M. Gersovitz, H.G. Jacoby, F. Seri Dedy, and A. Goze Tape. The balance of self-reported heterosexual activity in kap surveys and the aids epidemic in africa. *JOURNAL-AMERICAN STATISTICAL ASSOCIATION*, 93:875–883, 1998.

R.H. Gray, M. Wawer, D. Serwadda, N. Swankambo, C. Li, F. Wabwire-Mangen, L. PAxton, N. Kiwanuka, G. Kigozi, J. Konde-Lule, T. Quinn, C. Gaydos, and D. McNAirn. Population-based study of fertility in women with hiv-1 infection in uganda. *Lancet*, 351, 1999.

R.H. Gray, M. J. Wawer, R. Brookmeyer, N.K. Swankambo, D. Serwadda, F. Wabwire-MAngen, T. Lutalo, X. Li, T. vancott, T.C. Quinn, and the Rakai Project Team. Probability of hiv-1 transmission per coital act in monogamous, heterosexual, hiv-1-discordant couples in rakai, uganda. *Lancet*, 357:1149–53, 2001.

O. Grinstead, S.E. Gregorich, Coates Choi, K., the Voluntary HIV-1 Counseling, and Testing Efficacy Study Group. Positive and negative life events after counselling and testing: the voluntary hiv-1 counselling and testing efficacy study. *AIDS*, 15, 2001.

R. Jensen. The (Perceived) Returns to Education and the Demand for Schooling*. *Quarterly Journal of Economics*, 125(2):515–548, 2010.

SC Kalichman and LC Simbayi. HIV testing attitudes, AIDS stigma, and voluntary HIV counselling and testing in a black township in Cape Town, South Africa. *Sexually Transmitted Infections*, 79(6):442, 2003.

M.C. Kamenga, M.D. Sweat, I. De Zoysa, and G. and Dallabetta. The voluntary hiv-1 counseling and testing efficacy study: Design and methods. *ADIS and Behavior*, 4, 2000.

H.P. Kohler, J. Behrman, and S. Watkins. Social networks and hiv/aids risk perceptions. *Demography*, 44(1):1–33, 2007.

M. Kretzschmar, Y.T.H.P. van Duynhoven, and A.J. Severijnen. Modeling prevention strategies for gonorrhea and chlamydia using stochastic network simulations. *American Journal of Epidemiology*, 144(3):306–317, 1996.

J.L. Lauby, L. Bond, D. Eroğlu, and H. Batson. Decisional balance, perceived risk and HIV testing practices. *AIDS and Behavior*, 10(1):83–92, 2006.

C.F. Manski. Measuring expectations. *Econometrica*, 72(5):1329–1376, 2004.

C.K. Mauck and A. Straten. Using objective markers to assess participant behavior in HIV prevention trials of vaginal microbicides. *JAIDS Journal of Acquired Immune Deficiency Syndromes*, 49(1):64, 2008.

S. Mechoulan. Hiv testing: A trojan horse. *Topics in Economic Analysis & Policy*, 4 (1), 2004.

A. M. Minnis, M.J. Steiner, M.F. Gallo, L. Warner, M.M. Hobbs, A. van der Straten, T. Chipato, M. Macaluso, and N.S. Padian. Biomarker validation of reports of recent sexual activity: Results of a randomized controlled study in zimbabwe. *American Journal of Epidemiology*, 2009.

L.S. Neinstein, J. Goldenring, and S. CArpenter. Nonsexual transmission of sexually transmitted diseases: An infrequent occurence. *Pediatrics*, 74:67–76, 1984.

T. Nguyen. Information, role models and perceived returns to education: Experimental evidence from Madagascar. 2008.

S. Nnko, J.T. Boerma, M. Urassa, G. Mwaluko, and B. Zaba. Secretive females or swaggering males? an assessment of the quality of sexual partnership reporting in rural tanzania. *Social Science and Medicine*, 59(2):299–310, 2004.

T. Philipson and R.A. Posner. *Private Choices and Public Health: The AIDS Epidemic in an Economic Perspective*. Harvard University Press, 1993.

ML Plummer, DA Ross, D. Wight, J. Changalucha, G. Mshana, J. Wamoyi, J. Todd, A. Anemona, FF Mosha, AIN Obasi, et al. A bit more truthful, the validity of adolescent sexual behaviour data collected in rural northern tanzania using five methods. *Sexually Transmitted Infections*, 80(90002), 2004.

T.M. Rehle, T.J. Saidel, S.E. HAssig, P.D. Bouey, E.M. GAillard, and D.C. Sokal. Avert: a user-friendly model to estimate the impact of hiv/sexually transmitted disease prevention intervetions on hiv transmission. *AIDS*, 12(suppl 2):S27–S35, 1998.

M.G. Sangiwa, O. Grinstead, M. Hogan, D. Mwakagile, J.Z.J. Killewo, S.E. Gregorich, M.C. Kamenga, M. Sweat, K.R. O'Reilly, S. Kalibala, E. Pragg, and T. Coates. Charcteristics of individuals and couples seeking hiv-1 prenvetion services in dar es salaam, tanzania: The voluntary hiv-1 cousenlgin and testing effiacy study. *AIDS and Behavior*, 4(1):25–33, 2000.

L.C. Simbayi, S. Kalichman, A. Strebel, A. Cloete, N. Henda, and A. Mqeketo. Internalized stigma, discrimination, and depression among men and women living with HIV/AIDS in Cape Town, South Africa. *Social Science & Medicine*, 64(9):1823–1831, 2007.

D. Skinner and S. Mfecane. Stigma, discrimination and its implications for people living with HIV/AIDS in South Africa. *SAHARA J (Journal of Social Aspects of HIV/AIDS Research Alliance)*, 1(3):157, 2005.

K.P. Smith and S.C. Watkins. Perceptions of risk and strategies for prevention: responses to hiv/aids in rural malawi. *Social Science and Medicine*, 60:649–660, 2004.

