Published in final edited form as:

J Dev Econ. 2014 January ; 106: 78–91. doi:10.1016/j.jdeveco.2013.08.012.

Is Sex Like Driving? HIV Prevention and Risk Compensation.

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Abstract

Risk compensation has been called the “Achilles’ heel” of HIV prevention policies (Cassell et al 2006). This paper examines the behavioral response to male circumcision, a major HIV prevention policy currently being implemented throughout much of Sub-Saharan Africa. Contrary to the presumption of risk compensation, we find that the response due to the perceived reduction in HIV transmission appears to have been a reduction in risky sexual behavior. We suggest a mechanism for this finding: circumcision may reduce fatalism about acquiring HIV/AIDS and increase the salience of the tradeoff between engaging in additional risky behavior and avoiding acquiring HIV. We also find what appears to be a competing effect that does not operate through the circumcision recipient’s belief about the reduction in the risk of acquiring HIV.

Keywords

beliefs; HIV/AIDS; Kenya; male circumcision; risk compensation

1 Introduction

Standard consumer demand models indicate that individuals may respond to improvements in health production technologies that reduce the riskiness of a particular behavior by increasing their consumption of this behavior.¹ This response, known as risk compensation, means that technological improvements in health production may generate smaller improvements in health outcomes than as predicted by traditional epidemiological models. If individuals overestimate the technological improvement or if there are important externalities associated with this risky behavior (Bennett 2012), then risk compensation may

*We thank Jenny Aker, Robert Bailey, Jon Bakija, Daniel Bennett, Marianne Bitler, William Dow, Pascaline Dupas, Andrew Foster, Bob Gazzale, Amar Hamoudi, Dan Korenblum, Kenneth Kuttner, Sara Lalumia, David Love, Jeremy Magruder, Emily Oster, Jonathon Robinson, Michael Rolfeigh, Lucie Schmidt, Manisha Shah, Gil Shapira, Wei Sun, Harsha Thirumurthy, Rebecca Thornton, Susan Watkins, Tara Watson, Rachel Wilson, and two anonymous referees. We also thank conference participants at the Economic Demography Workshop at the 2012 Population Association of America annual meeting, MIEDC 2012 at the University of Minnesota, NEUDC 2011 at Yale University, PACDEV 2012 at the University of California, Davis, and seminar participants at Santa Clara University, the University of California, Berkeley, the University of California, Davis, and Williams College for many helpful comments. All errors are our own.

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¹For example, the government of Tanzania is in the process of circumcising 2.8 million young males by 2016 (Plusnews 2011a). Similarly, the Bill and Melinda Gates Foundation is funding the circumcision of approximately 650,000 males in Swaziland and Zambia (Cohan 2009).

mean that technological improvements in health production actually result in worse health outcomes. Thus, understanding the extent of risk compensation is central to the welfare analysis of many health policies.

Although HIV/AIDS is the leading cause of death in Sub-Saharan Africa and governments spend billions of (US) dollars annually on HIV/AIDS policies, there is little economic research on risk compensation associated with HIV prevention policies in Sub-Saharan Africa.^{2,3} Moreover, global HIV incidence has fallen only slightly despite a tremendous increase in government spending on HIV/AIDS (WHO 2011), suggesting that there may be large compensatory responses to HIV prevention policies.⁴ Perhaps risk compensation, as suggested in Cassell et al (2006), is in fact the “Achilles’ heel” of HIV prevention interventions?

We examine risk compensation associated with adult male circumcision. Experimental evidence from recent medical trials (Auvert et al 2005, Bailey et al 2007, Gray et al 2007a) demonstrates that medically performed male circumcision reduces the probability of female-to-male transmission of HIV by as much as 76 percent. This finding has spurred plans for mass male circumcision campaigns for HIV prevention in a large number of Sub-Saharan African countries, the region of the world most affected by the HIV/AIDS pandemic.⁵ Although there appears to be strong support among many policymakers, concern remains about risk compensation associated with male circumcision (e.g., Cassell et al 2006, Gray et al 2007b, WHO 2007).

Our data come from a nested study in a randomized controlled trial (RCT) in Kisumu, Kenya. In this nested study, individuals participating in a RCT designed to evaluate the efficacy of male circumcision for HIV prevention were recruited to participate in a study examining risk compensation. Seventy-three percent of individuals from the full study who were recruited to participate in the nested study actually participated in the nested study. Although uncircumcised men were slightly more likely to participate in the nested study, circumcised and uncircumcised men in the nested study generally appear to have had similar observable characteristics and behaviors at baseline aside from circumcision status.⁶ In addition to collecting information on their risky sexual behavior, the nested study surveyed

²For example, see Peltzman (1975), a seminal study on this topic.

³In contrast, there is more economic research on risk compensation associated with *treatment* for HIV/AIDS. de Walque et al (2010) examines the effect of awareness about highly active antiretroviral therapy (HAART) on risky sexual behavior in Mozambique. Nikolov (2011) examines the behavioral response to antiretroviral therapy (ART) in a field experiment in South Africa. Friedman (2012) examines the behavioral response to the nationwide roll out of ART in Kenya, Rwanda, and Uganda. In the context of the United States, Lakdawalla et al (2006) examines the behavioral response to subsidized HAART.

⁴Using data from a field experiment in Malawi, Godlonton et al (2011) examines the effect of providing information about the efficacy of male circumcision for HIV prevention on risky sexual behavior. Although Godlonton et al (2011) does not examine the direct effects of a HIV prevention policy per se, it illuminates possible responses to the rise of knowledge about the protective benefits of male circumcision.

⁵Of course HIV incidence may have fallen little because of supply-side factors associated with HIV prevention efforts or because of demand-side factors aside from risk compensation.

⁶Circumcised and uncircumcised respondents differed on one dimension at baseline: prevalent sexually transmitted infections (STIs). By prevalent, we mean infected at baseline, not during the course of the study. Although biomarker data were unavailable for the current analysis, Mattson et al (2008) reports that in the nested study 10 percent of circumcised men had a prevalent sexually transmitted infection (STI) at baseline compared to 7 percent of uncircumcised men. To investigate this concern, we examine the sensitivity of our estimates to controlling for baseline risky behavior.

individuals about their belief about whether male circumcision has a protective effect against acquiring HIV.

In contrast to the standard approach in the existing literature on male circumcision for HIV prevention, we emphasize that it is only those individuals who believe that male circumcision is protective who should engage in risk compensation.⁷ Risk compensation is a behavioral response that operates through a change in the riskiness of a particular activity that is actually perceived by the individual. Of course there may be a response to male circumcision for reasons other than the recipient's belief about its effect on HIV transmission (e.g., circumcision reduces other STIs which may result in increased demand for sexual activity or increased marketability among potential partners) and measuring this response is also of interest. Thus, in our empirical analysis we disaggregate the behavioral response to male circumcision by beliefs. We interpret the response to circumcision among non-believers as the non-beliefs channel and the response to circumcision among believers as the sum of the non-beliefs and beliefs (i.e., risk compensation) channels. The difference between these two estimates (i.e., the effect of circumcision among believers net of the effect among non-believers) measures the extent of risk compensation.

The results of our empirical analysis suggest that the behavioral response to circumcision among believers net of the response among non-believers was a reduction in risky sexual activity. That is, we find what appears to be a behavioral response that is the opposite of the risk compensation hypothesis. The response to circumcision among believers net of the response to circumcision among non-believers appears to have been a 10 to 20 percentage point reduction in the likelihood of having multiple sexual partners. Similarly, although there does not appear to have been a difference in condom use in the short term, after one year there was a significant increase in condom use among circumcised believers as compared to circumcised non-believers.

We suggest a mechanism for this finding: in a high HIV prevalence environment circumcision may reduce fatalism and increase the salience of the tradeoff between engaging in additional risky sexual behavior and avoiding acquiring HIV.⁸ In the absence of male circumcision, individuals in this environment may be likely to believe that they will acquire HIV with high probability at some point in their life, meaning that the expected marginal cost of additional risky sexual behavior may be relatively low. After receiving male circumcision, an intervention that lowers the female-to-male HIV transmission probability by as much as 76 percent (Auvert et al 2005, Bailey et al 2007, Gray et al 2007a), individuals may no longer perceive engaging in a "normal" amount of risky sexual behavior as a death sentence. Thus, although male circumcision reduces the likelihood of HIV transmission, it may actually increase the expected marginal cost of risky sexual behavior by increasing the life expectancy of a circumcised male.⁹

⁷To the best of our knowledge, Godlonton et al (2011) provides the only empirical analysis that focuses on risk compensation behavior among individuals who believe male circumcision is effective.

⁸Our use of the term "fatalism" is not meant to restrict our interpretation of this mechanism as a purely psychological or cultural phenomenon. In fact, a standard expected utility framework is able to generate this result.

⁹Kremer (1996) makes a similar point. Namely, increases in HIV prevalence may actually increase risky behavior among already high risk populations. Higher HIV prevalence increases the likelihood that high risk individuals are already infected, reducing the marginal probability of infection from an incremental increase in their risky behavior.

