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INCENTIVIZING SAFER SEXUAL BEHAVIOR: EVIDENCE FROM A LOTTERY EXPERIMENT ON HIV PREVENTION

Abstract

The need for effective HIV prevention programs, especially in Sub-Saharan Africa, remains urgent. We investigate the effect of a financial lottery program in Lesotho with relatively low expected payments but a chance to win a high prize conditional on negative test results for sexually transmitted infections. The intervention resulted in a 21.4% reduction in HIV incidence over two years. Lottery incentives appear to be particularly effective in targeting individuals with ex ante risky sexual behavior, consistent with the hypothesis that lotteries are more valued by individuals willing to take risks.

JEL Classification: I12, I15, O15

Keywords: Financial incentives, lotteries, HIV prevention

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1 Introduction

An estimated 1.4 million new HIV infections occurred in Africa alone in 2015, adding to the nearly 37 million people living with HIV on the continent. New infections continue to outpace antiretroviral therapy uptake in most developing countries (UNAIDS, 2016). Thus the global need for effective HIV prevention programs remains urgent.

In this paper we present the results from a financial incentive program designed in the form of a lottery with low expected payments ($20-$40 per year) conditional on testing negative for two markers of risky sexual behaviors (two curable sexually transmitted infections (STIs)), but with relatively high payments for lottery winners.

We find that HIV incidence in the intervention groups fell by 21.4% relative to the control group over a two-year period and estimate that the cost of averting a primary HIV infection was $882, or less than one-tenth of the costs of averting an HIV infection in the only other behavioral trial documenting significant reduction in HIV prevalence (Baird et al., 2012). Consistent with the reduction in risky sexual behavior, we also document large reductions in both the prevalence of STIs and in births and pregnancies, especially among single women.

We provide suggestive evidence that the lottery design played an important role in achieving the effects we document. Specifically, the expected utility of a lottery with cash prizes depends on individuals' attitude towards monetary risk. If individuals exhibiting risk-loving preferences in monetary gambles are also more risk-loving in other domains, including sexual behavior, lottery incentives may better target those with the highest risk of HIV/AIDS.

Using data from the control group, we show that risk-lovers – with the degree of risk aversion measured using a simple multiple price list design – were more than twice as likely to become infected with HIV over the trial period, thus providing support for the assumption that risk-loving behavior in hypothetical monetary gambles translates to objectively measured risk-loving sexual behavior. In the intervention groups, on the other hand, where participants were offered lottery incentives to promote safer sexual behavior, we find that the risk-loving individuals were as likely as risk-averse individuals to become HIV infected during the two year trial period. That is, the lottery program lowered HIV incidence rates in the treatment relative control group by making individuals, with greater preference for risk at baseline, behave similarly to risk-averse individuals in terms of their sexual behavior.

The use of lotteries as part of a public health intervention is not unprecedented, including in the area of HIV prevention, but, to the best of our knowledge, this is the first

large scale randomized trials to assess its impact as a prevention tool.[1]

Our findings have implications for both policy and research. Prevention programs for HIV can be divided into two types: biomedical interventions that aim at reducing susceptibility to HIV holding behavior constant, and interventions aimed at reducing risky sexual behavior.[2] In both types of programs, low demand and high costs are constraining factors. Our evidence suggests that lotteries may be an effective method to enhance the demand for safer sexual behavior and could presumably also be employed to increase the demand for biomedical HIV prevention initiatives, such as male circumcision and pre-exposure prophylaxis. Such a lottery program could also be implemented at lower costs than traditional CCT programs as only winners need to be paid. Moreover, we show that a large share of the individuals that changed their behavior in response to the lottery intervention had a relatively high ex ante risk of getting infected by HIV. Targeting those with the highest risk of becoming infected is a key objective in HIV promotion programs. Such targeting is also important in many other types of prevention programs. Thus, our

[1]The HIV screening lottery in the Western Cape province in South Africa is probably the most notable example. The lottery, developed by ideas 42 – a Harvard-affiliated organization set up to develop psychology- and economics-based strategies for social policy – aims at encouraging people to get tested for HIV (Keating, 2013). Another well-known example of the use of lotteries in public health campaigns is the 1957 anti-Tuberculosis campaign in Glasgow. Geffen (2011) reports that intense media coverage and a weekly prize draw resulted in a number of screenings almost three times higher than the initial aim of reaching 250,000 people.

[2]Several biomedical interventions, such as male circumcision and pre-exposure prophylaxis, have been shown to significantly reduce HIV transmission in field trials (Gray et al., 2007; Bailey et al., 2007; and Auvert et al., 2005). However due to low demand and high costs they have been difficult to scale up (Sawires et. al., 2007). Evidence from randomized controlled trials of behavioral interventions, on the other hand, is at best mixed (see McCoy et al. 2010 and Padian et al. 2010 for reviews.). No traditional programs offering some combination of risk-reduction counseling, condom promotion, referral and treatment for sexually transmitted infections have documented significant effects on HIV incidence. More recent evidence have shown that financial incentive interventions aimed at promoting safe sexual behavior by conditional payments on HIV or STI status, or school enrollment, can have an impact, at least when the financial payments are sufficiently large. For example, Baird et al. (2012) evaluate an intervention where cash transfers ($120 per year and household) were conditional on school attendance for adolescent girls. The intervention led to a significant reduction in HIV prevalence after 18 months. de Walque et al. (2012) evaluate a conditional cash grant program in Tanzania. They document a significant reduction in the prevalence of a set of treatable STIs in the intervention arm where participants were eligible for $60 over one year. However, interventions with relatively small (conditional) financial payments do not appear to result in measurable reductions in HIV or STI prevalence. For example, Kohler and Thornton (2012) assesse an experiment in Malawi that offered a single cash reward of up to $10 after one year to individuals who remained HIV negative. The intervention had no measurable effect on HIV status. de Walque et al. (2012) evaluate a conditional cash grant program in Tanzania where in the low value intervention arm participants were eligible for $30 over one year. They document no impact on a set of treatable STIs or HIV status. Duflo, Dupas and Kremer (2015) find no impact (even in the longer run) on STIs infection rate from an education subsidy program, which subsidized the cost of education for upper primary school students by providing free school uniforms in Kenya. However, the education subsidy combined with HIV prevention education focusing on abstinence until marriage resulted in a significant reduction in STIs infection rate in the treatment compared to the control group.

findings open up new avenues for future research.

The remainder of the paper is organized as follows. Details on the study setting, the research design, and the intervention are presented in section 2. Section 3 reports the main results. Section 4 discusses the implications of the findings and relate them to recent work on financial incentives for HIV prevention. Section 5 concludes. Additional results are reported in appendix.

2 Experimental design and data

2.1 Study setting

Lesotho is a small lower-middle-income country with an estimated population of 2.1 million. Poverty is widespread with 43 percent of the population (in 2003) living on less than $1.25 a day (World Bank, 2014). Lesotho has one of the highest HIV adult prevalence rate in the world (23.3%), with the HIV prevalence rate peaking 40.5% among individuals aged 30-34 (Ministry of Health and Social Welfare and ICF Macro, 2010). Largely due to the HIV/AIDS epidemic, life expectancy at birth is low even by African standards (48 years).

2.2 Conceptual framework

We designed a financial incentive program – a lottery – with relatively low expected payments but with high prizes conditional on negative STI test results. As sexually transmitted infections can be viewed as markers for risky sexual behaviors (Crosby et al, 2003; Fishbein and Pequegnat, 2000), our intervention aimed at modifying the trade-off between the benefit and costs of unprotected sex. If individuals' decisions on sexual behavior ignore the health externality of risky sexual behavior, such a transfer program can be justified by the negative externalities generated by a higher number of HIV positive individuals within a society. That is, the (expected) transfer can be viewed as a Pigouvian subsidy aimed at correcting the externality.