M. Sweat, S. Gregorich, G. SAngiwa, C. Furlonge, D. Balmer, C. Kamenga, O. Grinstead, and T. Coates. Cost-effectiveness of voluntary hiv-1 counseling and tesitng in reducing sexual transmission of hiv-1 in kenya and tanzania. *Lancet*, 356:112–21, 2000.

R. Thornton. The demand for and impact of learning hiv status: Evidence from a field experiment. *American Economic Review*, 2008.

A.N. Turner, A.E. De Kock, A. Meehan-Ritter, K. Blanchard, M.H. Sebola, A.A. Hoosen, N. Coetzee, and C. Ellertson. Many vaginal microbicide trial participants acknowledged they had misreported sensitive sexual behavior in face-to-face interviews. *Journal of clinical epidemiology*, 62(7):759–765, 2009.

Gray R.H. Wawer, M.J., N.K. Sewankambo, D. Serwadda, X. Li, O. Laeyendecker, N. Kiwanuka, G. Kigozi, M. Kiddugavu, T. Lutalo, F. Nalugoda, F. Wabwire-Mangen, M.P. Maeehan, and T.C. QUinn. Rates of hiv-1 transmission per coital act, by stage of hiv-1 infection, in rakai, uganda. *The Journal of Infectious Diseases*, 191:1403–9, 2005.

.L.S. Weinhard, M.P. Carey, B.T. Johnston, and N.L. Bickham. Effects of hiv counseling and testing on sexual risk behavior: A meta-analytic review of published research. *American Journal of Public Health*, 1999.

L.S. Weinhardt, A.D. Forsyth, M.P. Carey, B.C. Jaworski, and L.E. Durant. Reliability an dvalidity of self-report measures of hiv-related sexual behavior: Progress since 1990 and recommendations for research and practice. *Archieves of Sexual Behavior*, 27, 1998.

WHO. *Towards Universal Access: Scaling up prioirty HIV/AIDS interventions in the health section. Progress Report 2009.* World Health Organization, UNAIDS, UNICEF, 2009.

