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Long-term Effects of Male Circumcision on Risky Sexual Behaviors and STD Infections: Evidence from Malawian Schools

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October, 2016
Working Paper 16-08

KDI 국제정책대학원
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* We are grateful to the KDI School of Public Policy and Management for providing financial support.

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PRELIMINARY DRAFT. PLEASE DO NOT CITE OR CIRCULATE WITHOUT AUTHORS' PERMISSION.

Abstract

The introduction of risk-reducing technology can lead to unintended consequences, especially when risk compensation can be one of potential operating mechanism to offset the positive impact. For male circumcision, its preventive effect against HIV infection might diminish if circumcised men engage in riskier sexual behaviors. The purpose of this study is to investigate risk-compensating behavior after medical male circumcision in the long run. We randomly provided free male circumcision surgery to 2,667 adolescent male students at secondary schools in Malawi and conducted long-term follow-up survey after about four years. We find that male students who received the offer more intensively were 35 percent more likely to be infected with HSV-2 than the other students, suggesting riskier sexual behavior after circumcision. Self-reported sexual behavior, meanwhile, are showing little-to-no evidence of practicing riskier sex after circumcision, except for the inconsistent use of condom.

(JEL: C93, I12, I18)

(Keywords: HIV/AIDS, STI, Male circumcision, Risk compensation, Malawi)

1 Introduction

Medical male circumcision has been actively discussed as one of the most cost-effective HIV/AIDS prevention strategies since three randomized control trial studies proved its protective effect against female-to-male HIV transmission risk up to 60 percent (Auvert et al., 2005; Bailey et al., 2007; Gray et al., 2007). Global health agencies did not hesitate to recommend scaling up male circumcision to be a key component in national HIV/AIDS plan, especially for 14 African countries with low prevalence rate of male circumcision (WHO/UNAIDS, 2007). However, not only insufficient resources but also one concern has played as critical obstacles to hider the scale-up of male circumcision. That is risk compensation, which circumcised men may participate in riskier sexual behaviors if they perceive reduction in infection risk following the procedure, and thus mitigate the direct preventive effect of male circumcision (Cassell et al., 2006; Kalichman et al., 2007; Eaton and Kalichman, 2009).

Examining potential behavioral response has been the crucial component of numerous research which aims to grasp the net impact of risk-reducing technology. As pioneered by Peltzman (1975), the effect of technological improvements like seatbelt in transportation cannot be fully accounted for without considering offsetting effects generated from consumers' potential response to the change. In this sense, medical male circumcision would not be that different case from that of seat belt in transportation: possible increase in risky sexual behavior after the surgery may reduce the magnitude of estimated benefit of male circumcision (Wilson et al., 2014).

In this paper, we aim to assess the long-term impacts of free medical male circumcision program on sexual behaviors and infection with HIV and Herpes Simplex Virus Type 2 (HSV-2). We targeted 2,667 adolescent male students at secondary schools in Malawi, who were going through the critical period when most sexual debuts happen and attitudes toward safe or risky sex can form and might sustain for several years (Shafii et al., 2007). This study exploits a unique panel dataset which covers one of the longest follow-up periods, over four years after random provision of free male circumcision surgery for students, which can provide most relevant evidence for policymakers who are concerned about "long-term" consequence of scaling up male circumcision program. The male circumcision program was a part of broader HIV/AIDS prevention program, which includes HIV/AIDS education, male circumcision, and education support (cash transfers) for female students. The data for this study were collected from 33 secondary schools near Lilongwe in Malawi. All students enrolled in grade 9 or 10 in 2011 were sampled for the study and followed for four to five years. 124 classrooms randomly phased into two rounds of free male circumcision surgery at our partner hospital. Students who were randomly assigned in the Round 1 offer group were provided with more intensive treatment in terms of the length of validity period for surgery at the hospital and transportation support compared to those students with Round 2 offer. Two follow-up surveys were conducted, about one year and five years after baseline. Especially the 2nd follow-up survey makes our dataset unique since it collected not only information on self-reported sexual behavior but also blood test results for HIV and HSV-2 infection with such a high follow-up rate (84.5 percent).

1.1 Literature Review

Here, although we aim to find empirical evidence of risk-compensating behaviors after male circumcision, theoretical predictions of the net impact are ambiguous; changes in sexual behavior to be riskier or safer could either reinforce or offset their positive medical effects of male circumcision, which can strictly reduce the HIV infection risk. To be specific, circumcised men might be more likely to compensate their reduced risk of HIV infection by having unprotected sex or multiple sexual relations. Alternatively, they could also engage in safer sexual behaviors, if the intervention had an educational component or circumcised men are preferred by women with lower risk. In addition, ex-ante risk type of a man also can play as one of important determinants explaining selection into for medical male circumcision. For example, Chinkhumba et al. (2014) showed that men who practiced safe sex were more likely to get circumcised. Thus, if most circumcision is driven by a preference for safe behavior ex-ante, we are likely to find little evidence of risk compensation due to continued safe sexual behavior even after surgery.

This ambiguity has made researchers argue that measuring true impact of scaling up of male circumcision cannot be done without accounting for potential risk-compensating behavior (Cassell et al., 2006). Three seminal randomized control trials and their posttrial studies empirically examined the behavioral response to male circumcision, but they suggest insufficient evidence to conclude the existence of behavioral disinhibition. First, the three RCT studies assessed changes in sexual behavior in addition to HIV infection up to two years after circumcision, but disproportionate increase in risky sexual behavior among circumcised men was found only in a few measures. For example, the study in South Africa found circumcised men were more likely to have larger number of sexual contacts compared to the uncircumcised, out of five sexual behavior indicators (Auvert et al., 2005)[1]. In the Kenya trial, fewer circumcised men responded that they used condom consistently than uncircumcised men did at the final visit in 24 months (Bailey et al., 2007)[2]. Nested studies based on the RCT in Kenya (Mattson et al., 2008; Wilson et al., 2014) and posttrial studies after the trial closure in Uganda (Gray et al., 2012; Kong et al., 2012) also conclude that no compelling evidence of increased risky sexual behavior among circumcised men was found. It is notable that Mattson et al. (2008) additionally diagnosed STI incidence (gonorrhea, chlamydia, or trichomoniasis) among participants in the nested study, but they could not find any significant differences in the incidence of those STIs between circumcised and uncircumcised men. However, we also need to know that intensive VCT and HIV education in the Kenyan trial substantially reduced risky sexual behaviors of both circumcised and uncircumcised men throughout all the follow-up visits, which suggests the trajectory of participants' sexual behavior can be dependent on the context of the program settings (Mattson et al., 2008). More recently, economists delve into risk compensation pertinent to male circumcision by focusing on differential behavioral responses depending on prior beliefs or risk type. Wilson et al. (2014), also using a nested study in the trial in Kenya, examined behavioral responses after the random offer of male circumcision, differentially by prior beliefs on the protective effect of male circumcision at baseline which they presume to be exogenous. In contrast, Godlonton et al. (2016) stratified on participants' circumcision status and randomly provided information about the protective effect of male circumcision on HIV infection, which would lead to asymmetric behavioral responses depending on newly acquired information on one's risk type. The findings about risk compensation from the both are consistent with previous studies in general. Wilson et al. (2014) suggest that circumcised men with ex-ante belief about the efficacy of male circumcision did not practice riskier sex after the surgery. Godlonton et al. (2016) also find that circumcised men were not more likely to engage in riskier sex after learning that they

[1] The five measures are at least one sexual contact without a condom, being married or living as married, more than one non-spousal partner, at least one sexual partnership with only one sexual contact, and more than five sexual contacts.