This finding contrasts with the “Peltzman effect” documented in most of the previous economic literature on risk compensation (e.g., Peltzman 1975, Evans and Graham 1991, Keeler 1994, Dickie and Gerking 1997, Winston 2006). These studies mostly examine risk compensation associated with improvements in automobile safety technology and find evidence consistent with riskier behavior in response to safety improvements.¹⁰ Nonetheless, the divergent finding in the current analysis is consistent with the difference in the relative magnitude of the effect of the safety improvement on life expectancy. Although driving was more dangerous prior to the widespread availability and use of seatbelts in automobiles, presumably driving per se was not perceived as being particularly lifethreatening. Thus, it seems unlikely that seatbelts led to an increase in perceived life expectancy. In contrast, more than 15 percent of adults in our study setting, Kisumu, Kenya, are HIV positive (Central Bureau of Statistics 2003), suggesting that a 51 to 76 percent reduction in the likelihood of HIV transmission generates a large increase in life expectancy for young adults. Our main finding is also consistent with previous research on health complementarities under competing risks (Dow et al 1999) and the argument in Oster (2012) that lower life expectancies and lower incomes reduce the responsiveness of sexual behavior in Sub-Saharan Africa to the risk of HIV infection.¹¹

In addition to our primary empirical finding, our results indicate the existence of a behavioral response that was not due to a perceived reduction in the HIV transmission probability. Namely, circumcised males who did not believe circumcision is effective at reducing HIV transmission appeared to increase their risky behavior. Although by definition this cannot be due to risk compensation, this is a notable behavioral response to male circumcision. There are at least two possible explanations for this finding. First, circumcision reduces the likelihood of acquiring other STIs (Weiss et al 2006, Auvert et al 2009, Tobian et al 2009), including some with observable symptoms, possibly increasing demand for sexual activity on the part of the recipient even though the recipient is not aware of the exact mechanism underlying this effect. Second, potential partners may prefer circumcised males (e.g., because potential partners may be aware of the fact that male circumcision protects against HIV transmission or for hygiene reasons).¹² Because of the existence of a non-beliefs mechanism linking circumcision to increased risky behavior, most of our specifications suggest there was no effect of male circumcision on risky sexual behavior on average. Nonetheless, we emphasize that the apparent behavioral response due to a perceived reduction in the probability of HIV transmission contradicts the presumption of risk compensation associated with male circumcision.

The rest of the analysis is organized as follows. Section 2 discusses medical evidence on the efficacy of male circumcision for HIV prevention and mass male circumcision campaigns

¹⁰An important exception is Cohen and Einav (2003), which finds no association between automobile safety improvements and traffic accident fatalities among non-occupants (e.g., bicyclists or pedestrians), suggesting the lack of a compensatory response among drivers.

¹¹An important difference between our research and Dow et al (1999) is that our finding relates to complementary behavior for a single disease.

¹²Evidence from randomized controlled trials suggests that male circumcision may not directly reduce the likelihood of male-to-female transmission of HIV (Wawer et al 2009, Weiss et al 2009, Hallet et al 2011)). However, potential partners may still prefer circumcised males because a circumcised male may be less likely to be HIV positive. Among a survey of 110 women in Nyanza Province, 69 percent reported a preference for circumcised partners and the vast majority of respondents cited hygiene as the primary reason (Mattson et al 2005).

currently underway in Sub-Saharan Africa. Section 3 discusses the data and Section 4 discusses the empirical strategy. Section 5 presents the results of the empirical analysis. Section 6 examines explanations for these results and implications for future research. Section 7 concludes.

2 Male Circumcision for HIV Prevention

The results of recent randomized controlled medical trials provide conclusive evidence that male circumcision reduces the likelihood of circumcised males acquiring HIV. Estimates of the biological prophylactic effect of male circumcision range from a 51 to 76 percent reduction in the female-to-male HIV transmission rate (Auvert et al 2005, Bailey et al 2007, Gray et al 2007).¹³ These estimates are qualitatively consistent with the prior, observational evidence on the negative correlation between male circumcision rates and HIV prevalence (e.g., Alecena 1986, Fink 1986, Bongaarts et al 1989, Moses et al 1990, Weiss et al 2000). Although male circumcision may not provide a direct protective effect against male-to-female transmission of HIV (Wawer et al 2009, Weiss et al 2009, Hallet et al 2011), it may indirectly reduce male-to-female transmission of HIV by reducing HIV prevalence among males.

This evidence on the biological efficacy of male circumcision for HIV prevention has encouraged the scale-up of mass male circumcision campaigns across many countries in Sub-Saharan Africa. The World Health Organization (WHO) recommends that medically performed male circumcision be part of a comprehensive HIV/AIDS prevention program. In particular, thirteen priority countries with high HIV prevalence and low circumcision rates have been advised to focus on scaling-up this intervention (WHO 2009). The WHO has provided financial and technical support to the priority countries that responded with cooperation.

Kenya, the location of our study setting, is one of the thirteen priority countries and has recently circumcised large numbers of adult males. Although 85 percent of men in Kenya are circumcised, only 40 percent of men in Nyanza Province, the province with the highest HIV prevalence, are circumcised (WHO 2009). Thus, the Kenyan government launched a national male circumcision campaign in 2008 and circumcised more than 90,000 men (40,000 men in Nyanza Province) by the end of 2009. The government's goal is to circumcise the estimated 1.1 million uncircumcised men who remain in Kenya by 2013 (PlusNews 2010). As of December 2011, Kenya has circumcised approximately 350,000 men (PlusNews 2011b).

Despite enthusiastic support among policymakers, concerns remain about risk compensation associated with male circumcision (e.g., Cassell et al 2006, Gray et al 2007b, WHO 2007).¹⁴ If individuals respond to the lowered risk of HIV transmission per risky act by increasing the number of risky acts in which they engage, then the reduction in HIV incidence would be

¹³Estimates of the overall probability of female-to-male transmission of HIV per unprotected discordant act in a population with low rates of male circumcision are approximately 0.001 (Gray et al 2001, Wawer et al 2005). By discordant, we mean discordant in HIV status: the reference individual is HIV negative and his partner is HIV positive.

¹⁴Similarly, Richens et al (2000) argues that risk compensation may undermine condom promotion efforts.

less than that predicted by the biological protective effect of a 51 to 76 percent reduction. In fact, this compensatory response may overwhelm the biological protective effect and lead to an increase in HIV incidence, particularly if individuals overestimate the prophylactic effect of male circumcision.

Several medical and public health studies have examined the behavioral response to male circumcision in an experimental setting (e.g., Agot et al 2007, Bailey et al 2007, Gray et al 2007a, Mattson et al 2008). In general, these studies find little-to-no evidence of behavioral disinhibition (i.e., increased propensity for risky sexual behavior) among circumcised males as compared to uncircumcised males. Because these studies do not disaggregate the behavioral response to circumcision by whether the recipient believes it is protective against HIV transmission, we do not interpret these studies as providing direct evidence on risk compensation.¹⁵ Instead, they provide evidence on the average effect among believers and non-believers. In a policy environment where individuals may be voluntarily selecting into mass adult male circumcision campaigns for HIV prevention only if they believe circumcision is effective, the behavioral response among believers is of central importance. Alternatively, individuals may not believe circumcision is effective at reducing HIV transmission yet still choose to get circumcised (e.g., possibly because of aesthetic reasons), in which case identifying the response among non-believers is also important.

To the best of our knowledge, there is one other empirical analysis that focuses on risk compensation behavior among individuals who believe male circumcision is effective at reducing HIV transmission.¹⁶ In a field experiment in Malawi, Godlonton et al (2011) examined risk compensation associated with receiving information on the efficacy of male circumcision for HIV prevention. They found that uncircumcised men reduced their risky sexual behavior in response to receiving this information, whereas circumcised men did not change their behavior in response to receiving this information. Perhaps surprisingly, the group that changed their behavior in response to the information (i.e., uncircumcised males) did not change their beliefs about the efficacy of male circumcision for HIV prevention. Similarly, the group that did not change their behavior in response to the information (i.e., circumcised males) did change their beliefs in accordance with the information about the efficacy of male circumcision for HIV prevention. This suggests that the mechanism generating the behavioral response was not risk compensation, which by definition operates through a change in beliefs. In any case, although the effect of circumcision may differ from the effect of information, these findings suggest that individuals in mass male circumcision campaigns may not respond to circumcision by increasing their risky sexual behavior.

¹⁵In an analysis of the behavioral response to circumcision, Mattson et al (2008) controlled for belief in the efficacy of male circumcision for HIV prevention. The current analysis extends the focus on beliefs in Mattson et al (2008) by allowing the response to circumcision to vary by beliefs instead of simply controlling for beliefs.

¹⁶Several other studies examine beliefs about the efficacy of male circumcision for HIV prevention. For example, Mattson et al (2008). In addition, Westercamp et al (2011) surveyed women and uncircumcised men and examined the correlates of belief in the efficacy of male circumcision for HIV prevention as well as the implications for risk compensation.

3 Data

3.1 Study design

We investigate the behavioral response to male circumcision using data from a nested study in a randomized controlled trial (RCT) conducted in Kisumu District, Kenya.^{17, 18, 19} The RCT recruited HIV negative, uncircumcised, sexually active males age 18–24. Between February 2002 and September 2005, the RCT successfully enrolled nearly 2,800 participants and assigned 1,391 to receive a medically performed circumcision and 1,393 to remain uncircumcised.^{20, 21} The nested study recruited all 1,780 RCT participants enrolling between March 2004 and September 2005 and successfully enrolled and collected complete baseline information from 1,300 participants (i.e., 73 percent of eligible RCT participants). All participants received HIV testing and counseling at baseline and hence were aware of the fact that they were HIV negative at baseline.

A precondition for participating in the RCT was a willingness to receive a medically performed circumcision. As we shall see momentarily, it does not appear that individuals participated simply because they thought that circumcision would reduce the likelihood of HIV transmission. Moreover, consistent with this claim, existing medical evidence on the efficacy of male circumcision for HIV prevention at the time of the study was inconclusive. Monetary compensation, medical care (other than male circumcision), and possibly aesthetic reasons appear to be important motivations for participation. At each visit, RCT participants received 300 Kenyan shillings (approximately US \$4) and HIV testing and counseling (Bailey et al 2007). Participants in the nested study received an additional 150 Kenyan shillings at each visit (Mattson et al 2008).