The use of lotteries and thus an uncertain return contingent on behavioral change makes lottery incentives different from traditional conditional cash transfer (CCT) programs. Specifically, the expected utility of a lottery with cash prizes depends on individuals' attitude towards monetary risk. If individuals exhibiting risk-loving preferences in monetary gambles are also more risk-loving in other domains, including sexual behavior, lottery incentives may be particularly effective in targeting individuals with the highest

risk of HIV/AIDS.

2.3 Trial design

The study was a two-year parallel group randomized trial. It had three separate arms – a control arm with an allocation ratio of 40% and two intervention arms - low-value lottery and high-value lottery - with an allocation ratio of 30% each. In the low-value lottery arm individuals were eligible to win lottery prizes worth 500 maloti or approximately $50 every four months conditional on being tested negative for two curable STIs (syphilis and trichonomiasis). In the high-value lottery arm individuals were eligible to win lottery prizes of twice that amount (1,000 maloti or approximately $100), again conditionally of testing negative for syphilis and trichonomiasis.

In expected terms, and conditional on being STI negative, the lottery paid $3.3 every four months in the low-value lottery group, $6.6 in the high-value lottery group and $4.9 in the pooled intervention group. In the pooled intervention group, and over the two years trial period, participants were thus eligible to receive approximately $30 in expectation. Both lottery prizes represent a meaningful proportion of household income. The study population were primarily shepherds and self-employed workers and data from the Lesotho Labor Force Survey (2008) show that average monthly earning in the informal sector was 235 maloti (approximately $23.5) for men and 135 maloti (approximately $13.5) for women.

The choice to condition the incentives on two curable STIs, rather than directly on HIV status, was made for both ethical and epidemiological reasons. First, conditioning incentives on curable STIs allowed individuals testing positive at one round to be eligible to win in the following rounds, if the individual got treatment and remained STI negative. Second, conditioning incentives on curable STIs allowed inclusion of HIV positive individuals in the trial. Risk reduction among HIV positive individuals may have higher impact on HIV transmission in the community than that of HIV negative individuals.

The choice to condition the incentives to syphilis and trichonomiasis status was based on the relatively high prevalence of these two STIs in Lesotho and the fact that they are curable and rapid test technologies are available, practical and affordable. Both STIs have high co-infection rates with HIV (Johnson and Lewis, 2008; Kalichman, Pellowski and Turner, 2011).

Similarly to other conditional cash transfer programs aimed at incentivizing safer sexual behavior, the intervention was designed to offer frequent rewards at short intervals (every 4 months). The short time interval between lottery rounds was intended to bring

the benefits of safe sex closer to the present, which may be important if many individuals have high discount rates or a limited horizon (Oster, 2012).

2.4 Participants

Inclusion criteria consisted of males and females, aged 18-32 years, residing in 29 rural and peri-urban villages across 5 districts in Lesotho. Both HIV-positive and HIV-negative individuals were eligible to enroll. Participation was voluntary but a variety of channels were used to maximize the interest in the project and boost participation.[3] First, a community liaison officer from the implementing NGO visited each participating community before the beginning of the project to garner support from village leaders. Second, media channels were utilized in the form of radio announcements through the most popular local radio stations. Third, posters advertising the project were put up in visible places to inform the communities about the project. Approximately 40% of the age-eligible population in the targeted villages agreed to participate in the study. In total, the various procedures yielded a baseline study sample of 3,427 individuals, of which 3,029 (88.4%) completed baseline interview and tests for syphilis, trichonomiasis, and HIV.

2.5 Implementation

Randomization took place at study mobile clinics in each village separately after baseline interview and STI/HIV testing, with participants selecting one of 10 colored marbles from an opaque bag containing 4 marbles assigning to the control arm, 3 marbles assigning to the low lottery prize arm and 3 marbles assigning to the high lottery prize arm. This highly transparent procedure was considered necessary for acceptability of randomization in the study population.

Lottery tickets were distributed immediately after the survey and STIs tests to all the individuals tested negative for both syphilis and trichonomiasis in the treatment arms. Individuals in the intervention arms testing positive for any of the two STIs did not receive a lottery ticket. They could, however, continue as study participants and thus become eligible in subsequent rounds. Individuals in the control arm were not eligible for lottery tickets, but all other study procedures were identical between the control and intervention arms. Anyone testing positive for an STI (regardless of arm) was offered counseling and

[3] Although recruitment was based on voluntary enrollment the sample looks similar to the general population of Lesotho. HIV prevalence rates by age group according to the Lesotho DHS 2010 were: age 15-19: 4.1% for women (2.9% for men); age 20-24: 24.1% for women (5.9% for men); age 25-29: 35.4% for women (18.4% for men). HIV prevalence at baseline in our sample was: age 18-19: 5.4% for women (1.2% for men); age 20-24: 17.6% for women (4.2% for men); age 25-29: 29.1% for women (15.2% for men).

free STI treatment and individuals tested positive for HIV were referred to public health clinics offering AIDS treatment for appropriate follow-up. Individual pre-test and post-test counseling following Lesotho national guidelines was provided to study enrollees at each testing interval.

Lottery draws, organized every four months in each village, were conducted approximately one week after the first interview. Four lottery winners (one male and one female per lottery arm) per village were drawn.

Over two years, we conducted 7 rounds of data collection. At baseline each individual received an ID card with a unique identification number that was used to identify the respondents in subsequent rounds. Each participant received a small in-kind incentive (candles, matches, and washing powder), worth approximately $3, as a reward for their participation.

2.6 Measurement

All participants were tested for HIV, following the Lesotho national testing guidelines, at baseline and months 16, 20 and 24. Participants were tested for syphilis and trichonomiasis at baseline and before each lottery draw.

A baseline and end of trial survey were administered to all participants. The surveys were conducted in private with an enumerator of the same gender as the respondent to mitigate potential reporting biases. The surveys included modules on socioeconomic characteristics, sexual attitudes and behaviors, and knowledge about HIV/AIDS and other sexually transmitted infections. Participants' preferences for risk were measured using a simple multiple price list (MPL) design (Andersen et al. 2008).[4] In the baseline survey, individuals were presented with a question with 15 decision rows. For each decision row, respondents were asked to choose between a fixed amount, with payments starting at 0 and increasing by 25 maloti up ($2.5) to 350 maloti ($35), or a risky lottery with a 50% chance to win 500 maloti ($50) or 50% chance to receive nothing. We made clear that we were putting them in a hypothetical situation, but that they should try to provide an answer that was as realistic as possible.

We create two measures of risk preferences at baseline. First, we construct an indicator variable ("Risk lover") which takes the value 0 for respondents who preferred a fixed amount of money below the expected value (of 250 maloti) instead of a lottery with 50% chance of winning 500 maloti, and 1 otherwise. Second, we follow Andersen et al. (2008)

[4]The MPL design has been used to elicit risk attitudes by, among others, Holt and Laury (2002) and Tanaka, Camerer and Nguyen (2010).

and assume a constant relative risk aversion (CRRA) utility function, $u(y) = \frac{y^{1-r}}{1-r}$, where y is the lottery prize and r is the latent risk coefficient. The point at which respondents switch from the risky to the safe option are then used to deduce bounds on the subject's risk preference (r).[5] We use the midpoints on these bounds as a measure of the participants' preferences for risk.

2.7 Timing

Recruitment and baseline data collection started in February, 2010. The lottery trial was stopped after two years, following the protocol. A follow-up study was implemented one year after the intervention ended (February-May, 2013). The time line of the project is described in Figure 1.

2.8 Power calculations

Power calculations were based on a comparison of HIV incidence between two, equal-sized study arms assuming a two-sided alternative hypothesis. No prior data were available on HIV incidence in the study communities. HIV prevalence data by age group from the 2009 DHS, however, suggested a high incidence rate in the study population (Ministry of Health and Social Welfare and ICF Macro, 2010). According to the 2009 DHS data, HIV prevalence among women was 4.1% in the 15-19 age group and 24.1% in the 20-24 age group, which is consistent with an annual HIV incidence rate of 4.6 percent over five years. HIV prevalence among women in the 25-29 age group was 35.4%, which is consistent with an annual HIV incidence rate of 3.9 percent over 10 years. HIV prevalence among men in the 15-19 age group and the 25-29 age group were 2.9% and 18.4%, respectively. With the assumption of a 4% annual incidence rate in the study population (which is consistent with a 4.6% annual HIV incidence rate for women and a 50% lower rate for men, and a study population with 75% women), a total sample size of 2,500 HIV negative individuals would be sufficient to provide at least 80% power to detect a 26% intervention-related reduction in annual HIV incidence (significant at the 5% level) over two years in each intervention arm.