[2] In the Kenya trial, the following sexual behavior variables were evaluated: unprotected intercourse with any partner in the previous 6 months, last sexual relations with a casual partner, sexual abstinence in the last 6 months, consistent condom use in the previous 6 months, and two or more partners in the previous 6 months.

are low risk type, while uncircumcised men did reduce their risky sexual behavior.

Here, we need to notice two important limitations to the findings of previous studies. First, most of previous studies followed participants up to 24 months, which can provide insufficient evidence for "long-term" effect of male circumcision on risky sexual behavior. Although it is ambiguous when circumcised men are more likely to practice risky sex after surgery, one can expect risky behaviors might show up in the long run because the effect of education could persist only for a certain period of time and then fade away. Furthermore, those findings using self-reported sexual behavior instead of biomarker outcomes can be susceptible to potential misreporting of true behaviors. Numerous studies point out that self-reported answers can be poor proxies for true attitudes toward private and sensitive subjects like sexual activities in particular (Palen et al., 2008; Minnis et al., 2009)[3]. To be specific, social pressure might work against true reporting, which leads to under-reporting of unsafe sex and over-reporting of desirable behaviors.

In this sense, this study can provide the most relevant piece of evidence to many policymakers' essential question, "how much should we be concerned about risk compensation after male circumcision program in the long run?". In our unique experimental setting of secondary schools in Malawi, exogenous variation in intensities of male circumcision interventions for two groups of students allowed us to examine the causal impact of male circumcision program on HIV and HSV-2 infections as well as changes in sexual behavior in the long run. We, in this study, provide new findings which are quite contrary to what previous study presented: male students who received the free male circumcision offer during Round 1 were 35 percent more likely to be infected with HSV-2 measured by IgG than students with the Round 2 offer, suggesting riskier sexual behavior after circumcision. Self-reported sexual behavior, meanwhile, are showing little-to-no evidence of practicing riskier sex after circumcision, except for the inconsistent use of condom. Our rather striking new results can remind policymakers again of the importance of carefully designed policy: the introduction of risk-reducing technology like male circumcision can lead to unintended consequences, especially when risk compensation can be one of main operating mechanism.

The paper proceeds as follows. We present our experimental design and data as well as background information on male circumcision in Malawi in Section 2. Section 3 shows the take-up of

[3]On the other hand, Clark et al. (2011) argue that self-reported accounts of sexual behavior within reported relationship can act as reliable measure. Mattson et al. (2008) also point out a low degree of misreported sexual behavior by showing the overall consistency of the self-reported answers with biomarker results.

male circumcision in our program. Section 4 discusses the empirical strategy we employ. Results are presented in Section 5, and Section 6 concludes.

2 Background, Experimental Design and Data

This section describes male circumcision in Malawi, our program setting and data collection.

2.1 Background: Male Circumcision in Malawi

In Malawi, ranked the ninth highest infection rate in the world, approximately 11 percent of adults are living with HIV (UNAIDS, 2013). But prevalence of male circumcision in Malawi is very low; although official estimate is 19% (MDHS, 2011), only fraction of it can meet the medical standards because most male circumcision in Malawi has been conducted for cultural or religious reasons using traditional methods which involve incomplete removal of the foreskin. Thus male circumcision in Malawi may have limited benefits against female-to-male HIV transmission (Bengo et al., 2010). With high potential for medical male circumcision to work as an effective strategy to fight against HIV transmission, Malawi has become one of sixteen high priority countries for scale-up of medical male circumcision (UNAIDS, 2013). But it was 2011 that the Malawi government finally endorsed and included medical male circumcision as one of key pillars constituting its national HIV prevention strategy (NAC, 2012). Religious and cultural context of male circumcision in Malawi was the main reason, but a concern of behavioral changes also delayed the official endorsement of medical male circumcision (Bengo et al., 2010).

2.2 Experimental Design

Our male circumcision program started in October 2011 for a sample of 3,974 male students at 33 public secondary schools located in four rural districts in the catchment area of our partner hospital in Lilongwe. Unlike previous studies which recruited sexually active young adults for male circumcision, this study targeted secondary school students; in addition to allocating our limited resources in one of the most cost-effective (school) setting for rapid scale-up of medical male circumcision, we intended to focus on this population who were right at the formative years for sexual and reproductive behavior. After collecting the list of enrolled students, we conducted baseline survey between October 2011 and May 2012. 3,974 adolescent boys, 74.4% of a total of students in the school roll-call lists completed the survey. The baseline survey collected respondents' demographic information, HIV knowledge, sexual behaviors, and friendship network. At the end of the survey we conduct an experiment by giving students 10 kwacha and selling two condoms at subsidized price 5 kwacha to measure a demand for safe sex[4]

After the baseline, we used a two-step randomization design; we randomize treatment across and also within classes in order to measure not only direct but also peer effect of male circumcision intervention[5]. Table 1 describes the experimental design of this study. We stratified 124 classes at 33 schools by grade and assigned them into three groups (100% Treatment (Group 1), 50% Treatment (Group 2 and 3), or No Treatment class (Group 4)), and we further randomly selected half of the male students in the 50% Treatment class for treatment (Group 2). Right after baseline, we provide each student in the treatment group (Group 1 and 2) with male circumcision offer. This offer consists of male circumcision surgery free of charge at the assigned hospital, transportation support and two complication check-ups (3-day and 1-week after surgery) at students' school. About transportation support, students can choose either direct pick-up service between schools and the hospital or transportation voucher which can be reimbursed at the hospital. Enumerators and the consent form explained partially protective effect of medical male circumcision against HIV transmission using the results from three RCTs in South Africa, Uganda, and Kenya.