Respondents in the nested study were interviewed at baseline, 6 months after initiation into the trial, and 12 months after initiation into the trial.^{22, 23} The respondents also received HIV testing and counseling and risk reduction advice at each of these follow-ups, as well as one month after initiation into the study. We refer to the baseline survey as Visit 1, the 6 month follow-up as Visit 2, and the 12 month follow-up as Visit 3. At Visit 1, participants were asked to enumerate all partners since sexual debut.²⁴ At Visits 2 and 3, participants

¹⁷See Bailey et al (2007) for the original description of the RCT study design.

¹⁸See Mattson et al (2008) for the original description of the nested study design.

¹⁹Kisumu is located in Nyanza Province, where roughly 40 percent of males were circumcised at the time the RCT took place compared to 85 percent for Kenya as a whole (WHO 2009).

²⁰Nearly 99 percent of participants were of Luo ethnicity, the main ethnic group in the study setting. Notably, the Luo are one of the few Kenyan ethnic groups that do not traditionally practice male circumcision. In Kisumu at the time of this study (i.e., 2004–05), approximately 10 percent of adult Luo males were circumcised (Buve et al 2000).

²¹The extent of non-compliance appears to have been relatively low. Only 3 men (0.44 percent) assigned to the control group received circumcision and 16 men (2.6 percent) assigned to the treatment group did not receive circumcision. In our empirical analysis, we use the term circumcised to refer to circumcision assignment.

²²Among the 1,300 participants, 1,001 (77%) were successfully interviewed at 6 month follow-up and 1,007 (77%) were successfully interviewed at 12 month follow-up. However, the interview rate did not differ significantly between the treatment and control groups (Mattson et al 2008). In addition, we estimate the parameters of Equation (1), but with an indicator variable for non-response at Visit 2 as the dependent variable (and repeat for non-response at Visit 3). Table 7 presents the results of this analysis and we discuss them in more detail in Section 5.6. As a preview, none of the point estimates are statistically significant. Moreover, the point estimate for each parameter reverses sign for Visit 3 when compared to Visit 2. That is, the estimate of α_1 in the non-response regressions is positive for Visit 2 and negative for Visit 3. For α_2 and α_3 , the point estimates are positive (Visit 2) and negative (Visit 3), and negative (Visit 2) and positive (Visit 3), respectively. These results suggest that differential non-response does not explain our findings on the behavioral response to male circumcision.

²³Respondents received HIV testing and counseling at each interview, as well as at clinical follow-ups at 1 month and 3 months after the baseline interview.

were asked to enumerate all partners in the six months since the last interview. Participants were also asked questions about risky sexual behavior including for each partner whether he used a condom during the last sexual encounter.²⁵ We use this information to construct a count variable measuring the number of partners the respondent had and an indicator variable for whether they had multiple partners. We also construct two measures of the propensity for using condoms. “Always use condom” is defined as the fraction of partners with which the respondent reported always using a condom. “Used condom last time” is defined as the fraction of partners with whom the respondent reported using a condom during their most recent sexual encounter.

3.2 Beliefs

In addition to basic demographic, socioeconomic, and sexual behavior information, each respondent in the nested study was asked whether they believed male circumcision was protective against acquiring HIV.²⁶ This beliefs question was asked at all three survey rounds. Respondents were told during recruitment that male circumcision might be protective against acquiring HIV, but that the medical evidence was inconclusive.²⁷

Table 1 reports beliefs by survey round disaggregated by circumcision assignment. At baseline, approximately one-half of respondents believed in the efficacy of male circumcision. During the course of the study, there was a secular increase in the proportion of respondents believing circumcision reduces the risk of HIV infection, possibly because individuals strengthened their beliefs after initially being less certain about the recruitment message that male circumcision might be protective against acquiring HIV. The fact that the proportion of respondents believing in the efficacy of male circumcision for HIV prevention did not evolve differentially by circumcision assignment suggests that circumcision assignment did not affect beliefs. Nonetheless, we investigate this more formally in Section 4.2.

3.3 Circumcision

We proceed by investigating whether the randomization implemented in the full study remained effective in the nested study. Columns (1) and (2) in Table 2 report sample

²⁴Mattson et al (2008) reports information on risky sexual behavior in the six months preceding the baseline survey. To construct these measures, they use information on the start and end dates for the relationship with a given partner. We eschew this approach because it cannot identify self-reported behavior (e.g., condom use at last sexual encounter with a given partner, or number of partners) that actually occurred during the six month period. For example, a relationship that began prior to the six month period and was not reported to have ended during the six month period may not have included any sexual intercourse during the six month period.

²⁵Biomarker data were unavailable for the current analysis. However, Mattson et al (2008) demonstrates that in these data self-reported sexual behavior closely matches sexually transmitted infection (STI) outcomes.

²⁶The survey instrument asked, “Do you believe that male circumcision increases, decreases, or does not influence your risk of acquiring HIV?” Possible responses on the survey instrument were: “increases”, “decreases”, “does not influence”, and “don’t know”. We define our belief variable as equal to one if the respondent answered, “decreases”, and as equal to zero otherwise. Thus, respondents indicating they did not know the answer to this question were coded as zeros. Less than one percent of respondents reported that male circumcision increased HIV risk.

²⁷The first randomized controlled trial of male circumcision for HIV prevention, the Orange Farm study in South Africa (Auvert et al 2005a) was stopped in 2005 because the efficacy demonstrated in the trial made it unethical to keep the control group uncircumcised (Bailey et al 2007). The Orange Farm researchers announced their results at the 3rd International AIDS Society Conference on HIV Pathogenesis and Treatment in Rio de Janeiro in July of 2005 (Auvert et al 2005b). At that point, the UN and the WHO released a statement (UNAIDS/WHO/UNFPA/UNICEF 2005) indicating that male circumcision may reduce HIV transmission, but that it should not be used as a HIV prevention strategy until the two other randomized controlled male circumcision trials (i.e., Bailey et al 2007 and Gray et al 2007) had been completed. As discussed in Section 3.1, our data are from a study nested within Bailey et al (2007) (i.e., Mattson et al 2008).

descriptive statistics at baseline in the nested study, disaggregated by circumcision assignment status. Circumcised and uncircumcised respondents appear to be nearly identical on most observable characteristics and past behavior at baseline. For example, circumcised respondents report 5.78 lifetime sexual partners and uncircumcised respondents report 5.74 lifetime sexual partners. Similarly, circumcised and uncircumcised respondents reported using a condom at last intercourse 6.6 and 6.7 percent of the time, respectively. For none of the measures of past sexual behavior or socioeconomic characteristics is there a statistically significant difference between circumcised and uncircumcised respondents. Notably, less than 10 percent of respondents were married or cohabiting. The lack of noticeable differences at baseline in behavior and observable characteristics by circumcision assignment status suggests that the randomization implemented in the full study remained effective in the nested study. However, circumcised and uncircumcised respondents differed on one dimension at baseline: prevalent sexually transmitted infections (STIs).²⁸ By prevalent, we mean infected at baseline, not during the course of the study. Although biomarker data were unavailable for the current analysis, Mattson et al (2008) reports that in the nested study 10 percent of circumcised men had a prevalent sexually transmitted infection (STI) at baseline compared to 7 percent of uncircumcised men.

Although the data largely suggest that the randomization implemented in the full study remained effective in the nested study, there is evidence of differential selection into the nested study based on observable characteristics.²⁹ As compared to the full RCT, participants in the nested study were less likely to be circumcised (47% versus 50%, p -value=0.01), were more educated (58% completed secondary school versus 53%, p -value=0.03), were younger (46% were between the ages of 18–20 versus 41%, p -value=0.03), and were more likely to be unemployed (67% versus 60%, p -value=0.02) (Mattson et al 2008). However, there were no statistically significant differences between the full RCT and the nested study in the number of lifetime sexual partners, in the number of partners in the past six months, or in sexually transmitted infections (STIs) at baseline (Mattson et al 2008).

4 Empirical Strategy

4.1 Estimation

Our empirical strategy emphasizes the role of beliefs in the process determining risk compensation. We interpret the response to circumcision among non-believers as the non-beliefs channel and the response to circumcision among believers as the sum of the non-beliefs and beliefs (i.e., risk compensation) channels. Thus, we measure the extent of risk compensation by measuring the response to circumcision among believers net of the response among non-believers. We do this in two ways. First, we estimate an ordinary least squares (OLS) regression model which allows us to disaggregate the response to circumcision into the beliefs and non-beliefs channels. Second, we fully exploit the

²⁸Although Mattson et al (2008) reports a statistically significant difference in employment status at baseline by circumcision assignment, we find no statistically significant difference in employment status by circumcision assignment (48% versus 50% for uncircumcised and circumcised respondents, respectively, p -value=0.36). One possible explanation for this discrepancy is that Mattson et al (2008) may have defined employment status using information on reported occupation.

²⁹We note that the full study was not designed to be statistically representative of young men Kisumu, Kenya.

longitudinal dimension of the data and estimate individual random and fixed effects models to provide an alternative method of identifying the response to circumcision through the beliefs channel.

The primary ordinary least squares (OLS) regression specification is:

$$risky_{it} = \alpha_0 + \alpha_1 circumcised_i + \alpha_2 believe_{it} + \alpha_3 circumcised_i \times believe_{it} + \varepsilon_{it} \quad (1)$$

where $risky_{it}$ denotes the risky sexual behavior of individual i over reference period t , $circumcised_i$ is an indicator variable equal to one if individual i was assigned to receive circumcision, and $believe_{it}$ is an indicator variable equal to one if individual i believed in the protective benefits of male circumcision at the beginning of reference period t .³⁰ The parameter α_1 is the effect of circumcision on risky sexual behavior independent of the beliefs mechanism. The parameter α_2 simply captures the difference in risky sexual behavior between believers and non-believers. Our interpretation of risk compensation indicates that α_3 is the parameter that measures the extent of risk compensation. That is, it is the response to circumcision among believers net of the response among non-believers. We report heteroskedasticity robust standard errors.