[5] That is, if the respondent chose the risky option when the safe option paid s, but the safe option when safe option paid $s + 25$, the bounds are $1 + \frac{\ln(1/2)}{\ln(500)-\ln(s+25)} < r < 1 + \frac{\ln(1/2)}{\ln(500)-\ln(s)}$.

3 Results

Baseline characteristics

Baseline HIV and STI prevalence rates are reported in Table 1. At baseline, 16.7% of the study participants tested positive for HIV and 13.5% tested positive for any of the two STIs (syphilis and trichonomiasis).[6] Consistent with data from the 2009 DHS survey in Lesotho, the HIV prevalence rate was significantly higher for females (20.4%) than males (8.7%) participants and significantly higher for the older compared to the younger age cohorts.

Baseline characteristics, by assignment group, are presented in Table 2.[7] Prevalence rates for HIV, and the two curable STIs, were similar across groups (panel A). The three assignment groups also had similar demographic and socioeconomic characteristics (panel B). Self-reported sexual behavior outcomes (panel C) were also similar on all but two outcomes – self-reported use of a condom during last intercourse (significantly higher at the 10%-level in the pooled intervention vs. control group) and self-reported likelihood that the last partner was HIV infected (significantly higher at the 10%-level in the pooled intervention vs. control group).

In the last row of panel C we report average standardized pre-treatment effects of the four sexual behavior outcomes; i.e., we estimate a seemingly unrelated regression system,

$$Y = [I_K \otimes T]\,\beta + v\,, \tag{1}$$

where Y is a vector of K related sexual behavior outcomes, I_K is a K by K identity matrix, T is a vector of assignment to intervention group(s) indicators and derive an average standardized pre-treatment effect, $\tilde{\beta} = \frac{1}{K}\sum_{k=1}^{K}\frac{\hat{\beta}_k}{\hat{\sigma}_k}$, where $\hat{\beta}_k$ is the point estimate on the treatment indicator in the k^{th} outcome regression and $\hat{\sigma}_k$ is the standard deviation of the control group for outcome k (see Kling et al., 2004; Duflo et al., 2008). We find no significant difference between assignment groups using this aggregate measure of self-reported sexual behavior (denoted "Practice safe sex"). Furthermore, as shown in panel D, among HIV negative individuals at baseline – the main sample for the HIV incidence analysis – all four self-reported sexual behavior outcomes - were also similar across assignment

[6] 3.8% of the respondents were tested positive for syphilis while the prevalence of *Trichomoniasis* was 10.4%. To increase precision, we consider the joint measure of syphilis and trichomoniasis prevalence as the main STI outcome.

[7] In expectations, 30% of the sample should have been assigned to the high and low lottery arm, respectively. While the share assigned to the high [low] group is higher [lower] than 0.3, we cannot reject the null hypotheses that the sample comes from a distribution with means 0.3 for each group (results available upon request).

groups.

The attrition rate was low (Table 3), with 95.4% (2888 out if 3029) of the participants surveyed and tested in the last round and 94.6% (2,865 out of 3,029) of the participants surveyed and tested in the one-year follow-up round. The attrition rate (5-6%) was similar across the three assignment groups and not predicted by any of the baseline socio-demographic characteristics listed in Table 2, panel B, or STI status, except that HIV positive individuals at baseline were more likely to be lost at follow-up (41 of 507 or 8% of HIV positive individuals at baseline were lost at follow up).

STIs as markers for risky sexual behavior

The main objective of the intervention was to incentivize safer sexual behavior as a route to reducing the spread of HIV. The lottery incentives, however, were tied to STI status. Table A1 in appendix reports correlations between STI status and HIV status and self-reported sexual behavior using baseline data. STI-positive individuals were approximately 2.5 times more likely than STI-negative individuals to be HIV positive at baseline (column 1); i.e., there is a strong positive correlation between STI and HIV status. Columns (2)-(6) show that STI-positive individuals were also more likely to be involved in (self-reported) risky sexual behavior. The average standardized effect ("Practice safe sex") is significantly negative and precisely estimated, providing evidence in favor of the assumption that prevalence of the two STIs can be viewed as a marker for risky sexual behavior.

Average treatment effects: HIV and STI

To assess the impact of the lottery intervention, we compare mean outcomes after accounting for stratification. That is, we estimate

$$y_{ij} = \alpha + \beta^L T_{ij}^L + \beta^H T_{ij}^H + \eta_j + \varepsilon_{ij}\,, \tag{2}$$

where y_{ij} is a binary variable that for HIV incidence takes value 1 if individual i living in village j became HIV infected over the trial period and 0 otherwise. For HIV [STI] prevalence, y_{ij} takes value 1 if individual i living in village j was HIV [STI] positive at the end of the trial, and 0 otherwise. T^L and T^H are indicator variables for assignment to the two intervention groups (low and high lottery group, respectively), η_j are village fixed effects, and ε_{ij} is an error term. Standard errors are clustered at the village level. We estimate the effects for the high- and low-value lottery arm and the pooled treatment effect using both OLS and a Probit model.

Table 4 describes the impact of the lottery program on HIV incidence – the primary

study outcome.[8] Over the two-year trial period, the HIV incidence rate was reduced by 2.5 percentage points, or 21.4% (column 1), leading to a 3.4 percentage points lower HIV prevalence rate at the end of the trial (column 5), in the pooled intervention compared to the control group. Columns (3), (4), and (6) report the effects by intervention group. Relative to the control arm, HIV incidence fell by 3.3 percentage points, or 28%, in the high prize lottery arm, and by half that size, 1.6 percentage points or 14%, in the low prize lottery arm. The HIV incidence rates did not differ significantly between the two intervention arms. However, the difference in HIV incidence between the high price lottery arm and the control group was statistically significant while the difference in HIV incidence between the low price lottery arm and the control group was not.[9,10]

In appendix, Table A4, we report treatment effects by gender. The point estimates for the pooled intervention group and the high value lottery arm were statistically significant in the sample of female participants but not significant in the sample of male participants. We can reject the equality of treatment effects for female and male participants for the pooled intervention group (F-stat=3.79, p-value=0.06) for HIV incidence, but cannot reject the equality of treatment effects for males and females (F-stat=0.25, p-value=0.62) for HIV prevalence. Overall the differences between male and female participants should be interpreted with caution because the study was not designed to pick up gender specific treatment effects and ex post power calculations show that the study was not powered to detect effects on HIV incidence for men only.[11]

Table 5 reports the estimated treatment effects on syphilis and trichonomiasis. Two findings stand out. First, STI prevalence rates have fallen in all three assignment groups. At baseline, 13.5% of the participants were infected by at least one of the two STIs (see Table 1). After two years, STI prevalence in the control group is 3.8%. This large reduction in STI prevalence in the control group should be viewed through the lens of the trial protocol. Regular screening and free treatment of the two STIs were provided across all three study groups throughout the trial to participants who were tested positive for STIs. Second, in the intervention groups STIs prevalence was essentially zero in both lottery arms (0.2% in the high lottery arm and 0.5% the low lottery arm), implying effect sizes of 89% and 82%, respectively. Our core sample consists of HIV negative individuals at baseline. However, participation in the project was not conditional on HIV status.

[8] HIV incidence is the flow of new infections; HIV prevalence is the stock of existing infections.

[9] Adjusted odds-ratios and relative risk ratios are reported in table A2 in appendix.

[10] To examine potential bias due to non-random attrition, table A3 in appendix reports Lee bounds estimates. The significant effects for the pooled lottery and the high lottery arms remain intact.