Due to limitations on administrative and financial capacity of our collaborating NGO and hospital, the classes were phased into two treatment stages: a total of 1,972 male students in Group 1 and 2 received free male circumcision offer during December 2011-June 2013 (**Round 1 offer group**), and the remaining 2,002 students in Group 3 and 4 who were temporarily untreated in Round 1 received the offer right after Round 1 until December 2013 (**Round 2 offer group**). Those two stages differ in treatment intensity in terms of validity period and transportation support: the validity period for Round 1 was almost a year longer than that of Round 2, and thus pick-up services were provided for 76th times during Round 1 while 38th times during Round 2.

[4] A similar experiment conducted by Thornton (2008).

[5] This is to investigate the role of peer effects in the demand for male circumcision (Kim et al., 2016).

2.3 Data

The main sample for our long-term study consists of 2,667 boys who were 9th and 10th grade at baseline and were followed up to the 2nd follow-up survey. In addition, the sample of 3,974 male students who were enrolled in 9th-11th grade at baseline and followed up to the 1st follow-up survey will be analyzed to measure changes in short-term behavioral response.

2.3.1 Baseline and randomization balance

Table 2 reports summary statistics and randomization balance of 9th and 10th student at baseline[6]. Columns from (1) to (4) in Table 2 present sample descriptive statistics, disaggregated by treatment status. The average age of students was 16 years old and about 19 percent students in the Round 1 offer group belong to circumcising ethnic groups. Students answered HIV/AIDS related questions correctly in general, but just 64 percent were aware of the medical benefit of male circumcision. Only 28 percent of adolescent boys in the Round 1 offer group answered they ever had sex, which means this cohort was about to experience their sexual debut. Due to small number of students who were sexually active, other measures of sexual behavior like indicator for multiple partners in the past 12 months or STI experience are very small in magnitude. Lastly, we can find low demand for condoms, less than one condom on average. Differences in a full set of baseline characteristics across two treatment groups (Column (5)) are small in magnitude, and not statistically significant in general except for HIV/AIDS Knowledge at the 10% significance level (Column (6)). Furthermore, the p-value of joint F-test from regressing an indicator for Round 1 offer on a full set of socio-demographic baseline characteristic is 0.472, suggesting that we cannot reject the null hypothesis that all the coefficients are jointly equal to zero. Thus we can rest assured that randomization implemented for full sample (9-11th grade) was still effective for 9th-10th grade students for this long-term study since we stratified classes by grade before randomization.

2.3.2 1st Follow-up Data

The first follow-up survey was conducted about a year after baseline between January and June 2013. This was conducted to measure short-run changes by our program in various dimensions

[6]Summary statistics and balance table for full sample at baseline (9-11th grade student) is presented in Table A1.

including attitudes toward HIV/AIDS and male circumcision, sexual behaviors, and demand for condoms. This targeted a full sample of 9th-11th grade students at baseline, and 91.9% effective survey rate was achieved by intensive home-visit surveys after the surveys at schools[7]. Table A1 in Appendix presents summary statistics of students enrolled in 9th-11th grade at baseline, balance check and the determinants of participation in the first follow-up survey.

Respondents in both Round 1 and 2 offer groups are balanced in general in the full study, although five out of 18 baseline variables has statistically significant difference in sample means by the offer status. About attrition, there is no differential likelihood of completing the first follow-up survey across the circumcision offer (Column (6)), and further we show in Column (7) in Table A1 that the p-value of the interaction term between the treatment indicator and the baseline variable within an individual regression of the offer dummy on two main effects and the interaction term. This is to find any systemic attrition across offer status correlated with baseline characteristics, and we cannot find any convincing evidence of it.

2.3.3 2nd Follow-up Data

The second follow-up survey was initiated in October 2015 about four years after baseline and completed in August 2016. Since we started to find students from those schools where they were enrolled, we targeted only 9th and 10th grade students at baseline, who were less likely to move to another location than the older cohort, and thus could be tracked down most efficiently given our limited resources. The 2nd follow-up survey was conducted either at schools, or at the respondent's home if he was not able to respond to the invitation to the school. We have achieved very high follow-up rate, 84.5 percent, which is 2,254 out of 2,667 9th and 10th grade students. (as of July 16th).

We conduct the same tests for attrition for the 2nd follow-up survey as we did for the 1st follow-up, and cannot find any convincing evidence of systemic attrition between two groups: there is no differential attrition across the circumcision offers in Round 1 or Round 2, and most of p-values of interaction terms (15 out of 18) are not lower than any conventional level of statistical significance (Column 7, Table 2).

[7] 67.9% participated in the school follow-up survey. We implemented an intensive home visit-up survey targeting randomly selected 15% from attrition sample, which gives a sample weight 6.67 for them. The home survey follow-up rate was 74.9%, which makes the effective survey rate 91.9% (Baird et al., 2011).

The 2nd follow-up survey included not only the same questions on sexual behavior as asked at baseline and the 1st follow-up, but we also evaluated biomarkers (HIV and HSV-2) and two sexual behaviors using the item count technique. We include both measures to provide unbiased estimates on risk compensation by avoiding potential measurement error in self-reported sexual behaviors. To be specific, we have chosen HSV-2 as our main outcome for STI in addition to HIV because recent literature studying adolescent students consider it as an ideal biomarker of risky sexual behavior for the following two reasons (Duflo et al., 2015; Baird et al., 2012).

First, although male circumcision also can be effective in preventing HSV-2 incidence by about 25 percent (Tobian et al., 2009), HSV-2 can still truthfully reflect changes in sexual behavior because it is rarely transmitted other than sexual contacts (Smith and Robinson, 2002). Secondly, as Duflo et al. (2015) and Baird et al. (2012) did, our pilot program found that HSV-2 infections occurred at a relatively high rate in our study sample compared to other STIs[8], and thus we are less concerned about statistical power to discern differential prevalence rate between two groups. HSV-2 prevalence among respondents was measured at the end of survey by using two kinds of blood test kit detecting IgG and IgM antibodies, respectively. IgG can act as a permanent marker of HSV-2 infection happened at any point during lifetime because IgG appears soon after infection and stays in the blood for life (Obasi et al., 1999). On the contrary, IgM positive means one has recently contracted HSV-2, but the antibody may disappear thereafter and thus it may give deceptive testing results (Workowski and Bolan, 2015). Therefore, we use HSV2 blood test results using IgG as our primary outcome. Compliance rates for HIV and HSV-2 testing are very high, 90 percent of Round 1 Offer group and 90.7 percent of Round 2 Offer group, and we cannot find any statistically significant difference in baseline characteristics between two groups of students who chose to proceed with the testing. (not reported)

Lastly, we added two more sexual behavior questions using the item count technique (ICT) in the 2nd follow-up survey. Ever since originally proposed by Miller (1984), this survey technique is used to account for potential measurement error in self-reported responses. Although this method is yet extensively used in economics literature, several studies were successful in eliciting truthful answers on sensitive subjects (Coutts and Jann, 2011; Coffman et al., 2013). The key feature of the

[8]Mattson et al. (2008) used Chlamydia, Gonorrhea, Trichomonas Vaginalis and HIV as their main outcomes for STIs, but the prevalence rates were all less than 5 percent.