7 Figures & Tables

Figure 1: Study Design

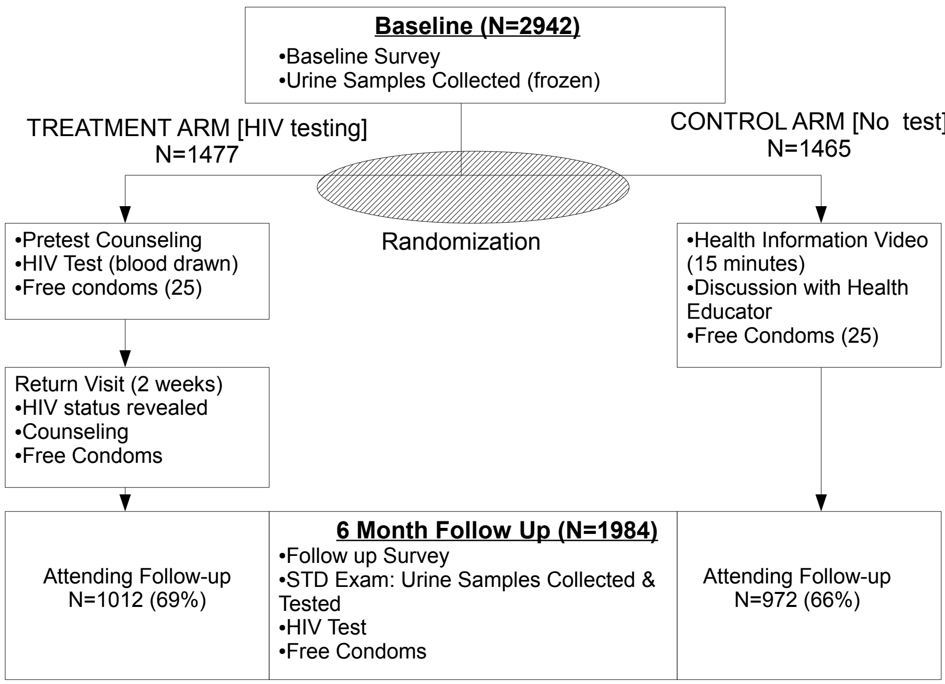


Figure 2: Attrition in Study

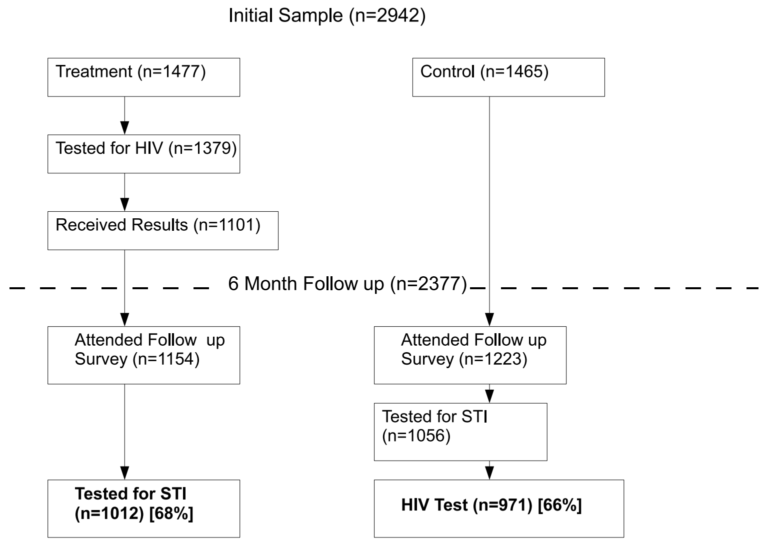


Figure 3: Distribution of Average Response to Questions A,B,C,D

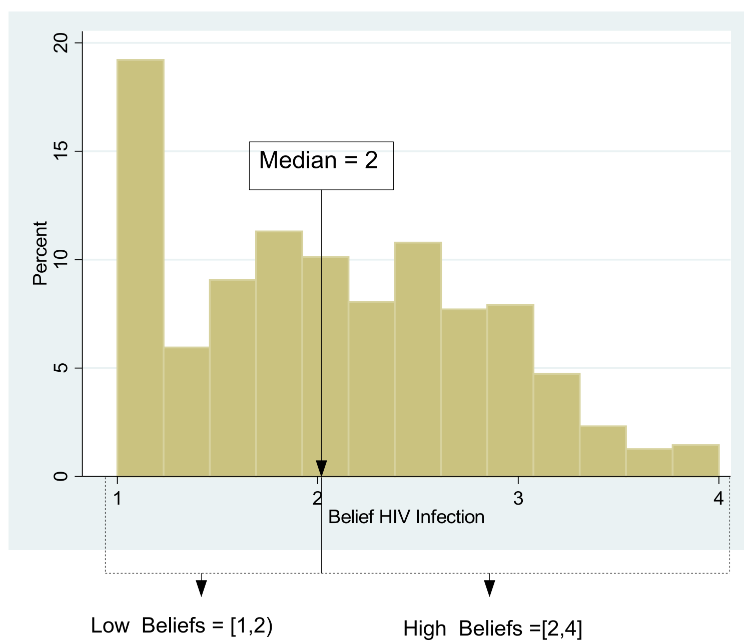
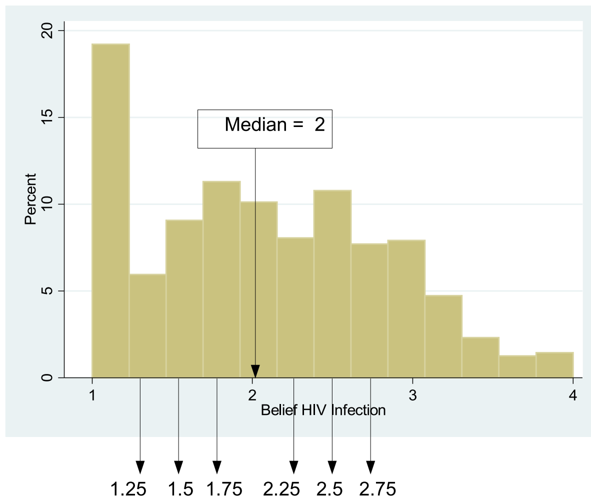


Figure 4: Alternative Cut Points



Cut Points Used to Split Sample into low and high prior belief groups

Table 2: Summary Statistics

	Variable	Treatment Mean	Control Mean	p value
	Demographics	(1)	(2)	(3)
(1)	Male	0.50	0.50	0.97
(2)	Age	28.3	28.3	1.00
(3)	Primary School	0.62	0.63	0.60
(4)	Secondary School	0.26	0.27	0.85
(5)	Muslim	0.28	0.29	0.46
(6)	Catholic	0.33	0.36	0.10
(7)	Christian	0.35	0.31	0.02
(8)	Tap water in home	0.54	0.54	0.96
(9)	Electricity in home	0.44	0.45	0.49
	Relationship Status			
(10)	Enrolled as Couple	0.33	0.32	0.90
(11)	Married	0.39	0.39	0.94
(12)	Cohabiting	0.49	0.49	0.69
(13)	Number Living Children	1.45	1.48	0.65
(14)	Planning for Children in near term	0.20	0.18	0.21
	HIV/AIDS			
(15)	HIV/AIDS Knowledge (out of 12)	9.73	9.76	0.75
(16)	HIV/AIDS Counseling	0.19	0.22	0.07
(17)	HIV Testing	0.01	0.02	0.15
(18)	Baseline HIV+	0.20		
	Sexual Activity Past 2 mo			
(19)	Two or More Partners	0.22	0.21	0.70
(20)	Unprotected Sex with			
(21)	Commerical Partner	0.12	0.13	0.38
(22)	Non-Primary Partner	0.25	0.24	0.42
(23)	Primary Partner	0.50	0.49	0.35
(24)	Episodes Unprotected Sex with			
(25)	Commerical Partner	6.37	7.32	0.31
(26)	Non-Primary Partner	6.50	7.40	0.21
(27)	Primary Partner	12.52	11.92	0.36
(28)	STD Symptoms	0.40	0.37	0.19
(29)	Sample Size	1477	1465	

P-values are reported from t-tests on the equality of means for each variable within treatment and control arms. A primary partner is either a legal/common-law spouse, boyfriend, or girlfriend. Non-primary partners encompass all other partnership types. Examples include: friends, coworkers, casual dates, and commercial sex workers. (Coates et al., 2000, CAPS, 2000)

Table 3: Attrition Analysis

		Treatment Group			Control Group			Attrition	
		In Study	Attrition		In Study	Attrition		Difference	
	Variable	Mean	Mean	p value	Mean	Mean	p value	(2) - (5)	p value
	Demographics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1)	Male	0.51	0.49	0.48	0.50	0.51	0.63	-0.02	0.48
(2)	Age	28.7	27.5	0.00	29.0	27.1	0.00	0.39	0.42
(3)	Primary School	0.62	0.62	0.74	0.63	0.62	0.66	0.00	0.88
(4)	Secondary School	0.27	0.25	0.60	0.26	0.27	0.78	-0.02	0.56
(5)	Muslim	0.25	0.34	0.00	0.26	0.35	0.00	-0.01	0.86
(6)	Catholic	0.34	0.29	0.04	0.37	0.33	0.13	-0.04	0.19
(7)	Christian	0.36	0.32	0.10	0.32	0.29	0.24	0.03	0.29
(8)	Tap water in home	0.53	0.57	0.10	0.51	0.60	0.00	-0.03	0.35
(9)	Electricity in home	0.42	0.47	0.06	0.40	0.54	0.00	-0.07	0.03
	Relationship Status								
(10)	Enrolled as Couple	0.33	0.31	0.40	0.32	0.33	0.83	-0.02	0.58
(11)	Married	0.40	0.38	0.57	0.41	0.36	0.11	0.02	0.54
(12)	Cohabiting	0.48	0.52	0.15	0.49	0.48	0.57	0.05	0.16
(13)	Number Living Children	1.53	1.26	0.01	1.68	1.10	0.00	0.16	0.23
(14)	Planning for Children in near term	0.19	0.21	0.27	0.17	0.20	0.16	0.02	0.56
	HIV/AIDS								
(15)	HIV/AIDS Knowledge (out of 12)	9.75	9.69	0.69	9.70	9.87	0.17	-0.18	0.22
(16)	HIV/AIDS Counseling	0.19	0.19	0.83	0.20	0.25	0.07	-0.05	0.05
(17)	HIV Testing	0.01	0.01	0.53	0.02	0.02	0.67	-0.01	0.33
(18)	Baseline HIV+	0.19	0.23	0.12					
	Sexual Activity								
(19)	Sexually Active	0.82	0.81	0.62	0.80	0.82	0.23	-0.01	0.56
(20)	Two or More Partners	0.22	0.21	0.71	0.21	0.21	0.81	0.00	0.90
(21)	Unprotected Sex with								
(22)	Commerical Partner	0.12	0.11	0.45	0.12	0.14	0.40	-0.03	0.15
(23)	Non-Primary Partner	0.26	0.24	0.42	0.23	0.26	0.19	-0.02	0.45
(24)	Primary Partner	0.51	0.50	0.73	0.48	0.49	0.89	0.01	0.81
(25)	Episodes Unprotected Sex with								
(26)	Commerical Partner	6.74	5.50	0.34	7.73	6.61	0.45	-1.11	0.43
(27)	Non-Primary Partner	6.76	5.92	0.40	7.68	6.93	0.52	-1.02	0.39
(28)	Primary Partner	12.2	13.3	0.24	12.1	11.5	0.51	1.83	0.12
(29)	STD Symptoms	0.38	0.44	0.03	0.37	0.37	0.97	0.07	0.04
	Sample Size	1012	465		972	493			