We complement our primary empirical specification with individual random and fixed effects specifications. This should help address concerns about time invariant unobserved heterogeneity associated with beliefs at baseline. This specification does not allow us to identify the effect of circumcision through the non-beliefs channel (i.e., α_1 in Equation (1)). Nonetheless, we can identify the differential effect of circumcision for believers (i.e., α_3 in Equation (1)) using variation in beliefs between Visits 2 and 3.³¹

4.2 Beliefs

To further illuminate the validity of our empirical strategy, Columns (5) and (6) in Table 2 provides descriptive statistics at baseline disaggregated by belief. For most measures of past sexual behavior and most socioeconomic characteristics believers and non-believers appear to be very similar. However, believers were 3 percentage points more likely to have had multiple partners in their lifetime (p-value=0.03) and were 0.27 years younger on average (p-value=0.01) than non-believers. Under the assumption that the source of this heterogeneity across belief status is time invariant or at least does not evolve differentially by circumcision status, then the parameter α_2 in Equation (1) should address this potential source of bias. In any case, we formally test whether belief varied by circumcision assignment at follow-up surveys and report the results in Table 3 (discussed momentarily).

We also test whether circumcision assignment affected belief in the prevention benefits of circumcision and examine the correlates of belief at baseline and follow-up surveys. Table 3 presents the results of regressing the indicator variable for belief on basic demographic and socioeconomic characteristics, as well as on baseline risky sexual behavior. Columns (1)–(6)

³⁰To clarify, risky behavior is measured over a six month interval and belief is recorded at the beginning of that interval.

³¹We cannot use measures of risky behavior collected at Visit 1 in these panel regression models because the risky behavior measures for Visit 1 are not comparable to those for Visits 2 and 3. Visit 1 asks about lifetime risky behavior, whereas the measures at Visits 2 and 3 refer to behavior during the preceding 6 month period.

report results for the full sample and Columns (7)–(12) report results for the respondents who were successfully interviewed at all three visits.

The beliefs regressions suggest that circumcision assignment did not affect beliefs. The coefficient estimate on circumcision is never statistically significant and it reverses sign across visits. Even the least precisely estimated specifications rule out an effect of circumcision on belief that is greater than 8.3 percentage points (i.e., roughly one-sixth of a standard deviation in beliefs).

The results of the belief regressions also suggest that belief is only weakly associated with most observable characteristics, including baseline risky sexual behavior. Among all the covariates, age appears to be the characteristic most closely associated with belief. The point estimates for belief at Visit 1 or at Visit 2 suggest that going from the oldest men in our sample (i.e., 24 years old at baseline) to the youngest (i.e., 18 years old at baseline) increases the likelihood of believing in the prevention benefits of circumcision by as much as 14 percentage points. This is a large coefficient estimate and statistically significant at the 1 percent level in some specifications so we examine the sensitivity of our risky behavior regressions to controlling for age (and other observable characteristics) as well as allowing the response to circumcision to vary by age (and other observable characteristics).

5 Results

5.1 Risk compensation

Table 4 presents the main regression results. We begin by examining the evidence on risk compensation. As discussed in the previous section, we interpret the estimate of α_3 in Equation (1) as the extent of risk compensation.

The estimates in Table 4 suggest a behavioral response to male circumcision that is contrary to the presumption of risk compensation. On the whole, the estimates for the circumcised-believe interaction indicate that the response to circumcision among believers net of the response among non-believers appears to have been a reduction in risky sexual behavior. For example, the response to circumcision among believers net of the response among non-believers appears to have been a 0.324 reduction in the number of partners as reported at Visit 2 (significant at the 10 percent level). The estimated 12.9 percentage point reduction in the likelihood of multiple partners (significant at the 5 percent level) suggests that there was a reduction on the intensive margin (i.e., particularly risky behavior) and not just the extensive margin. There is no evidence of an effect on condom use at Visit 2 according to either of our condom use measures. However, recall error may mean that these measures are noisier than the data on the number of partners.

Columns (5) through (8) repeat the analysis for Visit 3. In general, we find larger estimated responses at Visit 3 than at Visit 2. For example, the magnitude on the circumcised-believe interaction in the multiple partners regression increases in absolute value from -0.129 to -0.180 and is statistically significant at the 5 percent. Similarly, the point estimates in the condom use regressions increase in magnitude and become statistically significant at the 10 percent level or smaller. One interpretation of this pattern is that individuals found it easier

to adjust their behavior over a longer time horizon (i.e., 12 months instead of 6 months), possibly because existing relationships constrained the response in the short term.

We proceed by investigating the robustness of our main risk compensation results to including additional regressors. We include basic demographic/socioeconomic controls in Panel B. Panel C adds controls for baseline risky sexual behavior. In general, the estimated responses to circumcision through the risk compensation channel and through the non-beliefs channel are very similar to those presented in Panel A. The exceptions to this pattern are that the point estimates on the circumcised-believe interaction in the Visit 3 condom regressions become somewhat attenuated and are usually no longer statistically significant at conventional levels.

5.2 Effect of circumcision independent of beliefs

The coefficient estimates for circumcised (i.e., the estimate of α_1 in Equation (1)) in Table 4 measure the behavioral response to circumcision separate from the risk compensation mechanism. These estimates suggest that circumcision affected behavior aside from through its effects on the recipients' beliefs about the marginal cost of risky sexual behavior. The effect of circumcision on risky behavior through these non-beliefs mechanisms appears to have been an increase in the number of partners and in the likelihood of multiple partners at Visit 2 and at Visit 3. For example, the effect of circumcision through the non-beliefs channel was a 0.237 increase in the number of partners at Visit 2 and a 9 percentage point increase in the likelihood of multiple partners at Visit 2. Although these estimated responses through the non-beliefs channel are smaller than those documented as operating through the beliefs channel, they are statistically significant at (at least) the 10 percent level. Similar to the beliefs channel, there does not appear to have been an effect of circumcision through these non-beliefs mechanisms on condom use at Visit 2 and the non-beliefs effect of circumcision at Visit 3 appears to have been a reduction in the likelihood of condom use. For example, the effect on "always use condom" was approximately a 15 percentage point decrease in the likelihood of consistent condom use. Including additional controls in Panels B and C attenuates the estimates of the non-beliefs channel somewhat, but they remain statistically significant at (at least) the 10 percent level.

5.3 Individual random and fixed effects

We turn to the individual random and fixed effects estimation to provide additional evidence on risk compensation. This estimation uses changes in beliefs and changes in risky behavior between Visit 2 and Visit 3 to identify the response to circumcision through the beliefs channel. We restrict the regression sample to respondents who attended both Visit 2 and Visit 3. Table 5 reports the results of this analysis. Panel A shows the random effects estimates and Panel B shows the fixed effects estimates.

The results in Table 5 on the response to circumcision through the beliefs channel are broadly consistent with the OLS regression results discussed in Section 5.1. In Panel A and in Panel B of Table 5, the coefficient estimate for the circumcised-believe interaction is negative and statistically significant (at at least the 10 percent level) in the partnership regressions. However, the random effects and fixed effects results for condom use are

slightly weaker than in baseline specification (i.e., as reported in Table 4). Chi-squared tests largely fail to reject the equality of random effects and fixed effects parameters.

5.4 Placebo test

Information on risky sexual behavior engaged in prior to the study period provides a placebo test for the behavioral response to male circumcision. If the randomization of circumcision implemented in the full study remained effective in the nested study and if beliefs at baseline were exogenous to the process determining risky behavior during the course of the study, then we should not see any “effect” of circumcision through either the beliefs or non-beliefs channels. Table 6 presents evidence on this issue by showing the results of regressing past risky sexual behavior as reported at baseline (i.e., Visit 1) on circumcision assignment, belief about the efficacy of male circumcision at baseline, and the interaction thereof. Columns (1) through (4) report the results for the full sample of respondents at Visit 1. Columns (5) through (8) restrict the regression sample to those respondents at Visit 1 who also show up at Visit 2.

In general, the results of this placebo test are much smaller point estimates than in Table 4 and none of the terms are statistically significant. For example, the point estimates on circumcised and the circumcised-believe interaction in the multiple partners regression using the full sample (i.e., Column (2) of Table 6) are -0.006 and 0.027 , respectively, each a full order of magnitude smaller than the comparable point estimates from Table 4. Although the point estimates in the number of partners regressions in Table 6 are roughly as large as in Table 5, the definition of this variable differs between the baseline survey and Visits 2 and 3. At baseline, this variable refers to lifetime number of sexual partners, whereas at Visits 2 and 3 it refers to number of partners during the six months since the previous interview date. As reported in Panel B of Table 6, this “zero effect” is robust to including additional demographic/socioeconomic controls.

5.5 Alternative mechanisms

A remaining concern about the results presented thus far is that “believe” is simply proxying for some other characteristic that determines the behavioral response to male circumcision rather than capturing the extent of risk compensation. For example, the results in Table 3 suggest that younger males are more likely to believe in the prevention benefits of circumcision and it may be the case that younger males respond differently to circumcision. To investigate this concern, we allow the response to male circumcision to vary along dimensions other than believer/non-believer. We do this by interacting circumcision with one of the demographic or socioeconomic controls and including that control and the interaction with circumcision as additional regressors in a modified version of Equation (1). We repeat this exercise for each of the controls in each of the risky behavior regressions. Table 7 reports these results for partnerships at Visit 2.³² Throughout, the coefficient estimates largely suggest that it is differences in beliefs about the efficacy of male circumcision for HIV prevention that drive the behavioral response to circumcision among believers as compared to non-believers. In general, allowing the response to circumcision to

³²Appendix Tables A1 through A3 report these results for condom use at Visit 2 and partnerships and condom use at Visit 3.

vary by another characteristic does not substantially affect the point estimate on the circumcised-believe interaction or the associated standard error.