ICT is that respondents report the total number of true statements in the question that may include a sensitive item instead of directly endorsing it. By randomly providing two sets of questions, one only with non-sensitive items and the other one with extra statement of our interest, we can figure out the base rate estimate for the item by having the difference in the sample means of the two groups. In this study, we have two questions using the ICT, and those two sensitive statements are "I think I have to use a condom in case of sex with somebody that I do not know well" and "I had sex with more than two people in last 12 months".

3 Take-up of Medical Male Circumcision

To measure the take-up of male circumcision in our study, we use two sources of data: the hospital data and the 2nd follow-up survey data. Our partner hospital kept records of students who got circumcised during Round 1 and 2 with the information on types of transportation support a patient used (pick-up buses or voucher) and complication check-up status after the surgery. We also asked a student if he has been circumcised at each survey, and additionally about the timing of male circumcision at the 2nd follow-up survey. This program was quite successful in terms of promoting medical male: 515 and 126 students got circumcised at our partner hospital during Round 1 and 2, respectively. The take-up rate for Round 1 offer group is 20.5 percent and 11.9 percent for Round 2 offer group. Conditional on participation in the 2nd follow-up survey, Table 3 presents the take-up of male circumcision at the hospital and self-reported circumcision status disaggregated by random assignment of two rounds of offer. In Panel A, the take-up rate for the Round 1 offer group during Round 1 was 19.5 percent, while the rate for the Round 2 offer group during Round 1 was just 5 percent. This confirms that our intervention of free circumcision with transportation support was quite successful to boost the take-up among treated students during Round 1.

In Figure 1 (1), we can find how medical male circumcision take-up rates changed over time by the offer group conditional on retention at the 2nd follow-up. Since we provided free male circumcision offer more intensively during Round 1 in terms of the length of validity period and the number of pick-up services, we can find that considerable difference in the take-up rates between the two groups (about 9 percentage point) remained even at the end of Round 2. Furthermore, when we measure the length of protective periods by male circumcision, it is estimated that students who had the Round 1 offer had benefited from male circumcision about five months more on average, than students with the Round 2 offer had. Conditional on circumcision, circumcised students in the Round 1 offer group had enjoyed about nine more months of protection period compared to those students in the Round 2 offer group. (not reported)

In Figure 1 (2), we plot cumulative prevalence rates of male circumcision among participants at the 2nd follow-up survey using self-reported year and month of their circumcision. But we need to interpret this with caution because a considerable number of circumcised respondents at the hospital made mistakes in remembering the timing of their surgery (about 60 percent). The gap in the prevalence rate between the two groups is merely about 4 percentage point at the 2nd follow-up survey, which is less than the half of the difference measured at the end of Round 2 using the hospital data. But it is notable that there was a rapid catch-up of the Round 2 offer group during June-August 2014. This is very likely due to traditional male circumcisions which usually take place during June and August every year (Bengo et al., 2010). And given that traditional male circumcision conducted under unique cultural and religious context is associated with partial removal of foreskin, we need to concentrate on the effect of our program, instead of self-reported circumcision, to investigate the long-term effect of medical male circumcision on risky sexual behavior and STIs.

4 Estimation Strategy

Estimating long-term effects of a program with phase-in design is challenging since one group which was temporarily untreated would also receive the treatment eventually (Duflo et al., 2007). However, we can still exploit our experimental design, which exogenously provided treatments with different intensities to students depending on their random assignment into the Round 1 or Round 2 offer group. To capture the direct effect of being assigned to the Round 1 offer group we focus on intent-to-treat estimates, and thus our preferred specification is

$$Y_{ij} = \beta_0 + \beta_1 Round1Offer_{ij} + r'X_{ij} + \delta_j + \varepsilon_{ij} \tag{1}$$

We are interested in two kinds of outcome measures, Y_{ij} for student i in grade j: (i) biomarkers for HIV and HSV-2 infection and (ii) self-reported sexual behaviors which include nine conventional measures, an experiment to measure demand for condoms and questions using the ICT. The variable $Round1Offer_{ij}$ indicates individual i's assignment into the male circumcision offer in Round 1 regardless of being allocated to 100% or 50% treatment classroom. The main coefficient of interest β_1 captures the intent-to-treat effect of being selected into the male circumcision offer in Round 1 among adolescent boys in our experimental sample. Because the Round 1 offer was randomly provided to students at baseline, the error term is uncorrelated with β_1, allowing us to estimate the causal effects of medical male circumcision offer in Round 1 on STIs and risky sexual behaviors. X_{ij} is a control vector that includes the following socio-demographic variables at baseline: age, circumcising ethnicity, Muslim (circumcising religion), orphan status, parents' education, parents' job, household assets, and school type. We also include grade fixed effects, δ_j, in all specifications since the randomization was implemented within grade. Robust standard errors are clustered at the classroom level.

5 Results

In this section, we first assess the change in HSV-2 and HIV infection, and then further investigate changes in risky sexual behaviors to explain those biomarker results.

5.1 Biomarker Outcomes

Our biomarker outcomes are prevalence of HIV and HSV-2 about four years after baseline. These results are presented in Table 4. Column (1)-(3) show the estimated program effects on our main outcome, infection with HSV-2 measured by IgG, and Column (4)-(6) and (7)-(9) show the other two measures, HIV infection and HSV-2 infection detected by IgM. First, it is notable that the prevalence of HSV-2 is not negligible, 9.1 percent among 1,128 students in the Round 2 offer group who were 9th or 10th grade at baseline with complete follow-up at the 2nd survey. In Column (2), our preferred specification, the free male circumcision program with transportation support increased HSV-2 prevalence by 3.2 percentage point at the 5 percent significance level for those students who received the intervention in Round 1, a 35 percent increase compared to the Round 2 offer group. Secondly, in Column (4)-(6) Table 4, our sample showed very low HIV prevalence, seven of 1,126 in Round 1 offer group (0.6 percent) and three of 1,128 students in the Round 2 (0.3

percent) were diagnosed with HIV. It is extremely low rate of infection given that national estimate of percentage of young men aged 15-24 who are living with HIV is 1.9 percent (MDHS, 2011). This needs to be further investigated, but our sample seemed to have benefited from protective effect of medical male circumcision. However, this very low prevalence makes our study underpowered to detect statistical differences in the HIV infection, although HIV transmission is one of the most relevant outcomes for policymakers who are concerned about unintended consequences following the promotion of nationwide male circumcision. Lastly, Column (7)-(9) provide the result of the impact of Round 1 offer on HSV-2 infection which was diagnosed by antibody IgM. Although we can find 1.7 percentage point higher prevalence for students with the Round 1 offer compared to Round 2 offer group at the 1% significance level (155 percent increase), we interpret this result as only supplementary to the other biomarker results.