P-values are reported from t-tests on the equality of means for each variable within treatment and control arms.

In the sexual activity section, "primary" refers to a partner that is either a spouse or boyfriend/girlfriend. "NPP" are Non-primary partners and refer to commercial and casual sex partners.

Table 4: Summary Statistics of HIV Test Takers

		Treatment		Control	Diff: (1)-(3)	Diff: (2)-(3)
	Variable	Mean	Mean	Mean	p value	p value
	Demographics	(1)	(2)	(3)	(4)	(5)
(1)	Male	0.50	0.51	0.51	0.76	0.91
(2)	Age	28.4	28.7	28.9	0.12	0.64
(3)	Primary School	0.62	0.61	0.64	0.32	0.27
(4)	Secondary School	0.26	0.27	0.26	0.94	0.71
(5)	Muslim	0.27	0.25	0.27	0.69	0.27
(6)	Catholic	0.33	0.34	0.37	0.05	0.28
(7)	Christian	0.35	0.36	0.31	0.07	0.02
(8)	Tap water in home	0.54	0.53	0.51	0.19	0.47
(9)	Electricity in home	0.43	0.42	0.41	0.17	0.59
	Relationship Status					
(10)	Enrolled as Couple	0.33	0.33	0.32	0.46	0.34
(11)	Married	0.39	0.40	0.40	0.60	0.90
(12)	Cohabiting	0.49	0.48	0.49	0.86	0.83
(13)	Number Living Children	1.45	1.53	1.64	0.02	0.24
(14)	Planning for Children in near term	0.20	0.19	0.17	0.09	0.23
	HIV/AIDS					
(15)	HIV/AIDS Knowledge (out of 12)	9.71	9.74	9.69	0.77	0.61
(16)	HIV/AIDS Counseling	0.19	0.19	0.20	0.44	0.46
(17)	HIV Testing	0.01	0.01	0.02	0.14	0.21
(18)	HIV+ Test Result	0.20	0.19	0.19	0.37	0.77
	Sexual Activity					
(19)	Sexually Active	0.81	0.82	0.79	0.20	0.13
(20)	Two or More Partners	0.22	0.22	0.22	0.95	0.78
(21)	Unprotected Sex with					
(22)	Commerical Partner	0.12	0.12	0.12	0.62	0.86
(23)	Non-Primary Partner	0.25	0.26	0.23	0.19	0.17
(24)	Primary Partner	0.50	0.51	0.48	0.26	0.19
(25)	Episodes Unprotected Sex with					
(26)	Commerical Partner	6.39	6.62	7.46	0.32	0.48
(27)	Non-Primary Partner	6.58	6.72	7.40	0.32	0.44
(28)	Primary Partner	12.5	12.2	12.0	0.46	0.80
(29)	STD Symptoms	0.40	0.38	0.37	0.17	0.94
	Sample Size	1385	1009	1022		

Table 5: Beliefs of HIV Infection

	STI 6mo Mean = .043				HIV+ Baseline Mean = .20			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) High Belief B	.001	.006			.024	.031		
	(.015)	(.016)			(.026)	(.026)		
(2) High Beliefs (All 4 questions)			.038	.040			.037	.040
			(.012)***	(.013)***			(.021)*	(.021)*
Controls	No	Yes	No	Yes	No	Yes	No	Yes
Obs.	1044	1008	1044	1008	1376	1322	1376	1322
R^2	0	.032	.009	.041	.001	.049	.002	.051

Robust standard errors in parentheses. Disturbance terms are clustered within couple pairings. Significantly different from zero at 99(***), 95(**), and 90(*) percent confidence.The following consist of the control variables: indicator for marriage, primary school, secondary school, college, Muslim, Catholic, a variable for the number of children, number of assets, and a country fixed effect.