[11] Female and male participants differed in other observables, for example in earnings. The difference in earnings by gender might explain the differential impact on HIV incidence given that lottery prizes are a higher fraction of earnings for women in the sample.

Columns (7)-(8) of Table 5 show that the lottery program also affected STI outcomes for the subsample of HIV-positive participants (as measured at baseline). STI prevalence among HIV-positive participants in the control group was 11.2% (22/196), while no HIV-positive participants in the intervention arms was tested positive for the two STIs at the end of the trial. Table A5 in the appendix breaks down the STI results by gender. We document large effects for both the group of male (significant at the 10%-level) and female participants (significant at the 1%-level).

Sexual behavior and reproductive health

Sexual transmission is responsible for the vast majority of new HIV infections, particularly in Sub-Saharan Africa. The risk of getting HIV infected, in turn, can be reduced in several ways, including reducing the number of partners/sexual acts, changing the type of partner, and increasing the use of condoms. In this section we start by studying more closely these behavioral changes.

We focus on four self-reported outcomes: the number of partners in the last four months, whether a condom was used in the last intercourse, if the respondent think his/her last sexual partner was infected by HIV, and whether the last intercourse was extramarital sex. The results are reported in panel A, Table 6.

There is evidence of a reduction in risky sexual behavior across all four outcome measures and the average standardized treatment effect on safer sexual behavior, reported in column 5, is statistically significant.[12] The estimated treatment effects are small for number of partners and the use of a condom during last intercourse, but relatively large for the likelihood, as perceived by the respondent, that the last partner was HIV positive (which fell by 16% in the treatment relative the control group) and self-reported extramarital sex (which dropped by 29% in the treatment relative the control group). Thus, with the caveat that sexual behavior is difficult to measure using traditional survey techniques, the evidence in panel A suggests that the intervention primarily resulted in changes in the type of sexual partner.[13]

The primary objective of the intervention was to reduce HIV incidence. However, a shift towards less risky sexual behavior may also have additional health and socioeconomic benefits. The reduction in the prevalence of syphilis and trichonomiasis, as re-

[12]"Practice safe sex" is the average standardized effect of the four individual indicators in panel A, reversing the sign of "Number of partners last 4 months", "High likelihood last partner HIV+", and "Extramarital sex".

[13]Recall and social desirability biases in self-reported data on sexual behavior are a general concern, and especially so when the data are collected within the context of a project involving counseling and testing, as is the case here (Strauss and Thomas, 1998; Powers et al., 2008; Boily et al., 2009; Corno and De Paula, 2014).

ported above, is one example. In panel B, Table 6, we assess the effects of two additional reproductive health outcomes: pregnancy and births. As reported in column (6), women in the pooled intervention group were 22.3% less likely to have given birth in the last four months or be currently pregnant. Columns (7)-(8) split the sample on whether or not the woman live in a long-term relationship (here labeled as married versus unmarried). Pregnancies among single women are more likely to be unwanted and due to unprotected sex with a non-regular partner. Despite the smaller samples, the results suggest that the effect in the full sample was mainly driven by the sample of single women (a 31% reduction in recent births and pregnancies among single women).

Taken together, the findings on self-reported sexual behavior, as well as other reproductive health outcomes, show that behavior changed in response to the intervention and that these sexual behavioral changes also resulted in benefits apart from those we primarily targeted.

Heterogeneous effects: Preferences for risk

Better understanding of how to strategically target social behavioral programs to groups at higher risk of infection is often raised as a priority by policy makers. Apart from specific groups (commercial sex workers for example), however, little is known about how to identify and target those at high risk, in particularly in a population at large (UNAIDS, 2013). If more risk-loving individuals are also more risk-prone in other domains, including sexual behavior, the introduction of lotteries into an otherwise standard financial incentive program may be one way to better target those at higher risk of getting infected by HIV. In this section we investigate whether there is evidence in favor of such a mechanism.

Participants' preferences for risk at baseline were measured using a simple multiple price list (MPL) design as described in section 2.6. Table A6 in appendix replicates the 15 tasks presented to participants at baseline and the implied bounds on the latent risk coefficient r. The midpoints on these bounds are used to measure the respondents' preferences (r) for risk. In total, 60% of the respondents switched from choosing the risky lottery to the safe option; i.e. for these respondents we can deduce bounds on r. The remaining 40% of the respondents either choose the safe lottery for all 15 options being presented, including the first option where the safe option paid 0 (the expected value in the risky lottery was always 250 maloti), or choose the risky lottery for all 15 options presented, which implies a risk coefficient $r < -0.94$. While we cannot rule out that some individuals place a non-pecuniary cost of participating in a lottery, and thus prefer nothing as compared to a chance of winning, or that some individuals are highly risk loving, these choices are more likely to be a product of lack of comprehension of the MPL design. Thus

we restrict the sample to the sub-sample of switchers (for which we can deduce r). As a robustness test, however, we reestimate all core specifications with respondents always choosing the safe option coded as risk-averse (0) and respondents always choosing the risky option coded as risk-lovers (1).

Summary statistics for our two measures of risk preferences at baseline are provided in Table 2, Panel B. 35% of the sample are "risk lover", that is they prefer a lottery with 50% chance of winning 500 maloti compared to a fixed amount of money greater or equal to its expected value (of 250 maloti). The risk coefficient (r) is 0.245 on average, which is lower than that found in Holt and Laury (2002) for university students in the US ($r = 0.27$ on average) and Harrison et al. (2010) for poor subjects in Ethiopia, India and Uganda ($r = 0.54$ on average), but higher than those reported in Lammers and van Wijnbergen (2007) for students in South Africa ($r = 0.16$ on average) and in Tanner et al. (2005) for Nigerian subjects ($r = 0.15$ on average). Both measures are well balanced across treatment arms at baseline.

As individuals that exhibit risk-loving preferences in a monetary gamble may not be risk-loving in other domains, especially when it comes to sexual behavior, we start by investigating whether our measure of risk ("Risk lover") has bearing on risky sexual behavior. Table A7 in the appendix compares risk-loving and risk-averse individuals on observable characteristics at baseline. Risk-averse and risk-loving individuals had similar demographic and socioeconomic characteristics (panel B), but risk-loving participants were more likely to be HIV positive. Risk-loving participants were also less likely to report that they practice safe sex (panel C) and have on average a higher STI prevalence rate (although not significantly so, p-value=0.165) at baseline compared to risk-averse participant.

Do risk-loving individuals respond differently than risk-averse individuals to the lottery program? Table 7 suggests they do. We start by regressing HIV incidence on risk attitudes separately for each assignment group. Risk-lovers were more than twice as likely to become infected with HIV over the trial period in the control group (column 1). That is, although risk-lovers account for about one-third of the sample, they still account for more than half of the new HIV infections in the control group. In the pooled intervention group, on the other hand, the share of individuals infected by HIV during the trial period is approximately the same in the group of risk-loving and risk-averse individuals (column 2). Thus, the findings reported in columns (1)-(2) suggest that the lottery program lowered HIV incidence in the intervention group by making risk-loving individuals behave similarly to risk-averse individuals in terms of their sexual behavior. Column (3) uses the full sample and an interaction term between the pooled intervention group and

the risk-lover indicator. HIV incidence was 11.0 percentage points lower for risk-loving individuals in the intervention relative the control group. In both the intervention and control group, HIV incidence among risk-averse is approximately the same.

Columns (4)-(6) show that the relationship between risk aversion and risky sexual behavior remain intact when we replace the indicator variable of risk attitudes with the continuous risk coefficient r. Figure 2 illustrates the finding reported in column (6) by plotting the percentage reduction in HIV incidence (intervention vs. control group) conditional on r. The treatment effect for more risk-loving participants is quantitatively large: individuals with a deduced risk aversion coefficient one-standard deviation below the mean were 53% less likely to have been infected by HIV during the trial period in the intervention relative to the control group.