All in all, we have statistically significant result from HSV-2 prevalence measured by IgG, but it is also notable that all the estimated coefficients on biomarker outcomes are positive despite statistical insignificance on the estimate of HIV infection. This is a rather striking result since it contradicts not only results from previous studies but also expectations of policymakers who wish to expedite scaling up of medical male circumcision across African countries. We will discuss what brings about this new evidence by examining changes in sexual behaviors and other heterogeneous effects in Section 5.2.

5.2 Sexual Behavior Outcomes

In this section, we will investigate whether those biomarker results can be supported by differential changes in sexual behaviors depending on the random offer.

5.2.1 Trend in Sexual Behaviors: From Baseline to the 2nd Follow-up

Before analyzing the regression results using the 2nd follow-up data, it is interesting to find out how those two groups had changed their mean sexual behaviors from baseline to the 2nd follow-up. In Figure 2, mean values of six sexual behavior variables are plotted at each survey by the treatment group. In Panel (a), we can find that about 60 percent of students had experienced their sexual debut by the time of the 2nd follow-up survey as the average age increases from 16 at baseline to 21 at the 2nd follow-up. And in Panel (b), we also can find substantial increase in the number of students who answered they were sexually active at the 2nd follow-up (more than 50 percent) compared to the rate at baseline (about 10 percent). The increase mostly happened between the 1st and 2nd follow-up survey, which was after the Round 1 offer, so we can assume that most STIs and HIV infection could happen during this period. Panel (c) suggests very small fraction in our sample, less than 3 percent for both groups, had more than one sexual partner in the past 12 months. Considering that we targeted adolescent boys while previous literature focused on young adults, the indicator for having multiple sex partners in this setting might be insufficient to be an ideal measure although this variable is one of most conventional measures in the literature studying risky sexual behavior. The same logic also applies to the variable, 'having sex with non-marital partner', because only about 5 percent of our sample was married at the time of 2nd follow-up survey. In Panel (d), we report the mean trends of an indicator for inconsistent use of condoms, which we assign one if one had not used condoms occasionally during three most recent sexual contracts in the past 12 months. Both groups became more likely to use condoms inconsistently, but we can see disproportionate increase among students in the Round 1 offer group. Panel (e) present the mean trends for self-reported STI experience, and we can find that those rates are lower than one percent, which is much lower than the prevalence of HSV-2 presented in the previous section. This might be because symptoms were almost imperceptible to detect, or boys were reluctant to reveal the experience. Lastly, Panel (f) reports the number of condoms purchased by a respondent during the exercise at each survey.

In this study, it is notable that we do not see any declining trends in sexual behavior variables, which are quite different movement compared to those presented in the studies in Kenya (Bailey et al., 2007; Mattson et al., 2008). This might be because our younger cohort (16 vs. 20 in mean age) just experienced their sexual debut and became more sexually active during this study period, or because intensive counseling and HIV testing at each follow-up in Kenya could lead to declines in risky sexual behaviors for both circumcised and uncircumcised men (Mattson et al., 2008).

5.2.2 Regression Analysis of Sexual Behaviors

In Table 5 Panel A, we present the coefficient estimates on nine sexual behavior items about one year after baseline, using the 1st follow-up data. These estimate measure short-run impact of the Round 1 offer on behavioral changes. Our results are comparable to those of previous literature which showed no risk compensation behavior: not only are the magnitudes of estimated average behavioral response to the offer small but also statistically insignificant.

In Table 5 Panel B, we provide long-term results obtained from 2nd follow-up data. Although the point estimates on inconsistent condom use and unprotected sex during last sex suggest about a 3 percentage point increase in the likelihood of practicing risky sex among students with the Round 1 offer at the 10% significance level, the other estimates are small in magnitude and not statistically significant.

Column (1)-(3) Table 6 show the result from the exercise at each survey to measure demand for condom. Both group increased their demand for condoms at the 2nd follow-up than the 1st follow-up, but we could not find statistically significant difference in demand for condoms by the offer status. Lastly, Column (4)-(9) provide the results from two questions using the ICT. Given the random assignment of two different forms of survey for each intervention group, the interaction term between Round 1 offer and the indicator for Type A survey which contains the sensitive item of interest would capture the causal estimate of the likelihood of endorsing the extra statement among Round 1 offer students compared to those with Round 2 offer. We can find statistically significant estimate only on condom attitude in Column (5). This suggests that smaller fraction of students with Round 1 offer, by 19.3 percentage point at the 5% significance level, endorsed the sensitive item, "I think I have to use condom in case of a sex with somebody that you do not know well." Although this question using the ICT did not directly ask a respondent about his condom use as did those questions to construct the indicator for inconsistent condom use in Column (7) Table 5, the sign of the coefficient is negative, which corroborate riskier sexual behavior in terms of condom use among Round 1 offer group.

6 Conclusion

Although medical male circumcision has drawn substantial attention as one of most effective HIV/AIDS prevention strategies, risk compensation has made numerous researchers reserve their recommendation for scaling up medical circumcision targeting general male population across African countries. We randomly provided two rounds of free male circumcision offer to adolescent male students and tracked them down up to five years, enabling us to examine risk-compensating behavior after circumcision in the long run. We, in this study, provide rather contrary results compared to most of previous literature, which concluded no or insufficient evidence of risk-compensating behavior after circumcision based on self-reported risky sexual behavior. In this study, we first provide long-term biomarker results of risky sexual behavior, which is arguably robust to potential measurement error. We find that male students who received the offer more intensively were 35 percent more likely to be infected with HSV-2 than the other students, suggesting that fewer precautions among circumcised students may offset the positive medical effects. Self-reported sexual behavior, meanwhile, are showing little-to-no evidence of practicing riskier sex after circumcision, except for the inconsistent use of condom. Policymakers might need to reconsider current male circumcision campaigns, especially if they did not adequately account for possible risk compensation among circumcised men.