Table 6: Effect of HIV Testing on STI Incidence (Risky Sexual Behavior)

Dependent Variable: STI Incidence (mean = .039)

	(1)	(2)	(3)
(1) Test	-.008	.000	-.004
	(.009)	(.014)	(.014)
(2) High Prior Beliefs	.021	.044	.052
	(.009)**	(.018)**	(.019)***
(3) HIV+	.042	-.014	-.010
	(.014)***	(.015)	(.016)
(4) Couple	-.012	.000	.019
	(.009)	(.019)	(.019)
(5) Test X High Prior		-.040	-.037
		(.022)*	(.023)
(6) Test X HIV+		.136	.121
		(.050)***	(.049)**
(7) Test X High Prior X HIV+		-.120	-.106
		(.058)**	(.056)*
Interactions	No	Yes	Yes
Controls	No	No	Yes
Obs.	1961	1961	1887
R^2	.012	.028	.05
Linear Combinations: Effect of HIV Tests by Prior Beliefs			
HIV- test on low prior group			
(8) Test		0.000	-0.004
		(0.014)	(0.014)
HIV+ test on low prior group			
(9) Test+(Test X HIV)		0.135	0.117
		(0.049)***	(0.048)**
HIV- test on high prior group			
(10) Test+(Test X High)		-0.040	-0.041
		(0.017)**	(0.018)**
HIV+ test on high prior group			
(11) Test+(Test X HIV)+(Test X High)+(Test X High X HIV)		-0.025	-0.027
		(0.039)	(0.038)
F-Tests: Differential Effects of HIV+ and HIV- Tests			
Differential Effect of HIV+ vs. HIV- tests on Low Prior Group			
(12) (Test X HIV) = 0		7.49***	6.078**
Differential Effect of HIV+ vs. HIV- tests on High Prior Group			
(13) (Test X HIV) +(Test X High X HIV) = 0		0.14	0.13
Differential Effect of HIV- test on low vs. high prior group			
(14) (Test X High) = 0		3.167*	2.66
Differential Effect of HIV+ test on low vs. high prior group			
(15) (Test X High)+(Test X High X HIV)=0		8.04***	6.811***

Robust standard errors in parentheses.. Disturbance terms are clustered within couple pairings. Significantly different from zero at 99(***), 95(**), and 90(*) percent confidence.Interactions (columns 2-3) include all possible combinations of Test, High Prior, HIV+, and Couple. There are 6 double and 4 triple interaction terms (not all shown). Controls in column (3) include: indicator for marriage, primary school, secondary school, college, Muslim, Catholic, Christian, number of children, number of assets, and a country fixed effect. All standard errors on linear combinations are adjusted for covariance between variables.

Table 9: Comparison between Low and High Prior Belief Groups

Variable	Low Priors Mean	High Priors Mean	p value
Demographics			
Male	0.50	0.50	0.92
Age	28.9	27.9	0.00
Primary School	0.60	0.64	0.03
Secondary School	0.28	0.25	0.16
Muslim	0.26	0.30	0.00
Catholic	0.33	0.35	0.38
Christian	0.36	0.30	0.00
Tap water in home	0.51	0.57	0.00
Electricity in home	0.42	0.46	0.02
Relationship Status			
Enrolled as Couple	0.38	0.28	0.00
Married	0.45	0.34	0.00
Cohabiting	0.53	0.46	0.00
Number Living Children	1.63	1.32	0.00
Planning for Children in near term	0.17	0.20	0.03
HIV/AIDS			
HIV/AIDS Knowledge (out of 12)	9.83	9.69	0.09
HIV/AIDS Counseling	0.16	0.24	0.00
HIV Testing	0.01	0.02	0.04
Sexual Activity			
Sexually Active	0.80	0.82	0.28
Two or More Partners	0.16	0.25	0.00
Unprotected Sex with			
Commerical Partner	0.09	0.15	0.00
Non-Primary Partner	0.20	0.28	0.00
Primary Partner	0.52	0.47	0.01
Episodes Unprotected Sex with			
Commerical Partner	5.68	7.29	0.11
Non-Primary Partner	5.55	7.69	0.00
Primary Partner	11.9	12.5	0.39
STD Symptoms	0.31	0.45	0.00
Sample Size	1305	1617	

Table 7: Effect of HIV Testing on Self Reported Sexual Behavior

	Sexually Active	Multiple Partners	Unprotected Sex	New Partner	Partner Tested	STI Treatment
Mean Dependent Variable	.77	.20	.25	.25	.095	.46
	(1)	(2)	(3)	(4)	(5)	(6)
(1) Test	.051	-.008	-.071	-.007	.077	-.147
	(.041)	(.043)	(.046)	(.047)	(.033)**	(.114)
(2) High Prior Beliefs	.066	.075	.088	.054	.001	-.101
	(.039)*	(.044)*	(.047)*	(.046)	(.025)	(.095)
(3) HIV+	.081	-.025	.005	-.050	.148	-.162
	(.064)	(.068)	(.077)	(.076)	(.074)**	(.149)
(4) Couple	.120	-.066	-.072	-.152		-.250
	(.042)***	(.040)*	(.045)	(.041)***		(.117)**
(5) Test X High Prior	-.047	-.046	-.014	-.080	-.023	.029
	(.053)	(.058)	(.062)	(.061)	(.041)	(.138)
(6) Test X HIV	-.260	-.036	-.047	.037	-.250	.359
	(.090)***	(.086)	(.096)	(.106)	(.090)***	(.222)
(7) Test X High Prior X HIV	.154	-.004	-.019	.009	.180	-.072
	(.101)	(.097)	(.104)	(.114)	(.114)	(.236)
Interactions	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	1887	1474	1472	1474	916	436
R^2	.087	.1	.12	.194	.039	.105
	Linear Combinations: Effect of HIV Tests by Prior Beliefs					
HIV- test on low prior group						
(8) Test	0.051	-0.008	-0.071	-0.007	0.077	-0.147
	(0.041)	(0.043)	(0.046)	(0.047)	(0.032)**	(0.114)
HIV+ test on low prior group						
(9) Test+(Test X HIV)	-0.209	-0.044	-0.118	0.030	-0.173	0.212
	(0.086)**	(0.080)	(0.090)	(0.101)	(0.084)**	(0.206)
HIV- test on high prior group						
(10) Test+(Test X High)	0.004	-0.054	-0.085	-0.086	0.055	-0.118
	(0.035)	(0.041)	(0.044)*	(0.042)**	(0.025)**	(0.0835)
HIV+ test on high prior group						
(11) Test+(Test X HIV)+(Test X High)	-0.102	-0.094	-0.151	-0.041	-0.016	0.169
+(Test X High X HIV)	(0.067)	(0.071)	(0.074)**	(0.076)	(0.068)	(0.118)

Robust standard errors in parentheses.. Disturbance terms are clustered within couple pairings. Significantly different from zero at 99(***), 95(**), and 90(*) percent confidence.Interactions (columns 2-3) include all possible combinations of Test, High Prior, HIV+, and Couple. There are 6 double and 4 triple interaction terms (not all shown). Controls in column (3) include: indicator for marriage, primary school, secondary school, college, Muslim, Catholic, Christian, number of children, number of assets, and a country fixed effect. All standard errors on linear combinations are adjusted for covariance between variables.