Participants' preferences for risk are not randomly assigned. Thus a concern with the results reported in columns (1)-(6) is that the treatment effects for risk-loving individuals reflect differences in demographic and socioeconomic characteristics across participants, rather than truly stronger response to the lottery incentives for this sub-group. To partly address this concern we add the full set of baseline demographic and socioeconomic characteristics (listed in Table 2, panel B) and STI status at baseline as controls in columns (7)-(8). The point estimates on the interaction effects remain basically unchanged. Columns (9)-(10) in addition add interactions between assignment to intervention and all additional covariates. Again the results remain unchanged, suggesting that differences in demographic and socioeconomic characteristics and STI status at baseline do not drive the results reported in columns (1)-(6).

In Table A8 in appendix, we expand the sample by also including individuals that choose either the safe or risky options for all values of the safe payment in the MPL question. The main results remain intact, albeit less precisely estimated. If the no-switching behavior is driven by a lack of comprehension of the MPL design, the inclusion of the non-switchers will likely attenuate the true effect. The results in Table A8 are consistent with this interpretation.

Table 8 shows that the results remain broadly intact when using STI prevalence rather than HIV incidence as dependent variable. In both the group of risk-averse and the group of risk-loving individuals we observe large reductions in the prevalence of any of the two STIs in the intervention as compared to the control group. All 645 risk-averse individuals and 334 out of 337 risk-lovers (99.2%) in the pooled intervention group were tested STI negative at the end of the project period. In the control group 5.2% (12 out of 232) of the risk-loving individuals and 2.2% (9 out of 406) of the risk-averse individuals were tested STI positive at the end of the trial. For the group of risk-loving individuals this

corresponds to a reduction in STI prevalence of 83% (Table 8, column 3).

Longer run effects

The results reported so far were limited to a 24 months program with recurrent village level lotteries every fourth months, and cannot address the sustainability of the decline of HIV incidence over a longer period, particularly after the lottery program has been discontinued. Nor can the results address the possibility of adverse consequences to the extent that extrinsic incentives may reduce long-term intrinsic motivation to engage in safe sexual behaviors after incentives have been withdrawn. On the other hand, work on sexual behavior in Sub-Saharan Africa have highlighted various cultural barriers to changing behavior (e.g., fatalism, low levels of female bargaining power), and it is possible that the financial scheme considered here helps overcome these adverse cultural constraints.

To assess the longer run effects, a follow-up study was implemented one year after the intervention ended. The survey was not announced in advance. In the follow-up study we re-interviewed and re-tested the participants that were screened at the end of the intervention. Table 9 summarizes the main findings in the first year following the intervention. As evident, HIV incidence rates were similar across assignment groups in the year following the trial (column 1). That is, there is no evidence of adverse reactions or consequences in the intervention relative the control group, at least based on data one year after the intervention ended. As a result, HIV prevalence remains significantly different between the pooled intervention and control group (column 2) one year after the intervention ended.

4 Discussion

The lottery program reduced risky sexual behavior at relatively low costs.[14] We calculate that the cost of averting a primary HIV infection in the Lesotho trial was $882 (based on cash payments only). As a reference, Kohler and Thornton (2012) assessed an experiment in Malawi that offered a single cash reward of up to $10 after one year to individuals who remained HIV negative. The intervention had no measurable effect on HIV status; i.e., infinite cost per HIV infection averted. Baird et al. (2012) evaluated an intervention, also in Malawi, targeting human capital formation as an alternative HIV prevention strategy.

[14] A comparison of cost-effectiveness across studies should be considered as one input among others in assessing policy, especially because some interventions may create benefits beyond reducing the risk of HIV infections and because some interventions may be more context-dependent and sensitive to small differences in program design.

They found that a monthly cash transfer of $10 per household and conditional on school attendance for adolescent girls led to a significant reduction in HIV prevalence after 18 months. Based on cash payments only, the cost per HIV infection averted was $10,000. Another conditional cash transfer trial, in Tanzania, that shares a number of similarities to the Lesotho trial (financial incentives tied to periodic screening of STIs, free STIs treatment of all trial participants, similar inclusion criteria, and almost identical prevalence rates for any of syphilis and trichomonas at baseline) but where the cash rewards were higher and paid with certainty, report STIs prevalence as the key outcome variable (de Walque et al., 2012). They document a reduction in STIs prevalence in the treatment arm where participants were eligible for $60 but find no measurable effect on STIs prevalence in the pooled intervention group where participants were eligible for $40 on average. The study was not powered to directly examine HIV conversion, thus implications for HIV prevention remain speculative. The cost of averting a STIs infection (at the end of the study period and based on cash payments only), was $2500. The estimated cost of averting a STIs infection in the Lesotho trial was 75% lower, or $645.

Our findings – a significant reduction in HIV incidence and a large reduction for those with higher baseline risks of getting HIV – are certainly important in showing the potential power of lottery incentives to reduce risky behavior. However, further research is needed to establish the mechanisms at play. For example, while we do know that fixed payments of similar magnitudes as the expected value of the lottery have not resulted in significant reductions in the prevalence of sexually transmitted infections in other low-income countries (see Kohler and Thornton, 2012; and de Walque, et al., 2012), we cannot rule out that this differential effect between lottery and fixed payment is at least partly driven by context-specific factors. Ruling out this hypothesis would have required an additional arm where participants were offered the expected value of the lottery with certainty, conditional on testing STIs negative. Unfortunately, it was not feasible to add such an intervention arm in the Lesotho trial.

Our design, where assignment to treatment was randomized within villages, also does not allow us to estimate spillover effects. Such spillover effects are likely important and correctly estimating them is crucial to properly assess cost-effectiveness. But it would also require a design that randomize treatment at a more aggregate level. As a reduced transmission risk would affect participants in both the intervention and the control group, the treatment estimates we report in the paper do not capture the indirect spillover effects of a lower transmission risk among (all) participants.

The lottery intervention may have influenced outcomes through several channels. For example, a public lottery event every four months could have highlighted the role of pre-

vention in the community. This channel, though, presumably influenced all study participants, independent of assignment arm. Participation in a lottery may also have yielded direct non-pecuniary rewards, for example by offering participants an element of entertainment or fun. Moreover, if people tend to overestimate small percentages, as growing evidence from prospect theory suggest (Kahneman and Tversky. 1979; Kahneman, 2011; Barberis, 2013), the perceived return from participating in a lottery may also be higher than the return from an incentive program that pays the expected return with certainty, or likewise lotteries may provide stronger incentives for behavioral change compared to a traditional CCT programs holding the budget constant. Finally, a large, albeit uncertain, payment may be preferable to a lower but certain payment flow if consumers face saving constraints and cannot purchase an indivisible good out of current income.

5 Conclusions

The extremely high social and economic cost of the HIV/AIDS epidemic motivates the continued search for innovative and cost-effective prevention approaches. In this paper we investigate the effects of introducing a gamble into an otherwise standard financial incentive program. To the best of our knowledge, this is the first large scale randomized trial that assesses the impact of lottery as an HIV prevention tool. We find that the lottery program resulted in a significant reduction in HIV incidence. We further show that a large share of the individuals that changed their measured behavior in response to the intervention exhibited risk-loving preferences at baseline. Thus, our findings provide suggestive evidence that lotteries can be used to target groups at higher risks of getting HIV infected.

Lotteries may be successfully implemented in various prevention programs to enhance the demand for less risky behavior. Such a lottery program can presumably also be implemented at lower costs than traditional CCT programs as only winners need to be paid. Permutations of the design, such as only testing winners for STIs or subjecting the STI screening to a lottery, could further reduce costs and increase the scalability of the intervention.