5.6 Differential non-response

The interview response rate at 6 month and 12 month follow-ups exceeded 75 percent.³³ However, the fact that nearly 25 percent of respondents were not interviewed at a given follow-up survey raises the possibility that these results simply reflect differential non-response by the interaction of circumcision assignment and belief about the efficacy of male circumcision for HIV prevention. To investigate this concern, we estimate the parameters of Equation (1), but with an indicator variable for non-response at Visit 2 (i.e., 6 month follow-up) as the dependent variable and repeat this for non-response at Visit 3 (i.e., 12 month follow-up).

Table 8 reports the results of these non-response regressions. The dependent variable in Columns (1)–(3) is non-response at Visit 2 and the dependent variable in Columns (4)–(6) is non-response at Visit 3. The results suggest that among non-believers, circumcised men were slightly less likely to be successfully interviewed at Visit 2, but slightly more likely to be successfully interviewed at Visit 3, as compared to uncircumcised men. Among believers, circumcision assignment appears to be unrelated to non-response at Visit 2 and at Visit 3 circumcised men were slightly less likely to be successfully interviewed at Visit 3.³⁴ However, none of these effects are statistically significant at conventional levels. Older males appear to have been less likely to be successfully interviewed at follow-up surveys (significant at 10 percent level at Visit 2) and married males more likely to be successfully interviewed at follow-up surveys (significant at the 1 percent level at Visit 2). There does not appear to be a clear association between baseline risky sexual behavior and non-response. In general, these results do not provide strong support for the hypothesis that differential non-response is the mechanism underlying the risky behavior results.

5.7 Average response to circumcision

Although our empirical approach and findings appear to be unique among existing analyses of the behavioral response to male circumcision, our findings are not inconsistent with previous research on the behavioral response to male circumcision. In fact, a weighted average of the responses operating through the beliefs and non-beliefs channels is quite similar to the findings presented in the previous literature on this topic (e.g., Agot et al 2007, Bailey et al 2007, Gray et al 2007a, Mattson et al 2008) which indicate no difference between circumcised and uncircumcised males in risky behavior at follow-up visits.³⁵ Nonetheless, we emphasize that what we learn about human behavior and the associated

³³Among the 1,300 respondents successfully surveyed in the baseline sample, 1,001 (77 percent) were successfully interviewed at 6 month follow-up and 1,007 (77 percent) were successfully interviewed at 12 month follow-up. Among respondents successfully interviewed at Visit 2, 869 (87 percent) were successfully interviewed at Visit 3. Among respondents successfully interviewed at Visit 3, 869 (86 percent) were successfully interviewed at Visit 2. The sample size in the Visit 3 risky behavior regressions is further limited by the fact that these regressions require information on belief at Visit 2.

³⁴The effect of circumcision on follow-up among believers is the sum of the coefficients on circumcised and the circumcised-believe interaction. At Visit 2, this sum is virtually zero in each of the three regression specifications.

³⁵Several of these studies do document a modest secular decrease in risky behavior over the course of the study.

policy implications are substantively different. Of course the overall effect of circumcision may be the most relevant parameter from a policy perspective.³⁶

Table 9 presents our estimates of the average response to male circumcision in our study setting. Panel A shows the results from a simple regression with no controls. In Panel B we control for belief in the efficacy of male circumcision for HIV prevention. In Panel C we also include the demographic and socioeconomic controls from our prior analysis. Throughout, the estimated average response to circumcision tends to be statistically insignificant and small. The estimated average response to circumcision is statistically significant only for “always use condom” at Visit 3 and for “used condom last time” at Visit 3 when controlling for belief and demographic/socioeconomic characteristics. Although the Visit 3 condom use results suggest up to approximately a 7 percentage point reduction in the likelihood of consistent condom use, the other point estimates tend to be substantially smaller than either of the two effects documented in Table 4.

6 Discussion

The results of our empirical analysis suggest a behavioral response operating through beliefs that is contradictory to the presumption of risk compensation. This finding is somewhat puzzling given the fact that circumcision reduces the likelihood of HIV transmission. However, in a high HIV prevalence environment, a large reduction in the likelihood of HIV transmission may affect the marginal cost of risky sexual behavior for another reason: circumcision may reduce fatalism about acquiring HIV and increase the salience of the tradeoff between engaging in additional risky behavior and avoiding acquiring HIV.

Although we provide evidence rejecting several other possible explanations, we recognize that beliefs are not randomly assigned and we may measure beliefs with error so we interpret this result with caution. It would be useful to have information on other investment decisions that might change if an individual’s time horizon changes to help corroborate the mechanism we suggest for this finding. Unfortunately, although our data are uniquely suited for our purposes in other regards they do not contain this information. In any case, we demonstrate that if the mechanism we suggest is not correct, then the alternative mechanism is not one that is manifest as a differential response to circumcision by age, marital status, education, employment status, or income. An additional caveat is that our analysis relies on self-reported risky sexual behavior. Although biomarkers were not available for the current analysis, Mattson et al (2008) shows that sexually transmitted infection (STI) outcomes closely match self-reported risky sexual behavior in our data.

In addition to our main finding, our results suggest that there was a behavioral response to circumcision that did not operate through beliefs on the part of the circumcision recipient. The independent response to circumcision through this channel appears to have been an increase in risky sexual activity. One potential explanation for this finding is that demand for circumcised partners may be higher than that for uncircumcised partners, possibly because potential partners of the circumcised individuals believe that circumcision is effective at

³⁶Our findings suggest that the overall effect of circumcision will depend on the distribution of beliefs among individuals choosing to be circumcised as well as on local context (e.g., whether potential partners have an aesthetic preference for (un)circumcised men).

reducing HIV transmission. Likewise, potential partners may prefer circumcised partners for hygiene reasons (Mattson et al 2005).^{37,38} Another possible explanation for this finding is that circumcision reduced the prevalence of other STIs, potentially increasing demand for circumcised males as well as increasing their demand for sexual activity.^{39,40}

Under several of these possible explanations for this secondary finding, the non-beliefs circumcision effect may be greatly diminished in the context of mass male circumcision campaigns. These campaigns aim to circumcise nearly all males in a given location. If everyone were circumcised, then possible partner preference for circumcised males would seem to not be as likely to be manifest as additional risky behavior for circumcised males. However, if the STIs explanation is correct and reducing STIs actually increases demand for sexual activity on the part of the individual who had fewer STIs, then we may still expect this effect in the context of a mass male circumcision campaign.

Two important areas for future research are the behavioral response among females and the response to an actual mass circumcision campaign. Existing research suggests that male circumcision may not directly reduce the likelihood of male-to-female transmission of HIV (Wawer et al 2009, Weiss et al 2009, Hallet et al 2011).⁴¹ However, individuals may be unaware of the potential gender difference in the protective effects of circumcision. Examining the response among females may also illuminate the potential role of partner preference for circumcised males. Because of the scale of mass male circumcision campaigns, they may be less likely to affect behavior through mechanisms based on partner preference for circumcised males. Moreover, it is important to evaluate a policy that has taken a central place in the efforts to ameliorate the HIV/AIDS pandemic.

7 Conclusion

This paper examines risk compensation associated with male circumcision using data from a nested study in a randomized controlled trial conducted in Kisumu, Kenya. We emphasize the role of beliefs in the process determining risk compensation. In our interpretation, it is only those individuals who believe circumcision is effective at preventing HIV transmission who are at risk of demonstrating this compensatory response.

Our empirical analysis yields two key findings. First, contrary to the presumption of risk compensation, we find that the behavioral response to the perceived reduction in HIV transmission probability in this study setting appears to have been a reduction in risky sexual behavior. Second, we find that independent of the beliefs mechanism, circumcision in this study setting appears to have increased risky sexual behavior. Because circumcision was

³⁷Among a survey of 110 women in Nyanza Province, 69 percent reported a preference for circumcised partners and the vast majority of respondents cited hygiene as the primary reason (Mattson et al 2005).

³⁸See Westercamp and Bailey (2007) for a review of studies of acceptability of male circumcision for HIV prevention.

³⁹Male circumcision appears to reduce the likelihood of the recipient acquiring HSV-2 (Weiss et al 2006, Tobian et al 2009), HPV (Auvert et al 2009, Tobian et al 2009), syphilis (Weiss et al 2006), and chancroid (Weiss et al 2006). For most bacterial STIs, male circumcision does not appear to convey a prophylactic effect on the recipient (Laumann et al 1997, Moses et al 1998, Dave et al 2003, Ritchers et al 2006, Dickson et al 2008, Millet et al 2008, Mehta et al 2009).

⁴⁰Anecdotal evidence from fieldwork for the nested study suggests an increase in demand for sexual activity on the part of circumcision recipients. Many circumcised recipients stated they were eager to try out sex again now that they were circumcised.

⁴¹If male circumcision is effective at reducing HIV prevalence, then male circumcision may indirectly reduce male-to-female transmission through the reduction in HIV prevalence.

randomized in the RCT rather than in the nested study and beliefs were not randomly assigned, we caution against interpreting these results as definitive. Nonetheless, the circumcised and uncircumcised men in the nested study appear to have had generally similar observable characteristics and past behaviors at baseline and we show that the differential response to circumcision by belief is robust to a host of additional interactions.