Table 8: Balance by Beliefs and HIV Status

		Low Prior Beliefs						High Prior Beliefs					
		HIV Negative			HIV Positive			HIV Negative			HIV Positive		
		Treat	Control		Treat	Control		Treat	Control		Treat	Control	
	Variable	Mean	Mean	p value	Mean	Mean	p value	Mean	Mean	p value	Mean	Mean	p value
	Demographics	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
(1)	Male	0.56	0.52	0.33	0.35	0.36	0.94	0.56	0.57	0.72	0.29	0.25	0.57
(2)	Age	29.0	29.6	0.40	29.9	30.5	0.65	28.2	28.1	0.84	29.4	29.1	0.67
(3)	Primary School	0.57	0.62	0.21	0.61	0.64	0.72	0.65	0.63	0.56	0.60	0.66	0.31
(4)	Secondary School	0.30	0.29	0.68	0.20	0.28	0.31	0.25	0.26	0.89	0.26	0.22	0.41
(5)	Muslim	0.22	0.22	0.89	0.20	0.30	0.16	0.28	0.28	0.97	0.21	0.25	0.45
(6)	Catholic	0.35	0.36	0.73	0.38	0.38	0.98	0.32	0.36	0.19	0.40	0.45	0.39
(7)	Christian	0.37	0.36	0.79	0.38	0.29	0.27	0.36	0.31	0.18	0.36	0.23	0.02
(8)	Tap water in home	0.49	0.52	0.49	0.39	0.43	0.61	0.56	0.53	0.35	0.58	0.46	0.08
(9)	Electricity in home	0.42	0.41	0.66	0.28	0.35	0.41	0.44	0.42	0.54	0.40	0.33	0.29
	Relationship Status												
(10)	Enrolled as Couple	0.37	0.38	0.84	0.39	0.34	0.55	0.31	0.29	0.50	0.29	0.24	0.38
(11)	Married	0.47	0.49	0.60	0.50	0.38	0.16	0.34	0.37	0.55	0.34	0.28	0.35
(12)	Cohabiting	0.53	0.53	0.83	0.57	0.56	0.90	0.44	0.45	0.78	0.46	0.45	0.86
(13)	Number Living Children	1.68	1.81	0.45	1.77	1.83	0.86	1.33	1.55	0.09	1.66	1.54	0.58
(14)	Children in near term	0.16	0.12	0.17	0.28	0.26	0.78	0.19	0.18	0.69	0.25	0.21	0.55
	HIV/AIDS												
(15)	HIV/AIDS Knowledge	9.9	9.8	0.82	9.9	10.0	0.75	9.6	9.5	0.28	9.7	9.9	0.48
(16)	HIV/AIDS Counseling	0.16	0.16	1.00	0.12	0.16	0.54	0.23	0.25	0.48	0.19	0.24	0.45
(17)	HIV Testing	0.00	0.02	0.06	0.03	0.00	0.17	0.02	0.03	0.82	0.01	0.04	0.15
(18)	**Sexual Activity**												
	Sexually Active	0.81	0.76	0.06	0.82	0.83	0.95	0.82	0.82	0.90	0.82	0.83	0.87
(19)	Two or More Partners	0.16	0.16	0.76	0.15	0.22	0.31	0.28	0.24	0.26	0.24	0.30	0.32
(20)	Unprotected Sex with												
(21)	Commerical Partner	0.09	0.08	0.89	0.08	0.17	0.10	0.15	0.13	0.60	0.17	0.17	0.86
(22)	Non-Primary Partner	0.22	0.19	0.31	0.18	0.28	0.17	0.30	0.23	0.03	0.30	0.31	0.79
(23)	Primary Partner	0.55	0.50	0.20	0.48	0.51	0.74	0.48	0.49	0.79	0.50	0.43	0.27
(24)	Episodes Unprotected Sex with												
(25)	Commerical Partner	5.80	7.33	0.49	4.00	5.00	0.70	7.6	7.0	0.73	5.4	11.7	0.06
(26)	Non-Primary Partner	5.76	5.99	0.85	7.64	4.56	0.21	7.3	8.5	0.42	6.4	10.6	0.18
(27)	Primary Partner	11.0	11.9	0.48	13.9	10.3	0.23	12.7	12.0	0.58	13.5	15.2	0.53
(28)	STD Symptoms	0.30	0.26	0.21	0.46	0.43	0.77	0.38	0.41	0.32	0.57	0.57	1.00
(29)	Sample Size	371	377		74	70		441	400		118	110	

Table 10: Effect of HIV Testing on STI Incidence (Risky Sexual Behavior) with Multiple Interaction Terms