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Figures and Tables

Figures

Figure 1: Prevalence of Male Circumcision (Self-reported)

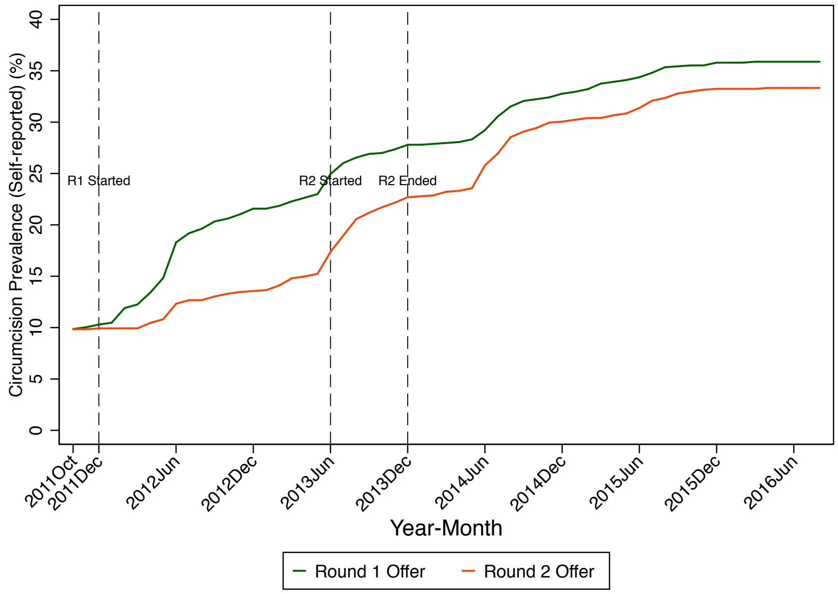


Figure 2: Male Circumcision Take-up (Hospital Admin.)

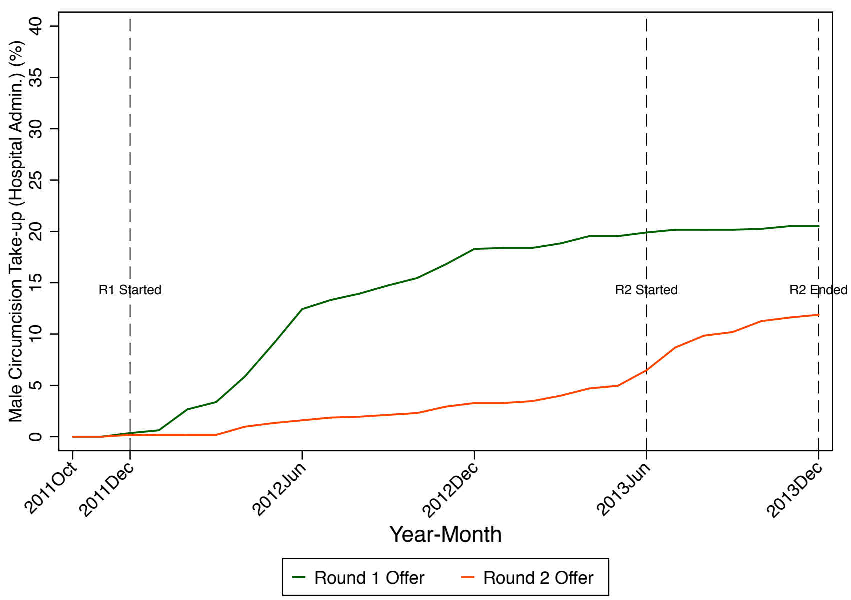
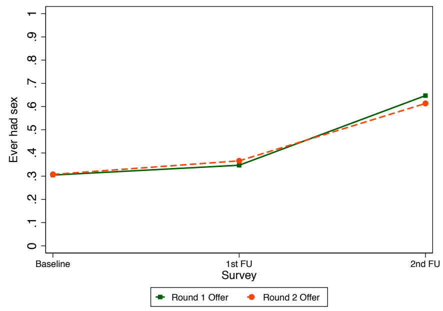
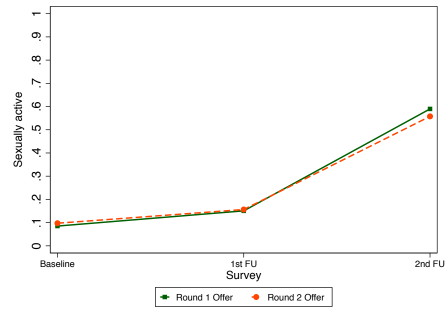


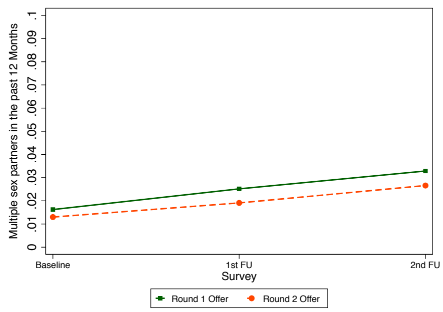
Figure 3: Comparison of Means of Self-reported Sexual Behavior at Baseline, 1st Follow-up and 2nd Follow-up between Round 1 and Round 2 Offer Groups



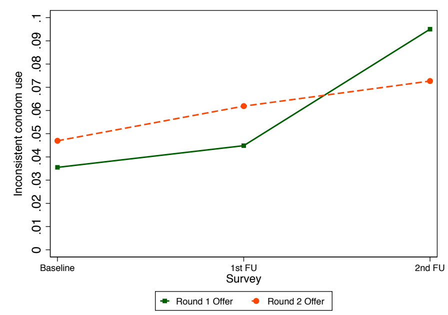
(a) Ever had sex



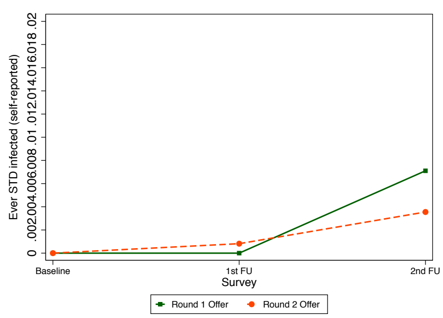
(b) Sexually Active



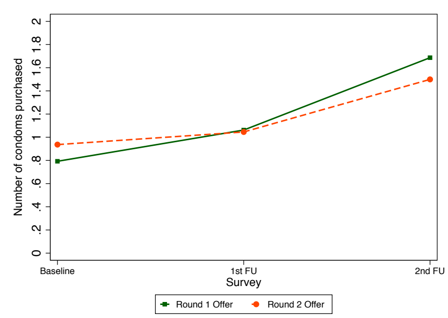
(c) Multiple partners in the past 12 months



(d) Inconsistent condom use



(e) Ever STD infected (self-reported)



(f) Number of condoms purchased

Notes: For an indicator for inconsistent use of condoms, we assign one if one had not used condoms occasionally during three most recent sexual contracts in the past 12 months.