These results suggest that in contexts where individuals do not have perfect information about the magnitude of changes in health production technologies, standard empirical tests of risk compensation may understate the degree of actual behavior change. More generally, to the extent that the mechanism we suggest is correct, then our results are consistent with the idea that changes in time horizon (e.g., life expectancy) may generate substantial changes in consumption decisions.

Several policy implications follow from our results. Our first key finding suggests that HIV prevention policies that noticeably reduce the likelihood of HIV transmission (e.g., male circumcision) may generate complementary behavioral responses, an implication that echoes those in Kremer (1996) and Dow et al (1999). This response may be larger in medium-to-high HIV prevalence populations that may have a fatalistic perspective on risky sexual behavior before the HIV prevention policy is implemented. In contrast, our second key finding suggests that circumcision may actually lead to increased risky sexual behavior among individuals who do not believe in its protective effect.⁴² Widespread information campaigns associated with mass male circumcision campaigns underway in much of Sub-Saharan Africa may mean that few individuals who choose to actually receive circumcision will fail to believe in its protective effects. This suggests that the net effect of mass adult male circumcision campaigns in higher HIV prevalence populations may be a reduction in HIV transmission, as the behavioral response may reinforce the biological effect. However, further research is required because there is little empirical evidence on the effects of an actual mass male circumcision campaign.

Appendix

Table A1

Robustness Checks for Condom Use at Visit 2 to Additional Interactions

Control:	<u>none</u>	<u>age</u>	<u>married/cohabit</u>	<u>years of schooling</u>	<u>employed</u>	<u>income</u>
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Dependent variable is “always use condom” at Visit 2						
Circumcised	−0.014 (0.045)	−0.043 (0.381)	−0.006 (0.045)	0.085 (0.153)	−0.010 (0.051)	−0.037 (0.050)
Believe	0.023 (0.041)	0.017 (0.041)	0.019 (0.040)	0.043 (0.040)	0.035 (0.040)	0.015 (0.041)
Circumcised × Believe	−0.027 (0.060)	−0.024 (0.060)	−0.041 (0.059)	−0.044 (0.059)	−0.042 (0.059)	−0.017 (0.060)
Control		−0.012 (0.013)	−0.340*** (0.073)	0.039*** (0.009)	−0.174*** (0.040)	−0.014*** (0.005)
Circumcised × Control		0.001 (0.018)	−0.051 (0.103)	−0.008 (0.013)	0.005 (0.059)	0.007 (0.009)
Panel B: Dependent variable is “used condom last time” at Visit 2						

⁴²Although believers shared this response operating through a non-beliefs channel, the estimated net effect among believers generally was zero, not an increase in risky behavior (see Table 4 for tests of the joint significance of the beliefs and non-beliefs channels).

Control:	none	age	married/cohabit	years of schooling	employed	income
	(1)	(2)	(3)	(4)	(5)	(6)
Circumcised	-0.013 (0.043)	0.036 (0.360)	-0.002 (0.042)	-0.037 (0.151)	0.004 (0.047)	-0.027 (0.047)
Believe	0.005 (0.039)	0.000 (0.039)	0.001 (0.038)	0.024 (0.039)	0.016 (0.038)	-0.004 (0.039)
Circumcised × Believe	-0.029 (0.058)	-0.027 (0.058)	-0.045 (0.056)	-0.042 (0.057)	-0.044 (0.057)	-0.016 (0.057)
Control		-0.011 (0.012)	-0.355*** (0.075)	0.035*** (0.009)	-0.164*** (0.038)	-0.015*** (0.005)
Circumcised × Control		-0.002 (0.017)	-0.079 (0.107)	0.003 (0.013)	-0.022 (0.057)	0.003 (0.009)
Observations	998	998	998	998	998	998

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Age measures the respondents age in years. Married/cohabit is an indicator variable. Employed is an indicator variable. Income measures average monthly income in '000's of Kenyan schillings. Always use condom measures the fraction of partners with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners with whom the respondent reported using a condom during their last sexual encounter. Visit 2 refers to the six month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

*** Significant at the 1% level

** Significant at 5% level

* Significant at 10% level.

Table A2

Robustness Checks for Partnerships at Visit 3 to Additional Interactions

Control:	none	age	married/cohabit	years of schooling	employed	income
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Dependent variable is number of partners at Visit 3						
Circumcised	0.328** (0.162)	-0.798 (1.078)	0.367** (0.157)	0.344 (0.454)	0.359** (0.179)	0.295* (0.165)
Believe	0.251* (0.147)	0.252* (0.147)	0.231 (0.149)	0.244* (0.148)	0.229 (0.148)	0.241 (0.149)
Circumcised × Believe	-0.537*** (0.197)	-0.525*** (0.196)	-0.518*** (0.199)	-0.534*** (0.197)	-0.521*** (0.197)	-0.538*** (0.197)
Control		0.015 (0.037)	0.486 (0.342)	-0.017 (0.028)	0.258* (0.141)	0.015 (0.019)
Circumcised × Control		0.055 (0.053)	-0.476 (0.363)	-0.001 (0.039)	-0.072 (0.185)	0.013 (0.024)
Panel B: Dependent variable is multiple partners at Visit 3						
Circumcised	0.128** (0.060)	-0.408 (0.413)	0.118* (0.061)	0.01 (0.166)	0.116* (0.066)	0.092 (0.063)
Believe	0.058 (0.049)	0.058 (0.049)	0.063 (0.049)	0.055 (0.049)	0.056 (0.049)	0.058 (0.049)
Circumcised × Believe	-0.180** (0.072)	-0.176** (0.072)	-0.186*** (0.072)	-0.177** (0.072)	-0.180** (0.072)	-0.186*** (0.072)
Control		-0.003 (0.014)	-0.134** (0.067)	-0.008 (0.010)	0.021 (0.046)	0.00 (0.005)
Circumcised × Control		0.026 (0.020)	0.128 (0.100)	0.011 (0.014)	0.026 (0.066)	0.016* (0.009)
Observations	867	867	867	867	867	867

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Age measures the respondents age in years. Married/cohabit is an indicator variable. Employed is an indicator variable. Income measures average monthly income in '000's of Kenyan schillings. Number of partners measures the number of sexual partners the respondent had during the six month period prior to the interview data. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner during the six month period prior to the interview date. Visit 3 refers to the twelve month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

*** Significant at the 1% level

** Significant at 5% level

* Significant at 10% level.

Table A3

Robustness Checks for Condom Use at Visit 3 to Additional Interactions

Control:	none	age	married/cohabit	years of schooling	employed	income
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Dependent variable is “always use condom” at Visit 3						
Circumcised	−0.149*** (0.056)	0.269 (0.392)	−0.127** (0.055)	0.012 (0.163)	−0.166*** (0.063)	−0.154*** (0.05)
Believe	−0.082* (0.046)	−0.081* (0.046)	−0.062 (0.043)	−0.068 (0.045)	−0.067 (0.045)	−0.074 (0.046)
Circumcised × Believe	0.116* (0.068)	0.113* (0.068)	0.091 (0.065)	0.106 (0.067)	0.105 (0.068)	0.111 (0.068)
Control		0.009 (0.013)	−0.499*** (0.060)	0.038*** (0.009)	−0.182*** (0.042)	−0.013*** (0.00)
Circumcised × Control		−0.020 (0.019)	−0.012 (0.079)	−0.014 (0.014)	0.041 (0.063)	0.003 (0.007)
Panel B: Dependent variable is “used condom last time” at Visit 3						
Circumcised	−0.145*** (0.054)	0.227 (0.380)	−0.124** (0.053)	0.015 (0.160)	−0.131** (0.060)	−0.153*** (0.05)
Believe	−0.097** (0.043)	−0.097** (0.043)	−0.076* (0.040)	−0.083* (0.043)	−0.084* (0.043)	−0.089** (0.043)
Circumcised × Believe	0.140** (0.066)	0.137** (0.066)	0.114* (0.063)	0.130** (0.065)	0.132** (0.065)	0.135** (0.066)
Control		0.006 (0.012)	−0.544*** (0.059)	0.037*** (0.009)	−0.159*** (0.041)	−0.014*** (0.00)
Circumcised × Control		−0.018 (0.018)	0.010 (0.082)	−0.014 (0.013)	−0.027 (0.060)	0.004 (0.007)
Observations	867	867	867	867	867	867

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Age measures the respondents age in years. Married/cohabit is an indicator variable. Employed is an indicator variable. Income measures average monthly income in '000's of Kenyan schillings. Always use condom measures the fraction of partners with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners with whom the respondent reported using a condom during their last sexual encounter. Visit 3 refers to the twelve month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

*** Significant at the 1% level

** Significant at 5% level

* Significant at 10% level.

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Table 1

Beliefs by Visit

Sample:	<u>circumcised</u>	<u>Uncircumcised</u>	<u>difference</u>	<u>p-value</u>
	(1)	(2)	(3)	(4)
Believe circumcision is effective:				
Visit 1 (<i>n</i> =1300)	0.57 (0.49)	0.56 (0.50)	0.01	0.63
Visit 2 (<i>n</i> =998)	0.68 (0.47)	0.70 (0.46)	−0.02	0.43
Visit 3 (<i>n</i> =1003)	0.75 (0.43)	0.76 (0.43)	−0.01	0.78

Notes: Entries in Columns (1) and (2) are sample means. Standard deviations in parentheses.