	Demographic	HIV/AIDS	STD	All
	(1)	(2)	(3)	(4)
(1) Test	-.005	-.014	-.010	-.022
	(.016)	(.015)	(.015)	(.018)
(2) High Prior Beliefs	.052	.055	.054	.057
	(.019)***	(.019)***	(.020)***	(.020)***
(3) HIV+	-.011	-.013	-.005	-.003
	(.019)	(.019)	(.023)	(.028)
(4) Couple	.014	.017	.018	.014
	(.020)	(.019)	(.019)	(.020)
(5) Test X High Prior	-.038	-.041	-.035	-.038
	(.023)	(.023)*	(.023)	(.024)
(6) Test X HIV	.142	.134	.099	.129
	(.050)***	(.052)***	(.054)*	(.057)**
(7) Test X High Prior X HIV	-.109	-.110	-.108	-.115
	(.056)*	(.058)*	(.057)*	(.057)**
Base Interactions	Yes	Yes	Yes	Yes
Demographic Interactions	Yes	No	No	Yes
HIV/AIDS Awareness Interactions	No	Yes	No	Yes
STD Symptoms Interactions	No	No	Yes	Yes
Obs.	1887	1887	1864	1864
R^2	.051	.056	.052	.059
Linear Combinations: Effect of HIV Tests by Prior Beliefs				
HIV- test on low prior group				
(8) Test	-0.005	-0.014	-0.010	-0.022
	(0.016)	(0.015)	(0.015)	(0.018)
HIV+ test on low prior group				
(9) Test+(Test X HIV)	0.137	0.121	0.090	0.108
	(0.049)***	(0.050)**	(0.052)*	(0.056)*
HIV- test on high prior group				
(10) Test+(Test X High)	-0.042	-0.055	-0.044	-0.060
	(0.019)**	(0.02)***	(0.022)**	(0.025)**
HIV+ test on high prior group				
(11) Test+(Test X HIV)+(Test X High)+(Test X High X HIV)	-0.010	-0.030	-0.053	-0.045
	(0.041)	(0.044)	(0.048)	(0.056)

Robust standard errors in parentheses.. Disturbance terms are clustered within couple pairings. Significantly different from zero at 99(***), 95(**), and 90(*) percent confidence. Base interactions include all possible combinations of Test, High Prior, HIV+, and Couple. There are 6 double and 4 triple interaction terms (not all shown). Additional interactions include marriage and christian (demographic), HIV counseling and testing (HIV/AIDS Awareness), and sexually transmitted disease symptoms (STD symptoms) interacted with Test and HIV+. Controls include:: indicator for marriage, primary school, secondary school, college, Muslim, Catholic, Christian, number of children, number of assets, and a country fixed effect. All standard errors on linear combinations are adjusted for covariance between variables.

Table 12: Parameter Estimates for AVERT model

	Gonorrhea/Chlamydia	HIV	
	(1)	(2)	(3)
Key Parameters			Source
P (Prevalence)	0.06	0.19	Dataset
R (Transmission)	0.35	0.001	Kretzschmar et. al. (1996); Gray et. al. (2001)
F (Fraction of Acts where Condom Used)	0.39	0.39	Dataset
E (Condom Effectiveness)	0.95	0.95	Sweat et. al. 2000 (Lancet)
N (Sex Acts per Partner)	8.40	8.40	Dataset

Table 13: Estimating Sexual Behavior and HIV Transmission using STI outcomes

	HIV Negative				HIV Positive			
		P(STI)	M	P(Infection)		P(STI)	M	P(Transmitting)
Low Priors	Control + Test	0.02	0.36	0.0004	Control	0.02	0.36	0.0015
					Test	0.14	2.67	0.0115
		P(STI)	M	P(Infection)		P(STI)	M	P(Transmitting)
High Priors	Control	0.05	0.95	0.0010	Control + Test	0.09	1.71	0.0073
	Test	0.01	0.22	0.0002				

Table 14: Effect of HIV Testing on HIV Infections

	HIV Negative		HIV Positive	
Low Prior	Mass	37%	Mass	7%
	N	3694	N	735
	New Infections		New Infections	
	Base	1.35	Base	1.14
	Testing	1.35	Testing	8.42
	Difference	0.00	Difference	7.28
High Prior	Mass	44%	Mass	12%
	N	4399	N	1172
	New Infections		New Infections	
	Base	4.25	Base	8.61
	Testing	0.99	Testing	8.61
	Difference	-3.26	Difference	0.00

	Base Case (No Testing)	Testing Case	Difference	Percentage Difference
Transmission (HIV+ infecting others)	9.75	17.03	+7.28	+75%
Infection (HIV- becoming infected)	5.60	2.34	-3.26	-58%
Total	15.35	19.37	+4.02	**+26%**

Table 11: Effect of HIV Testing on STI Incidence: Alternative Specifications for Beliefs

	Cut Points Used						Predicted Status	
	1.25	1.50	1.75	2.25	2.50	2.75	HIV	STI
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) Test	-0.03	-0.02	-0.01	0.00	-0.01	-0.02	-0.01	0.00
	(0.019)	(0.018)	(0.016)	(0.013)	(0.014)	(0.014)	(0.014)	(0.015)
(2) Test+(Test X HIV)	0.12	0.11	0.11	0.09	0.06	0.04	0.09	0.11
	(0.058)**	(0.052)**	(0.051)**	(0.040)**	(0.043)	(0.041)	(0.048)*	(0.044)**
(3) Test+(Test X High)	-0.02	-0.03	-0.03	-0.05	-0.05	-0.05	-0.04	-0.04
	(0.014)*	(0.015)*	(0.016)*	(0.021)**	(0.022)**	(0.024)**	(0.019)**	(0.019)**
(4) Test+(Test X HIV)+(Test X High)	0.01	0.01	0.00	-0.05	-0.04	-0.03	-0.03	-0.04
+(Test X High X HIV)	(0.034)	(0.034)	(0.036)	(0.046)	(0.039)	(0.042)	(0.039)	(0.041)
Interactions	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1887	1887	1887	1887	1887	1887	1887	1887
R-squared	0.04	0.04	0.05	0.05	0.04	0.04	0.04	0.04

Robust standard errors in parentheses.. Disturbance terms are clustered within couple pairings. Significantly different from zero at 99(***), 95(**), and 90(*) percent confidence.Interactions include all possible combinations of Test, High Prior, HIV+, and Couple. There are 6 double and 4 triple interaction terms (not all shown). Controls include:: indicator for marriage, primary school, secondary school, college, Muslim, Catholic, Christian, number of children, number of assets, and a country fixed effect. All standard errors on linear combinations are adjusted for covariance between variables.