Tables

Table 1: Experimental Design

Assignment	Group at Baseline	Classroom Classification	Number of Classes	Students (9th-10th Grades)	Students (9th-11th Grades)
Round 1 Offer	G1	100% Treatment	41	861	1,293
	G2	50% Treatment	41	481	679
Round 2 Offer	G3			472	678
	G4	No treatment	42	853	1,324
Total			124	2,667	3,974

Note: After stratifying 124 classrooms by grade, we randomly assigned classrooms into three groups: 100% (G1), 50% (G2 and G3) Treatment and No Treatment group (G4). Then, within 50% Treatment , only half of the students were randomly assigned to treatment (G2). Round 1 Offer refers to the group G1 and G2 who received free male circumcision offer with transportation support during Round 1, and Round 2 Offer applies to G3 and G4 students who had the offer during Round 2. The 2nd follow-up survey was conducted only for 9th and 10th grade students at baseline, while the 1st follow-up survey targeted a full sample of 9th-11th grade students at baseline.

Table 2: Baseline Statistics (9th and 10th Grade) and Check for Balance and Attrition

	Round 1 Offer		Round 2 Offer		Difference	Balance	Attrition
	Mean	SD	Mean	SD	(R1-R2)	p-value	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Socio-demographic Characteristics							
Age (Year)	16.176	(1.813)	16.172	(1.739)	0.004	0.925	0.776
Circumcising ethnicity	0.187	(0.390)	0.161	(0.367)	0.026	0.188	0.794
Muslim	0.072	(0.258)	0.052	(0.222)	0.020	0.109	0.217
Orphan	0.050	(0.218)	0.056	(0.230)	-0.006	0.463	0.765
Father's tertiary education	0.191	(0.393)	0.174	(0.379)	0.017	0.454	0.277
Mother's tertiary education	0.063	(0.244)	0.072	(0.259)	-0.009	0.475	0.469
Father's white-collar job	0.245	(0.430)	0.240	(0.427)	0.005	0.808	0.700
Mother's white-collar job	0.100	(0.300)	0.104	(0.306)	-0.004	0.785	0.973
Household asset count (0-16)	7.394	(3.470)	7.272	(3.413)	0.122	0.737	0.211
Conventional schools	0.261	(0.439)	0.215	(0.411)	0.046	0.477	0.028
Panel B. HIV/AIDS Knowledge and Sexual Behavior							
HIV/AIDS knowledge (0-20)	17.203	(1.805)	17.382	(1.693)	-0.179	0.052	0.972
Belief in the efficacy of MC	0.640	(0.480)	0.671	(0.470)	-0.031	0.231	0.616
Ever had sex	0.283	(0.451)	0.266	(0.442)	0.017	0.508	0.081
Sexually active	0.079	(0.270)	0.073	(0.261)	0.006	0.652	0.727
Multiple partners	0.013	(0.115)	0.011	(0.106)	0.002	0.652	0.435
Inconsistent use of condoms	0.034	(0.182)	0.044	(0.205)	-0.010	0.182	0.878
Unprotected sex with recent partner	0.033	(0.178)	0.044	(0.205)	-0.011	0.109	0.963
Number of condoms purchased	0.828	(1.582)	0.865	(1.606)	-0.037	0.658	0.010
Observations	1,342		1,325				

Note: This sample consists of 2,667 male students who were 9th and 10th grade when they completed the baseline survey. Standard deviations are in parenthesis. Circumcising ethnicity refers to a tribe of which more than 20 percent population reported being circumcised in 2010 MDHS. HIV/AIDS knowledge is constructed by counting the correct answers from 20 HIV/AIDS related questions. Inconsistent use of comdoms is an indicator which becomes one if the respondent did not use at least once during three most recent sexual intercourses in the past 12 months. Number of condoms purchased measures the demand for condom from an experiment in which we gave 10 kwacha and sold condoms. We test for the difference in each baseline variable across the treatment group, and p-values from those separate regressions are presented in Column (6). In Column (7) we show that the p-value of the interaction term between the treatment indicator and the baseline variable within an individual regression of the offer dummy on two main effects and the interaction term.

Table 3: Circumcised Students (by hospital data or self-report at survey)

	Round 1 Offer N=1,041		**Round 2 Offer** N=1,026	
	Number of Students	Percent of R1 Sample	Number of Students	Percent of R2 Sample
Panel A. Hospital Data				
Surgery at Hospital during Round 1 or 2	231	20.5%	134	11.9%
Surgery at Hospital during Round 1	220	19.5%	56	5.0%
Surgery at Hospital during Round 2	11	1.0%	78	6.9%
Panel B. Self-report from Survey				
Self-reported circumcised at Baseline	110	9.8%	111	9.8%
Self-reported circumcised at 1st Follow-up	258	22.9%	134	11.9%
Self-reported circumcised at the 2nd Follow-up	449	39.9%	407	36.1%

Note: Panel A and B are created based on the sample of 2,067 men who were interviewed at baseline and the 2nd follow-up. Panel A shows the number of students who were circumcised at our partner hospital. Panel B presents the number of students who self-reported that they were circumcised at the time of each survey.

Table 4: The Effect of Round 1 Offer on Biomarker Results

Dependent vars.	HSV2 IgG Positive			HIV Positive			HSV2 IgM Positive		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Round 1 Offer	0.029	0.032**	0.031**	0.004	0.004	0.004	0.015**	0.017***	0.017***
	(0.018)	(0.015)	(0.015)	(0.003)	(0.003)	(0.003)	(0.006)	(0.006)	(0.006)
Socio-demographic controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Sexual behavior controls	No	No	Yes	No	No	Yes	No	No	Yes
Observations	2,019	2,019	2,019	2,019	2,019	2,019	2,019	2,019	2,019
R^2	0.002	0.028	0.033	0.001	0.004	0.006	0.003	0.011	0.014
Mean of Dep. Var. (Round 2 Offer)	0.091	0.091	0.091	0.003	0.003	0.003	0.011	0.011	0.011

Note: Socio-demographic control includes age, circumcising ethnicity, Muslim (circumcising religion), orphan status, parents' education, parents' job, household assets, and school type. Sexual behavior control includes sexual debut, sexually active, multiple partner, inconsistent use of condom, unprotected sex with recent partner at baseline. *** $p<0.01$, ** $p<0.05$, * $p<0.10$