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Figure 1: Time line of the project

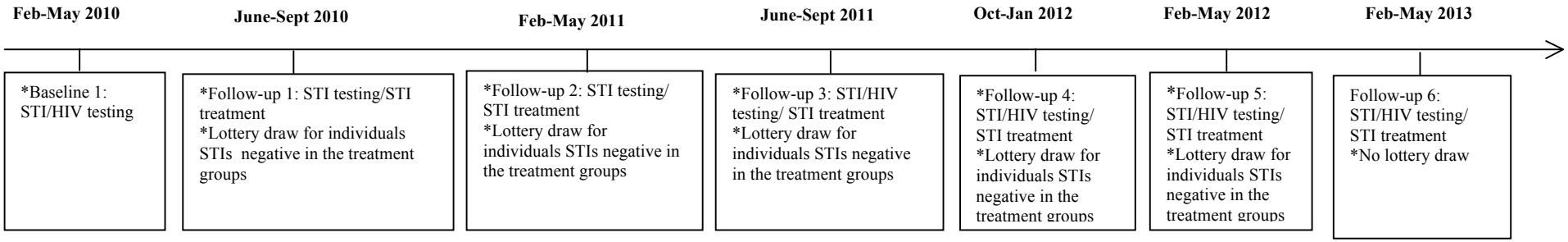
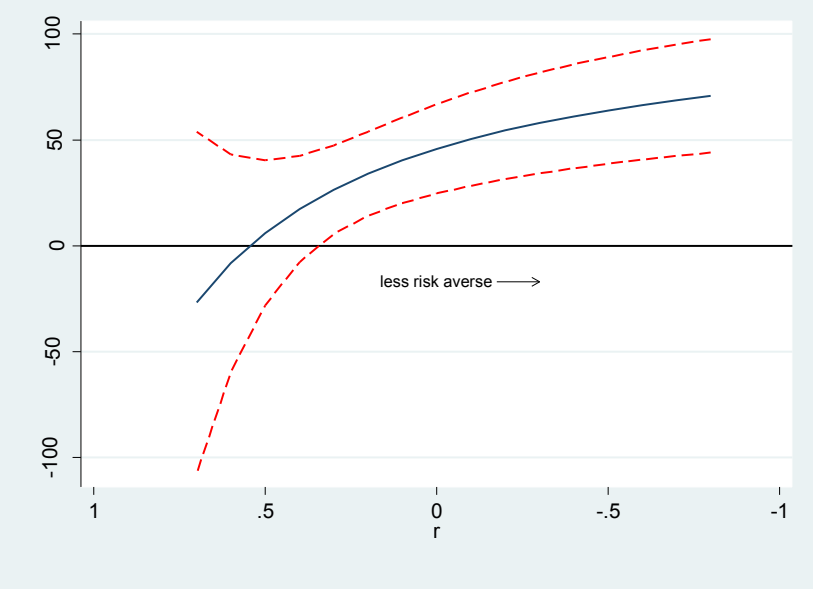


Figure 2. Treatment effects conditional on degree of risk aversion (reversed scale)



Note: Risk coefficient (r) is deduced from the MPL question and assuming a CRRA utility function (see main text for details). Reversed scale. % change predicted from specification (6), Table 7.

Figure 3. Estimated sexual behavior conditional on expected transfer

Fig 3a: Reduction in relative risk, full sample

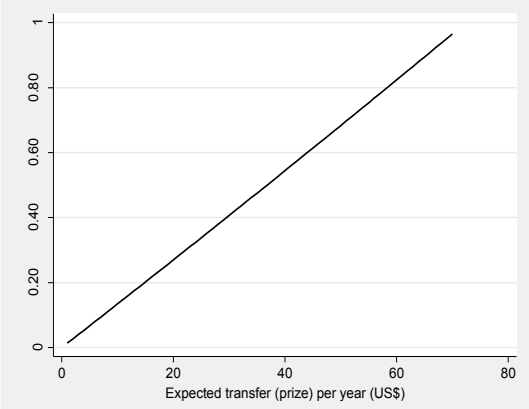


Fig 3b: Risky behavior, full sample

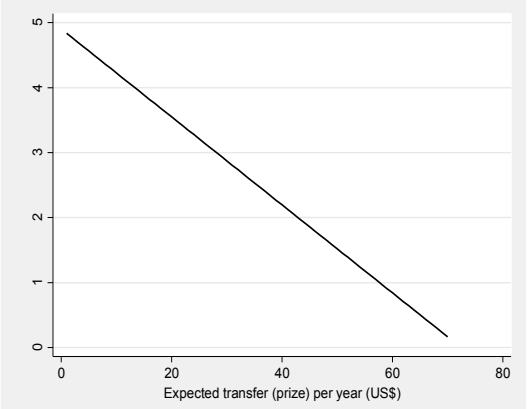


Fig 3c: Reduction in relative risk, risk-lovers

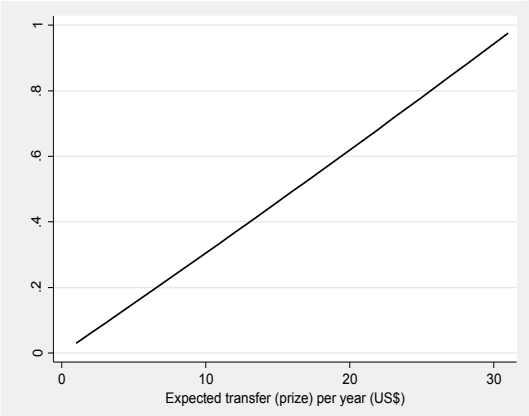
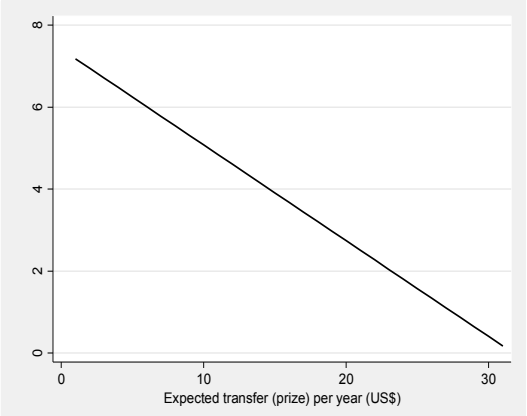


Fig 3d: Risky behavior, risk-lovers



Note: Top row, full sample. Bottom row, sample of risk-lovers. Reduction in relative risk is the relative difference in risk of getting HIV infected in the intervention relative the control group.

Table 1. Biomarkers: Summary statistics

	HIV positive	STI positive
All	16.7% (507/3029)	13.5% (409/3029)
Female	20.4% (424/2077)	17.1% (356/2077)
Male	8.7% (83/952)	5.6% (53/952)
Age 18-22	8.4% (115/1372)	12.0% (165/1372)
Age 23-27	18.3% (197/1076)	13.9% (150/1076)
Age 28-32	33.6% (195/581)	16.2% (94/581)

Note: Data are % (n/N). Sample of individuals age 18-32 at baseline with complete individual characteristics and biomarker data. HIV positive (HIV prevalence) is equal to 1 if the individual tested HIV positive at least twice and 0 otherwise; STI positive (STI prevalence) is equal to 1 if the respondents tested positive for any of the two STIs (syphilis and trichomoniasis).