8 Appendix

8.1 HIV Knowledge & Awareness

Besides an HIV test, there are additional differences in what was offered to the treatment vs. the control arms. These additional differences mean that the control arm is not a "true" control and that these other interventions might confound the interpretation of the results. For example, the treatment arm received pre-test counseling, which consists of an individual counseling sessions where recommendations are made on how to change risky sexual behavior. The control arm did not receive this intervention. Also, the control arm was offered a 15 minute video on safe sexual practices (including how to properly use a condom) that the treatment arm did not receive. These differences in interventions that go beyond HIV testing may affect HIV knowledge and awareness that could lead to behavioral changes.

To test whether their was differential learning about HIV in the treatment or control arms, I compare HIV/AIDS knowledge between both arms. At baseline and the 6 month follow up, 12 questions regarding HIV/AIDS were asked. The questions took the form: "Can you get the AIDS virus from the following? and each question posed a different scenario ranging from: "having sex without a condom" to "using public toilets". For each person in the study, I calculate the change in correct responses between baseline and the 6 month follow up. If people assigned into the testing arm are learning more about HIV/AIDS, then they should have an increase in the number of correct responses. I estimate the following equations:

$$HIV/AIDS\, Knowledge\, 6mo_{ij} = \alpha + \beta_1 Test_i + X_i'\delta + \gamma_j + u_{ij}$$

$$\Delta HIV/AIDS\, Knowledge_i = \alpha + \beta_1 Test_i + X_i'\delta + \gamma_j + u_{ij} \tag{8}$$

where $HIV/AIDS\, Knowledge\, 6mo_{ij}$ is the total number of correct responses at the 6 month follow up and $\Delta HIV/AIDS\, Knowledge_i$ is the change in the number of correct responses between baseline and 6 months for individual i. The indicator $Test_i$ denotes if the individual was assigned to the testing arm, X' is a vector of individual characteristics, and γ_j is a country fixed effect. If there was a differential effect on HIV/AIDS knowledge between the treatment and control arms, then $\beta_1 \neq 0$. Table 15 presents the results. Columns 1 and 2 estimate if there's any difference in HIV knowledge at 6 months, and columns 3 and 4 estimate changes in knowledge. In all four specifications, it appears that there are no differences in either overall knowledge or changes in knowledge between the treatment and control arms.

Table 15: HIV/AIDS Knowledge by Treatment/Control Arms

	(1)	(2)	(3)	(4)
Test	-.033	-.034	-.006	-.003
	(.068)	(.069)	(.092)	(.091)
Controls	No	Yes	No	Yes
Obs.	2942	2834	2942	2834
R^2	0	.021	0	.034

8.2 Incidence vs. Prevalence

Both incidence and prevalence at the 6 month follow up can be modeled as functions of risky sexual behavior during the study and baseline prevalence. Let $incidence_t = f(risky\,sex_t, prevalence_{t-1})$ and $prevalence_t = g(risky\,sex_t, prevalence_{t-1})$, where $t=$ 6 month follow up and $t-1=$ baseline, and suppose that STI tests pick up any risky sexual activity. Then using incidence will underestimate risky sexual behavior while prevalence at 6 months will overestimate risky sexual behavior.

Incidence as Outcome (underestimate risky behavior)	Prevalence as Outcome (overestimate risky behavior)
$0 = f(0,0)$ $0 = f(0,1)$ $0 = f(1,1)$ $1 = f(1,0)$	$0 = g(0,0)$ $1 = g(0,1)$ $1 = g(1,1)$ $1 = g(1,0)$

To see if the main results are affect by using prevalence as the outcome, I estimate equation 2 but I substitute STI incidence with prevalence. Results are presented in table 16. Almost all of the estimates remain consistent with the main findings using STI incidence as the outcome. The increase in risky sexual behavior for low priors who receive HIV positive tests (row 9) holds when using STI prevalence as the outcome. Both low priors receiving HIV- tests (row 8) and high priors receiving HIV+ tests (row 11) are not statistically significant, consistent with the main results. The only change is the effect of HIV- tests on the high prior group (row 10). The point estimate is attenuated and is no longer statistically significant. What explains this? As noted above, prevalence would tend to overestimate risky sexual behavior since it includes those who have preexisting cases of gonorrhea or chlamydia. Individuals who had a baseline STI infection and decreased their risky sexual behavior during the study may still have that same infection at the

6 month follow up. Since the duration of either STI is 6 months (Chen et al., 2008, Kretzschmar et al., 1996), people who are switching to safer sexual behavior are still counted as practicing risky behavior using prevalence as the outcome - this could explain the attenuation of the effect of HIV-tests on the high prior group.

Table 16: Effects of HIV Testing on STI Prevalence

	1	2	3
	(1)	(2)	(3)
(1) Test	-.005	-.004	-.005
	(.011)	(.018)	(.019)
(2) High Prior Beliefs	.015	.041	.046
	(.011)	(.021)*	(.022)**
(3) HIV+	.043	.000	.009
	(.017)**	(.033)	(.034)
(4) Couple	-.002	.012	.048
	(.012)	(.025)	(.027)*
(5) Test X High Prior		-.021	-.019
		(.028)	(.028)
(6) Test X HIV		.140	.121
		(.060)**	(.061)**
(7) Test X High Prior X HIV		-.138	-.120
		(.069)**	(.068)*
Interactions	No	Yes	Yes
Controls	No	No	Yes
Obs.	1970	1970	1895
R^2	.006	.017	.049
(8) Test		-0.004	-0.005
		0.018	0.019
(9) Test+(Test X HIV)		0.136	0.116
		0.058**	0.059**
(10) Test+(Test X High)		-0.025	-0.025
		0.021	0.022
(11) Test+(Test X HIV)+(Test X High)+(Test X High X HIV)		-0.024	-0.023
		0.041	0.04

Robust standard errors in parentheses.. Disturbance terms are clustered within couple pairings. Significantly different from zero at 99(***), 95(**), and 90(*) percent confidence.Interactions (columns 2-3) include all possible combinations of Test, High Prior, HIV+, and Couple. There are 6 double and 4 triple interaction terms (not all shown). Controls in column (3) include: indicator for marriage, primary school, secondary school, college, Muslim, Catholic, Christian, number of children, number of assets, and a country fixed effect. All standard errors on linear combinations are adjusted for covariance between variables.