Table 5: The Effect of Round 1 Offer on Self-reported Sexual Behavior

Dependent vars.	Ever had sex	Age at sexual debut	Sexually active	Multiple partners (12 mon.)	Multiple partners (lifetime)	Non-marital sex partner	Inconsistent condom use	Unprotected last sex	Ever STD infected
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. 1st Follow-up									
Round 1 Offer	-0.005	-0.357*	-0.001	0.007	0.001	0.000	-0.014	-0.015	-0.001
	(0.024)	(0.201)	(0.020)	(0.009)	(0.023)	(0.000)	(0.013)	(0.013)	(0.001)
Observations	2,819	905	2,819	2,819	2,819	2,819	2,816	2,819	2,818
R^2	0.111	0.171	0.066	0.019	0.061		0.029	0.031	0.003
Mean of Dep. Var. (Round 2 Offer)	0.370	16.141	0.158	0.019	0.200	0.000	0.062	0.060	0.001
Panel B. 2nd Follow-up									
Round 1 Offer	0.036*	-0.089	0.036	0.006	-0.013	-0.001	0.026*	0.024*	0.004
	(0.021)	(0.099)	(0.024)	(0.008)	(0.024)	(0.004)	(0.013)	(0.013)	(0.003)
Observations	2,236	1,410	2,240	2,240	2,240	2,240	2,240	2,240	2,239
R^2	0.067	0.114	0.062	0.007	0.038	0.007	0.047	0.047	0.008
Mean of Dep. Var. (Round 2 Offer)	0.612	17.788	0.557	0.027	0.347	0.006	0.073	0.071	0.004

Note: All the specifications control for socio-demographic characteristics. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

Table 6: The Effect of Round 1 Offer on Sexual Behavior (Experiment and ICT)

Dependent vars.	Number of condoms purchased			Condom attitude (ICT)			Multiple partners (ICT)		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Panel A. 1st Follow-up									
Round 1 Offer	0.029	0.068	0.054						
	(0.102)	(0.095)	(0.092)						
Socio-demographic controls	No	Yes	Yes						
Sexual behavior controls	No	No	Yes						
Observations	2,799	2,799	2,799						
R^2	0.002	0.025	0.053						
Mean of Dep. Var. (Round 2 Offer)	1.037	1.037	1.037						
Panel B. 2nd Follow-up									
Round 1 Offer	0.172	0.184	0.172	0.119*	0.118*	0.120*	0.054	0.054	0.053
	(0.129)	(0.131)	(0.128)	(0.069)	(0.069)	(0.068)	(0.066)	(0.067)	(0.067)
Type A				0.571***	0.578***	0.580***	0.141*	0.146*	0.147*
				(0.068)	(0.069)	(0.069)	(0.083)	(0.082)	(0.083)
R1 Offer × Type A				-0.189*	-0.193*	-0.197*	-0.102	-0.103	-0.102
				(0.107)	(0.108)	(0.107)	(0.093)	(0.094)	(0.095)
Socio-demographic controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Sexual behavior controls	No	No	Yes	No	No	Yes	No	No	Yes
Observations	2,237	2,237	2,237	2,236	2,236	2,236	2,237	2,237	2,237
R^2	0.001	0.003	0.013	0.040	0.044	0.046	0.002	0.009	0.010
Mean of Dep. Var. (Round 2 Offer)	1.509	1.509	1.509	1.810	1.810	1.810	2.170	2.170	2.170

Note: Column (1)-(3) provide the results from an experiment at the end of the survey we conducted by giving students 10 kwacha and selling two condoms at subsidized price 5 kwacha (Thornton, 2008). For ICT outcomes, given the random assignment of two different forms of survey for each intervention group, the interaction term between Round 1 offer and the indicator for Type A survey which contains the sensitive item of interest would capture the causal estimate of the likelihood of endorsing the extra statement among Round 1 offer students compared to those with Round 2 offer. Socio-demographic control includes age, circumcising ethnicity, Muslim (circumcising religion), orphan status, parents' education, parents' job, household assets, and school type. Sexual behavior control includes sexual debut, sexually active, multiple partner, inconsistent use of condom, unprotected sex with recent partner at baseline. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.10$

A1. Baseline Statistics (9th and 11th Grade) and Check for Balance and Attrition

	Round 1 Offer		Round 2 Offer		Difference	Balance	Attrition
	Mean	SD	Mean	SD	(R1-R2)	p-value	p-value
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Socio-demographic Characteristics							
Age (Year)	16.569	(1.883)	16.730	(1.998)	-0.161	0.238	0.524
Circumcising ethnicity	0.186	(0.389)	0.153	(0.360)	0.033	0.040	0.967
Muslim	0.071	(0.257)	0.050	(0.218)	0.021	0.023	0.138
Orphan	0.055	(0.229)	0.061	(0.240)	-0.006	0.438	0.660
Father's tertiary education	0.183	(0.387)	0.177	(0.382)	0.006	0.735	0.799
Mother's tertiary education	0.067	(0.250)	0.070	(0.255)	-0.003	0.776	0.349
Father's white-collar job	0.252	(0.434)	0.227	(0.419)	0.025	0.158	0.488
Mother's white-collar job	0.095	(0.294)	0.097	(0.297)	-0.002	0.850	0.974
Household asset count (0-16)	7.497	(3.463)	7.253	(3.458)	0.244	0.409	0.560
Conventional schools	0.241	(0.428)	0.243	(0.429)	-0.002	0.969	0.065
Panel B. HIV/AIDS Knowledge and Sexual Behavior							
HIV/AIDS knowledge (0-20)	17.276	(1.799)	17.355	(1.739)	-0.079	0.326	0.820
Belief in the efficacy of MC	0.641	(0.480)	0.658	(0.475)	-0.017	0.377	0.605
Ever had sex	0.305	(0.460)	0.308	(0.462)	-0.003	0.907	0.166
Sexually active	0.085	(0.279)	0.097	(0.297)	-0.012	0.318	0.745
Multiple partners	0.016	(0.126)	0.013	(0.113)	0.003	0.432	0.475
Inconsistent use of condoms	0.035	(0.185)	0.047	(0.212)	-0.012	0.061	0.587
Unprotected sex with recent partner	0.033	(0.179)	0.044	(0.206)	-0.011	0.043	0.557
Number of condoms purchased	0.794	(1.563)	0.938	(1.672)	-0.144	0.056	0.468
Observations	1972		2002				

Note: This sample consists of 3,974 male students who were 9th and 10th grade when they completed the baseline survey. Standard deviations are in parenthesis. Circumcising ethnicity refers to a tribe of which more than 20 percent population reported being circumcised in 2010 MDHS. HIV/AIDS knowledge is constructed by counting the correct answers from 20 HIV/AIDS related questions. Inconsistent use of comdoms is an indicator which becomes one if the respondent did not use at least once during three most recent sexual intercourses in the past 12 months. Number of condoms purchased measures the demand for condom from an experiment in which we gave 10 kwacha and sold condoms. We test for the difference in each baseline variable across the treatment group, and p-values from those separate regressions are presented in Column (6). In Column (7) we show that the p-value of the interaction term between the treatment indicator and the baseline variable within an individual regression of the offer dummy on two main effects and the interaction term.

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