Table 2

Descriptive Statistics by Circumcision Assignment and by Belief at Visit 1

Sample:	<u>circumcised</u>	<u>uncircumcised</u>	<u>difference</u>	<u>p-value</u>	<u>believe</u>	<u>not believe</u>	<u>difference</u>	<u>p-value</u>
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
<i>Sexual behavior at Visit 1</i>								
Number of partners	5.78 (3.30)	5.75 (3.35)	0.03	0.87	5.76 (3.24)	5.77 (3.44)	-0.02	0.92
Multiple partners	0.95 (0.22)	0.94 (0.23)	0.01	0.44	0.96 (0.20)	0.93 (0.25)	0.03	0.03
Always use condom	0.61 (0.43)	0.60 (0.43)	0.01	0.77	0.61 (0.43)	0.60 (0.43)	0.01	0.67
Used condom last time	0.66 (0.41)	0.67 (0.42)	-0.01	0.83	0.67 (0.41)	0.67 (0.42)	0.00	0.89
<i>Other characteristics at Visit 1</i>								
Age	20.44 (1.60)	20.48 (1.67)	-0.04	0.60	20.34 (1.65)	20.61 (1.60)	-0.26	0.00
Employed	0.50 (0.50)	0.48 (0.50)	0.03	0.36	0.50 (0.50)	0.48 (0.50)	0.02	0.42
Married/cohabit	0.068 (0.25)	0.072 (0.26)	-0.003	0.81	0.065 (0.25)	0.077 (0.27)	-0.012	0.42
Income (average monthly)	2.60 (2.91)	2.56 (3.89)	0.05	0.79	2.56 (2.99)	2.60 (3.98)	-0.04	0.85
Years of schooling	10.90 (2.44)	10.99 (2.39)	-0.09	0.50	10.88 (2.38)	11.04 (2.47)	-0.15	0.26
Observations	616	684			738	562		

Notes: Entries are sample means. Standard deviations in parentheses unless noted otherwise. Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if, at the beginning of the reference period over which sexual behavior was measured, the individual reported believing circumcision reduces the likelihood acquiring HIV. Number of partners measures the number of sexual partners the respondent had thus far during their lifetime. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner thus far during their lifetime. Always use condom measures the fraction of partners in his lifetime at baseline with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners in his lifetime at baseline with whom the respondent reported using a condom during their last sexual encounter.

Table 3

Correlates of Belief in Prevention Benefit of Circumcision

Dependent variable:		believe											
Sample:	Visit:	full sample						successfully interviewed at all three visits					
		visit 1		visit 2		visit 3		visit 1		visit 2		visit 3	
		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Circumcised		0.011 (0.027)	0.009 (0.027)	−0.022 (0.029)	−0.026 (0.029)	−0.008 (0.027)	−0.009 (0.027)	0.011 (0.034)	0.011 (0.034)	−0.019 (0.031)	−0.022 (0.031)	0.008 (0.030)	0.006 (0.030)
Age		−0.025*** (0.009)	−0.026*** (0.009)	−0.020** (0.010)	−0.022** (0.010)	−0.008 (0.009)	−0.01 (0.009)	−0.026** (0.011)	−0.028** (0.011)	−0.013 (0.010)	−0.016 (0.010)	−0.008 (0.009)	−0.010 (0.010)
Married/cohabit		−0.033 (0.056)	−0.031 (0.056)	0.035 (0.047)	0.035 (0.048)	−0.052 (0.044)	−0.057 (0.044)	−0.100 (0.065)	−0.103 (0.065)	0.016 (0.050)	0.015 (0.051)	−0.015 (0.047)	−0.019 (0.047)
Years of schooling		−0.002 (0.006)	−0.002 (0.006)	−0.006 (0.006)	−0.007 (0.007)	0.001 (0.006)	0.000 (0.006)	−0.008 (0.008)	−0.007 (0.008)	−0.007 (0.007)	−0.008 (0.007)	0.001 (0.007)	0.000 (0.007)
Employed		0.037 (0.030)	0.034 (0.031)	0.034 (0.031)	0.029 (0.032)	0.024 (0.030)	0.021 (0.030)	0.052 (0.037)	0.047 (0.037)	0.037 (0.033)	0.028 (0.034)	0.010 (0.032)	0.007 (0.033)
Income		0.000 (0.004)	0.000 (0.004)	0.007** (0.003)	0.007** (0.003)	0.002 (0.003)	0.001 (0.003)	−0.002 (0.004)	−0.002 (0.004)	0.007*** (0.003)	0.007** (0.003)	0.002 (0.003)	0.002 (0.003)
Number of partners [Visit 1]			−0.002(0.005)		0.002(0.005)		0.004(0.005)		0.001(0.006)		0.006(0.005)		0.002(0.005)
Multiple partners [Visit 1]			0.141** (0.066)		0.012(0.071)		−0.050(0.066)		0.090(0.082)		0.006(0.078)		−0.05(0.069)
Always use condom [Visit 1]			0.059 (0.074)		0.153* (0.078)		0.137* (0.077)		0.053 (0.089)		0.179** (0.086)		0.145* (0.083)
Used condom last time [Visit 1]			−0.045 (0.077)		−0.144* (0.081)		−0.133* (0.080)		−0.054 (0.092)		−0.164* (0.088)		−0.127 (0.086)
Observations		1,300	1,300	998	998	1,003	1,003	867	867	867	867	867	867

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Age measures the respondents age in years. Married/cohabit is an indicator variable. Employed is an indicator variable. Income measures average monthly income in '000's of Kenyan shillings. Visit 1 refers to baseline interview. Visit 2 refers to the six month follow-up after the baseline interview. Visit 3 refers to the twelve month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

*** Significant at the 1% level
** Significant at 5% level
* Significant at 10% level.

Table 4

Effect of Circumcision on Risky Sexual Behavior

Visit:	visit 2				visit 3			
Dependent variable:	number of partners	multiple partners	always use condom	used condom last time	number of partners	multiple partners	always use condom	used condom last time
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Baseline specification								
Circumcised	0.237* (0.134)	0.090* (0.046)	-0.014 (0.045)	-0.013 (0.043)	0.328** (0.162)	0.128** (0.060)	-0.149*** (0.056)	-0.145*** (0.054)
Believe	0.181 (0.117)	0.060 (0.042)	0.023 (0.041)	0.005 (0.039)	0.251* (0.147)	0.058 (0.049)	-0.082* (0.046)	-0.097** (0.043)
Circumcised × Believe	-0.324* (0.177)	-0.129** (0.062)	-0.027 (0.060)	-0.029 (0.058)	-0.537*** (0.197)	-0.180** (0.072)	0.116* (0.068)	0.140** (0.066)
P > F(Circumcised + Circumcised × Believe = 0)	0.452	0.344	0.302	0.277	0.064	0.186	0.389	0.890
Panel B: Controlling for demographic/socioeconomic characteristics								
Circumcised	0.233* (0.133)	0.086* (0.047)	-0.008 (0.043)	-0.009 (0.040)	0.315* (0.162)	0.130** (0.059)	-0.129*** (0.054)	-0.124** (0.052)
Believe	0.170 (0.122)	0.049 (0.043)	0.029 (0.040)	0.010 (0.038)	0.220 (0.149)	0.055 (0.049)	-0.044 (0.043)	-0.058 (0.040)
Circumcised × Believe	-0.312* (0.177)	-0.123** (0.062)	-0.044 (0.058)	-0.044 (0.055)	-0.513*** (0.198)	-0.180** (0.071)	0.085 (0.065)	0.107* (0.062)
P > F(Circumcised + Circumcised × Believe = 0)	0.461	0.321	0.167	0.152	0.080	0.202	0.211	0.626
Panel C: Controlling for demographic/socioeconomic characteristics and baseline risky sexual behavior								
Circumcised	0.246* (0.126)	0.094** (0.044)	-0.004 (0.042)	-0.002 (0.039)	0.284* (0.160)	0.121** (0.059)	-0.117*** (0.054)	-0.109** (0.052)
Believe	0.179 (0.114)	0.057 (0.040)	0.041 (0.039)	0.021 (0.036)	0.150 (0.144)	0.034 (0.048)	-0.038 (0.043)	-0.050 (0.040)
Circumcised × Believe	-0.361** (0.167)	-0.145** (0.058)	-0.050 (0.057)	-0.052 (0.054)	-0.464*** (0.194)	-0.166** (0.070)	0.063 (0.064)	0.085 (0.061)
P > F(Circumcised + Circumcised × Believe = 0)	0.291	0.182	0.171	0.152	0.101	0.248	0.117	0.461
Observations	998	998	998	998	867	867	867	867

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Number of partners measures the number of sexual partners the respondent had during the six month period prior to the interview data. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner during the six month period prior to the interview date. Always use condom measures the fraction of partners during the six month period with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners during the six month period with whom the respondent reported using a condom during their last sexual encounter. Visit 2 refers to the six month follow-up after the baseline interview. Visit 3 refers to the twelve month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

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*** Significant at the 1% level
** Significant at 5% level
* Significant at 10% level.

Table 5

Random Effects and Fixed Effects Estimates of Effect of Circumcision on Risky Sexual Behavior

Dependent variable:	<u>number of partners</u>	<u>multiple partners</u>	<u>always use condom</u>	<u>used condom last time</u>
	(1)	(2)	(3)	(4)
Panel A: Random effects				
Believe	0.041 (0.082)	0.006 (0.029)	0.003 (0.025)	0.031 (0.027)
Circumcised X Believe	-0.209 ** (0.096)	-0.057 * (0.033)	-0.008 (0.030)	-0.030 (0.032)
Panel B: Fixed effects				
Believe	0.028 (0.106)	0.021 (0.044)	0.032 (0.035)	0.088 ** (0.039)
Circumcised X Believe	-0.376 * (0.212)	-0.131 * (0.073)	0.006 (0.061)	-0.061 (0.065)
P > Chi2(coefficients REs = coefficients FEs)	0.193	0.382	0.237	0.107
Observations	867	867	867	867

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Number of partners measures the number of sexual partners the respondent had during the six month period prior to the interview data. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner during the six month period prior to the interview date. Always use condom measures the fraction of partners during the six month period with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners during the six month period with whom the respondent reported using a condom during their last sexual encounter. Heteroskedasticity-robust standard errors reported in parentheses.