Table 2. Baseline Characteristics

	Obs.	All	Control (C)	Any lottery (T)	High lottery (T_H)	Low lottery (T_L)	P-value (T=C)	P-value (T_H=C)	P-value (T_L=C)
Panel A: Biomarkers									
HIV positive	3029	0.167	0.176	0.161	0.162	0.160	0.452	0.494	0.467
STI positive	3029	0.135	0.133	0.136	0.137	0.136	0.853	0.837	0.897
Panel B: Household Characteristics									
Female	3029	0.686	0.698	0.678	0.684	0.671	0.395	0.513	0.343
Age	3029	23.45	23.50	23.41	23.33	23.50	0.539	0.339	0.996
Single	3029	0.491	0.481	0.498	0.510	0.484	0.363	0.184	0.896
No education	3029	0.012	0.014	0.010	0.010	0.011	0.416	0.383	0.526
Primary education	3029	0.456	0.456	0.456	0.436	0.478	0.985	0.358	0.298
Some secondary education	3029	0.399	0.383	0.410	0.422	0.396	0.203	0.096	0.610
Durable goods	3029	3 060	3.046	3.069	3.055	3.087	0.669	0.878	0.574
Risk lover	1703	0.351	0.359	0.346	0.357	0.334	0.584	0.950	0.313
Risk coefficient	1703	0.245	0.240	0.248	0.239	0.258	0.661	0.970	0.418
Panel C: Sexual behavior									
Extramarital sex last intercourse	1326	0.131	0.143	0.123	0.112	0.134	0.362	0.264	0.706
Condom used last intercourse	1836	0.347	0.323	0.364	0.374	0.352	0.096	0.063	0.325
N. of partners in lifetime	2987	2.149	2.147	2.150	2.091	2.216	0.983	0.719	0.571
High likelihood HIV last partner	1832	0.141	0.120	0.156	0.146	0.167	0.088	0.282	0.064
Practice safe sex				0,008	0.036	-0.020	0.800	0.370	0.548
				(.033)	(.040)	(.033)			
Panel D: Sexual behavior (for HIV negative)									
Extramarital sex last intercourse	1067	0.111	0.126	0.100	0.091	0.111	0.262	0.186	0.545
Condom used last intercourse	1486	0.354	0.333	0.368	0.374	0.360	0.246	0.197	0.462
N. of partners in lifetime	2486	2.042	2.054	2.035	1.986	2.090	0.886	0.679	0.782
High likelihood HIV last partner	1484	0.096	0.079	0.108	0.101	0.116	0.100	0.261	0.074
Practice safe sex				0,013	0.035	-0.013	0.728	0.394	0.748
				(.030)	(.041)	(.040)			

Note: Mean outcomes. Sample of individuals age 18-32 at baseline with complete individual characteristics and biomarker data. Any lottery is high and low lottery combined. The P-values for the null hypothesis that the means are equal are calculated using village-clustered standard errors. "HIV positive" (HIV prevalence) is equal to 1 if the respondent tested HIV positive for two consecutive rapid tests and 0 otherwise; "STI positive" (STI prevalence) is equal to 1 if the respondents tested positive for any of the two STIs (syphilis and trichomoniasis). "Female" is an indicator variable for female participants; "Age" is the age of the participant; "Single" is a indicator variable for singles (incl. divorced and widows); "No education"/"Primary education"/"(At least) some secondary" are indicator variables for educational outcomes; "Durable goods" is an index (0-7) indicating whether the household owned the following items: car, electricity, mobile phone, lamp, radio, fridge, television. “Risk lover” is a binary variable taking the value 0 for respondents who preferred a fixed amount of money below the expected value of 250 Maloti instead of a lottery with 50% chance of winning 500 maloti and 1 otherwise; "Risk coefficient " is deduced from the MPL question and assuming a CRRA utility function (see text for details); "Condom used last intercourse" is a indicator variable equal to 1 if the respondent reported using a condom in the last intercourse, 0 otherwise (restricted to individuals reported to have had sex in the last 4 months); "N. of partners" is the number of sexual partners the respondent reported to have, capped at 10; "High likelihood HIV last partner" is a binary variable equal to 1 if the respondent answered "very likely" or "likely" to the question: "What do you think is the likelihood that your last partner was infected with HIV?", 0 otherwise (restricted to individuals reported to have had sex in the last 4 months); "Extramarital sex" is a binary variable equal to 1 if the respondent reported that the last sexual intercourse was not with spouse/cohabiting partner (restricted to married or cohabiting individuals reporting to have had sex during the last 4 months). "Practice safe sex" is the average standardized pre-treatment effect of "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime" and "High likelihood HIV last partner", with robust standard errors clustered at the village level in parentheses.

Table 3. Sample sizes

	Full sample		Any lottery		High lottery		Low lottery		Control	
	obs.	share	obs.	share	obs.	share	obs.	share	obs.	share
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Baseline	3029		1821		967		854		1208	
16 months	2829	0.93	1717	0.94	916	0.95	801	0.94	1112	0.92
24 months	2888	0.95	1746	0.96	930	0.96	816	0.96	1142	0.95
36 months	2865	0.95	1735	0.95	921	0.96	814	0.95	1130	0.94

Note: Sample sizes by survey round (baseline, 16 months, 24 months and 36 months). Sample of individuals aged 18-32 at baseline with complete individual characteristics and biomarker data. Any lottery is high and low lottery combined. Share is number of observations at follow-up rounds out of total number of observations at baseline.

Table 4. Effects of the lottery incentive intervention on HIV incidence and prevalence

	HIV incidence				HIV prevalence	
	OLS	Probit	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.025**	-0.026**			-0.034*	
	(0.010)	(0.010)			(0.018)	
High lottery			-0.033**	-0.035***		-0.041**
			(0.013)	(0.014)		(0.019)
Low lottery			-0.016	-0.016		-0.027
			(0.014)	(0.013)		(0.020)
Mean control group	0.117	0.117	0.117	0.117	0.269	0.269
P-value (T_H=T_L)			0.297	0.253		0.390
Observations	2422	2422	2422	2422	2888	2888

Note: HIV incidence: Sample of HIV negative individuals aged 18-32 at baseline with the dependent variable equal to one if the individual tested HIV positive at least twice after 16, 20, or 24 months and zero if the individual test HIV negative after 24 months. HIV prevalence: Sample of individuals aged 18-32 at baseline with the dependent variable equal to one if the individual tested HIV positive at baseline or least twice after 16, 20, or 24 months, and zero if the individual test HIV negative after 24 months. Any lottery is high and low lottery combined. Probit estimates are marginal effects calculated at the mean. P-value (T_H=T_L) is the p-value for the test that the treatment effects are equal in the high and low lottery arm. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 5. Effects of the lottery incentive intervention on STI prevalence

Sample	All						HIV+ baseline	
	OLS	OLS	Probit	OLS	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Any lottery	-0.032***	-0.032***	-0.033***				-0.108***	
	(0.009)	(0.009)	(0.008)				(0.039)	
High lottery				-0.034***	-0.034***	-0.039***		-0.112***
				(0.010)	(0.010)	(0.013)		(0.039)
Low lottery				-0.031***	-0.031***	-0.029***		-0.102**
				(0.010)	(0.009)	(0.009)		(0.038)
Mean control group	0.038	0.038	0.038	0.038	0.038	0.038	0.112	0.112
Control STI status baseline	No	Yes	No	No	Yes	No	No	No
P-value (T_H=T_L)				0.44	0.41	0.49		0.13
Observations	2884	2884	2884	2884	2884	2884	466	466

Note: Sample of individuals aged 18-32 at baseline. The dependent variable (STI prevalence) is equal to one if the individual tested positive for any of the two STIs (syphilis and trichomoniasis) after 24 months and zero otherwise. Any lottery is high and low lottery combined. Probit estimates are marginal effects calculated at the mean. P-value (T_H=T_L) is the p-value for the test that the treatment effects are equal in the high and low lottery arm. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 6. Self-reported sexual behavior and reproductive health outcomes

Panel A: Sexual behavior

	Number of partners last 4 months	Condom used last intercourse	High likelihood HIV last partner	Extramarital sex last intercourse	Practice safe sex
	(1)	(2)	(3)	(4)	(5)
Any lottery	-0.020	0.021	-0.014	-0.030	0.051**
	(0.031)	(0.025)	(0.015)	(0.021)	(0.021)
Mean control group	1.115	0.485	0.088	0.103	
Observations	2707	1667	1775	1300	2920

Panel B: Reproductive health

	Birth or current pregnancy		
Sample	All	Unmarried	Married
	(6)	(7)	(8)
Any lottery	-0.056**	-0.069**	-0.047
	(0.022)	(0.035)	(0.030)
Mean control group	0,251	0,220	0,272
Observations	1652	644	1008