Significant at the 1% level

**
Significant at 5% level

*
Significant at 10% level.

Table 6

Placebo Test Using Baseline Risky Sexual Behavior

Sample: Visit:	full sample				sub-sample successfully interviewed at visit 2			
	visit 1				visit 1			
	number of partners	multiple partners	always use condom	used condom last time	number of partners	multiple partners	always use condom	used condom last time
Dependent variable:	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Baseline specification								
Circumcised	-0.224 (0.291)	-0.006 (0.022)	-0.012 (0.036)	-0.029 (0.035)	-0.072 (0.338)	0.003 (0.024)	-0.004 (0.040)	-0.023 (0.039)
Believe	-0.237 (0.260)	0.015 (0.018)	-0.007 (0.033)	-0.019 (0.032)	-0.158 (0.299)	0.016 (0.021)	-0.031 (0.037)	-0.037 (0.036)
Circumcised × Believe	0.458 (0.376)	0.027 (0.026)	0.036 (0.048)	0.044 (0.046)	0.242 (0.436)	0.019 (0.030)	0.032 (0.055)	0.032 (0.053)
P > F(Circumcised + Circumcised × Believe = 0)	0.346	0.152	0.493	0.673	0.570	0.222	0.489	0.886
Panel B: Controlling for demographic/socioeconomic characteristics								
Circumcised	-0.220 (0.283)	-0.009 (0.021)	0.000 (0.035)	-0.018 (0.034)	-0.068 (0.327)	-0.002 (0.024)	0.002 (0.039)	-0.017 (0.038)
Believe	-0.150 (0.255)	0.013 (0.018)	0.012 (0.032)	-0.002 (0.031)	-0.015 (0.296)	0.013 (0.022)	-0.004 (0.037)	-0.013 (0.035)
Circumcised X Believe	0.453 (0.367)	0.031 (0.026)	0.017 (0.047)	0.026 (0.045)	0.235 (0.426)	0.026 (0.030)	0.011 (0.054)	0.010 (0.052)
P > F(Circumcised + Circumcised X Believe = 0)	0.332	0.137	0.589	0.786	0.562	0.175	0.736	0.835
Observations	1,300	1,300	1,300	1,300	998	998	998	998

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at baseline the individual reported believing that circumcision reduces the likelihood acquiring HIV. Number of partners measures the number of sexual partners the respondent had thus far during their lifetime. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner thus far during their lifetime. Always use condom measures the fraction of partners in his lifetime at baseline with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners in his lifetime at baseline with whom the respondent reported using a condom during their last sexual encounter. Visit 1 refers to the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

*** Significant at the 1% level

** Significant at 5% level

* Significant at 10% level.

Table 7

Robustness Checks for Partnerships at Visit 2 to Additional Interactions

Control:	none (1)	age (2)	married/cohabit (3)	years of schooling (4)	employed (5)	income (6)
Panel A: Dependent variable is number of partners at Visit 2						
Circumcised	0.237* (0.134)	-0.211 (1.157)	0.261* (0.139)	0.273 (0.417)	0.153 (0.147)	0.196 (0.143)
Believe	0.181 (0.117)	0.19 (0.123)	0.185 (0.118)	0.169 (0.117)	0.169 (0.118)	0.193 (0.119)
Circumcised × Believe	-0.324* (0.177)	-0.323* (0.180)	-0.326* (0.177)	-0.316* (0.177)	-0.306* (0.176)	-0.351** (0.178)
Control		0.017 (0.036)	0.324 (0.289)	-0.023 (0.021)	0.172 (0.119)	0.021 (0.018)
Circumcised × Control		0.022 (0.055)	-0.282 (0.383)	-0.004 (0.035)	0.157 (0.175)	0.022 (0.025)
Panel B: Dependent variable is multiple partners at Visit 2						
Circumcised	0.090* (0.046)	-0.336 (0.393)	0.096** (0.048)	0.045 (0.152)	0.082 (0.054)	0.066 (0.052)
Believe	0.06 (0.042)	0.055 (0.043)	0.059 (0.042)	0.059 (0.043)	0.057 (0.042)	0.062 (0.042)
Circumcised × Believe	-0.129** (0.062)	-0.121* (0.063)	-0.132** (0.062)	-0.128** (0.062)	-0.125** (0.062)	-0.136** (0.062)
Control		-0.009 (0.013)	-0.025 (0.076)	-0.002 (0.009)	0.045 (0.042)	0.004 (0.006)
Circumcised × Control		0.021 (0.019)	-0.061 (0.113)	0.004 (0.013)	0.011 (0.062)	0.011 (0.009)
Observations	998	998	998	998	998	998

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Age measures the respondents age in years. Married/cohabit is an indicator variable. Employed is an indicator variable. Income measures average monthly income in '000's of Kenyan shillings. Number of partners measures the number of sexual partners the respondent had during the six month period prior to the interview data. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner during the six month period prior to the interview date. Visit 2 refers to the six month follow-up after the baseline interview. Heteroskedasticity robust standard errors reported in parentheses.

*** Significant at the 1% level

** Significant at 5% level

* Significant at 10% level.

Table 8

Differential Non-Response at Follow-Up Surveys

Dependent variable: Visit:	non-response					
	(1)	(2)	(3)	(4)	(5)	(6)
Circumcised	0.021 (0.035)	0.022 (0.034)	0.021 (0.034)	-0.035 (0.035)	-0.032 (0.035)	-0.034 (0.035)
Believe	0.047 (0.032)	0.05 (0.032)	0.048 (0.032)	-0.015 (0.032)	-0.011 (0.033)	-0.011 (0.033)
Circumcised × Believe	-0.017 (0.047)	-0.02 (0.047)	-0.019 (0.047)	0.073 (0.047)	0.07 (0.047)	0.073 (0.047)
Age		0.014* (0.008)	0.015* (0.008)		0.008 (0.007)	0.010 (0.008)
Married/cohabit		-0.111*** (0.041)	-0.109*** (0.042)		-0.053 (0.044)	-0.047 (0.044)
Years of schooling		-0.005 (0.006)	-0.005 (0.006)		0.004 (0.006)	0.003 (0.006)
Employed		0.019 (0.026)	0.019 (0.026)		-0.001 (0.026)	0.004 (0.026)
Income		-0.001 (0.003)	0.000 (0.003)		-0.002 (0.003)	-0.002 (0.003)
Number of partners [Visit 1]			-0.003 (0.004)			-0.005 (0.004)
Multiple partners [Visit 1]			0.034 (0.054)			-0.044 (0.059)
Always use condom [Visit 1]			0.045 (0.056)			-0.009 (0.061)
Used condom last time [Visit 1]			-0.048 (0.058)			0.017 (0.063)
P > F(Circumcised + Circumcised × Believe = 0)	0.900	0.946	0.956	0.223	0.233	0.209
Observations	1,300	1,300	1,300	1,300	1,300	1,300

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Believe is an indicator variable equal to one if at the beginning of the six month interval over which sexual behavior was recorded the individual reported believing that circumcision reduces the likelihood acquiring HIV. Number of partners measures the number of sexual partners in his lifetime at baseline. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner in his lifetime at baseline. Always use condom measures the fraction of partners in his lifetime at baseline with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners in his lifetime at baseline with whom the respondent reported using a condom during their last sexual encounter. Visit 2 refers to the six month follow-up after the baseline interview. Visit 3 refers to the twelve month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

Significant at the 1% level

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Significant at 5% level

*

Significant at 10% level.

Table 9

Average Response to Circumcision

Dependent variable:	visit 2				visit 3			
	number of partners (1)	multiple partners (2)	always use condom (3)	used condom last time (4)	number of partners (5)	multiple partners (6)	always use condom (7)	used condom last time (8)
Panel A: No controls								
Circumcised	0.057 (0.087)	0.018 (0.031)	-0.029 (0.030)	-0.029 (0.029)	-0.044 (0.093)	0.004 (0.033)	-0.068** (0.032)	-0.047 (0.031)
Panel B: Controlling for belief								
Circumcised	0.057 (0.088)	0.018 (0.031)	-0.029 (0.030)	-0.029 (0.029)	-0.044 (0.093)	0.003 (0.033)	-0.069** (0.032)	-0.048 (0.031)
Panel C: Controlling belief and demographic/socioeconomic characteristics								
Circumcised	0.058 (0.087)	0.018 (0.031)	-0.032 (0.029)	-0.032 (0.027)	-0.041 (0.093)	0.005 (0.033)	-0.070** (0.030)	-0.049* (0.028)
Panel D: Controlling for belief, demographic/socioeconomic characteristics, and baseline risky sexual behavior								
Circumcised	0.047 (0.082)	0.014 (0.029)	-0.031 (0.028)	-0.032 (0.027)	-0.038 (0.090)	0.007 (0.032)	-0.073** (0.029)	-0.050* (0.027)
Observations	998	998	998	998	867	867	867	867

Notes: Circumcised is an indicator variable equal to one if the individual was randomly assigned to receive circumcision. Number of partners measures the number of sexual partners the respondent had during the six month period prior to the interview data. Multiple partners is an indicator variable equal to one if the individual had more than one sexual partner during the six month period prior to the interview date. Always use condom measures the fraction of partners during the six month period with whom the respondent reported always using a condom. Used condom last time measures the fraction of partners during the six month period with whom the respondent reported using a condom during their last sexual encounter. Visit 2 refers to the six month follow-up after the baseline interview. Visit 3 refers to the twelve month follow-up after the baseline interview. Heteroskedasticity-robust standard errors reported in parentheses.

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