Note: Sample of individuals aged 18-32 at baseline. Panel A: Point estimates, standard errors, and average standardized effect are derived from a seemingly unrelated regression system of the variables in columns 1-4. "Number of partners last 4 months" is the number of sexual partners the respondent reported to have during the last 4 months; "Condom used last intercourse" is a indicator variable equal to 1 if the respondent reported using a condom last intercourse, 0 otherwise (restricted to individuals reported to have had sex in the last 4 months); "High Likelihood last partner HIV+" is a indicator variable equal to 1 if the respondent answered "very likely" or "likely" to the question: "What do you think is the likelihood that your last partner was infected with HIV?", 0 otherwise (restricted to those that reported to have had sex during the last 4 months) ; "Extramarital sex" is a binary variable equal to 1 if the respondent reported that the last sexual intercourse was not with spouse/cohabiting partner (restricted to married or cohabiting individuals reporting to have had sex during the last four months). "Practice safe sex" is the average standardized effect of the four estimates in panel A, reversing the sign of "Number of partners last 4 months", "High likelihood last partner HIV+", and "Extramarital sex". Panel B: OLS regressions. "Births or current pregnancy" is an indicator variable for whether the women had given birth in the last 4 months or was currently pregnant. Any lottery is high and low lottery combined. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 7. Heterogeneous treatment effects - HIV incidence: Risk preferences

Sample	HIV incidence									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Any lottery×Risk-lover			-0.110***				-0.099**		-0.095**	
			(0.038)				(0.037)		(0.036)	
Risk-lover	0.115***	-0.012	0.105***				0.097***		0.092**	
	(0.042)	(0.026)	(0.036)				(0.034)		(0.034)	
Any lottery×Risk coefficient						0.133**		0.119**		0.114**
						(0.055)		(0.055)		(0.055)
Risk coefficient				-0.139**	0.025	-0.117**		-0.106**		-0.101**
				(0.054)	(0.027)	(0.049)		(0.048)		(0.048)
Any lottery			-0.000			-0.072***	-0.003	-0.067***	0.177	0.113
			(0.018)			(0.024)	(0.018)	(0.023)	(0.136)	(0.141)
Sample	Control	Treatment	All	Control	Treatment	All	All	All	All	All
Mean group of risk-averse	0.095	0.095	-	-	-	-	-	-	-	-
Mean control group	-	-	0.129	-	-	0.129	0.129	0.129	0.129	0.129
Baseline controls	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Baseline control×treatment	No	No	No	No	No	No	No	No	Yes	Yes
Observations	535	824	1359	535	824	1359	1359	1359	1359	1359

Note: Sample of individuals aged 18-32 at baseline. "Risk lover" is a binary variable taking the value 0 for respondents who preferred a fixed amount of money below the expected value of 250 Maloti instead of a lottery with 50% chance of winning 500 maloti and 1 otherwise. Risk coefficient is deduced from the MPL question and assuming a CRRA utility function (see main text for details). The control variables are STI status at baseline and all household characteristics listed in panel B, table 2. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 8. Heterogeneous treatment effects - STI prevalence: Risk preferences

Sample	STI prevalence									
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Any lottery×Risk-lover			-0.021*				-0.021		-0.018	
			(0.012)				(0.013)		(0.014)	
Risk-loving	0.036**	0.008	0.031**				0.031**		0.028**	
	(0.014)	(0.005)	(0.011)				(0.012)		(0.012)	
Any lottery×Risk coefficient						0.038*		0.038*		0.035
						(0.020)		(0.020)		(0.022)
Risk coefficient				-0.056**	-0.008	-0.049**		-0.048**		-0.046**
				(0.021)	(0.006)	(0.019)		(0.020)		(0.021)
Any lottery			-0.020*			-0.037***	-0.021**	-0.037***	0.034	0.014
			(0.010)			(0.011)	(0.010)	(0.011)	(0.048)	(0.047)
Sample	Control	Treatment	All	Control	Treatment	All	All	All	All	All
Mean group of risk-averse	0.022	0.000	-	-	-	-	-	-	-	-
Mean control group	-	-	0.032	-	-	0.032	0.032	0.032	0.032	0.032
Baseline controls	No	No	No	No	No	No	Yes	Yes	Yes	Yes
Baseline control×treatment	No	No	No	No	No	No	No	No	Yes	Yes
Observations	638	982	1,620	638	982	1,620	1,620	1,620	1,620	1,620

Note: Sample of individuals aged 18-32 at baseline. See notes to table 5 for definition of STI prevalance. “Risk lover” is a binary variable taking the value 0 for respondents who preferred a fixed amount of money below the expected value of 250 Maloti instead of a lottery with 50% chance of winning 500 maloti and 1 otherwise. Risk coefficient is deduced from the MPL question and assuming a CRRA utility function (see main text for details). The control variables are STI status at baseline and all household characteristics listed in panel B, table 2. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table 9. Effects of the lottery incentive intervention one year after the intervention ended

Dep variable	HIV incidence	HIV prevalence
Years	2013	2011-2013
	(1)	(2)
Any lottery	-0.002	-0.038**
	(0.008)	(0.019)
Mean control group	0.051	0.320
Observations	2171	2783

Note: OLS regressions. Sample of individuals aged 18-32 at baseline and tested at 24 and 36 months. HIV incidence: Dependent variable equal to one if the individual tested HIV negative at 24 months and HIV postive at 36 months, and zero if the individual test HIV negative after 24 and 36 months. HIV prevalence: Dependent variable equal to one if the individual tested HIV positive at baseline or least twice after 16, 20, 24 or 66 months, and zero if the individual test HIV negative after 36 months. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Incentivizing Safer Sexual Behavior

Supplementary Appendix

Tables

Table A1. STI as marker for risky sexual behavior and HIV

	HIV prevalence	Extramarital sex last intercourse	Condom used last intercourse	N. of partners in lifetime	High likelihood HIV last partner	Practice safe sex
	(1)	(2)	(3)	(4)	(5)	(6)
STI positive at baseline	0.205***	0.038	- 0.063**	0.161	0.085***	-0.143***
	(0.029)	(0.030)	(0.030)	(0.137)	(0.024)	(0.033)
Mean: STI negative- at baseline	0.139	0.125	0.355	2.124	0.126	
Observations	3029	1326	1836	2987	1832	3021

Note: Baseline data. See table 2 for definitions of the variables. Point estimate and standard error in column (1)-(5) is from an OLS model. "Practice safe sex" in column (6) is the average standardized difference derived between STI+ and STI- individuals in "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime" and "High likelihood HIV last partner". Robust standard errors clustered at the village level in parentheses. *** 1% , ** 5% , * 10% significance.

Table A2. Effects of the lottery incentive intervention on HIV incidence: Adjusted OR and RR

	Intervention group	Control group	Adjusted OR (95% CI)	Adjusted relative risk (95% CI)
Combined intervention group				
HIV incidence	140/1476 (9.5%)	111/946 (11.7%)	0.76 (0.61-0.95)	0.79 (0.65-0.96)
High lottery arm				
HIV incidence	68/785 (8.7%)	111/946 (11.7%)	0.69 (0.51-0.93)	0.72 (0.55-0.94)
Low lottery arm				
HIV incidence	72/691 (10.4%)	111/946 (11.7%)	0.87 (0.66-1.15)	0.89 (0.70-1.13)

Note: Data are n/N (%) at 24 months. Confidence intervals are constructed using robust standard errors clustered at the village level. Adjusted odds ratios (OR) calculated with a logistic regression model of individual data with independent variables that include treatment status and indicators for geographical area (villages). Adjusted relative risks (RR) is estimated using the marginal standardization technique with the 95% CIs estimated with the delta method (Norton et al, 2013).

Table A3. Lee bounds: HIV incidence

	(1)	(2)
Any lottery l. bound	-0.038***	
	(0.013)	
Any lottery h. bound	-0.021*	
	(0.013)	
High lottery l. bound		-0.048***
		(0.017)
High lottery h. bound		-0.029**
		(0.015)
Low lottery l. bound		-0.025
		(0.018)
Low lottery h. bound		-0.012
		(0.016)

Note: Sample of HIV negative individuals aged 18-32 at baseline. See table 4 for details. Lee bounds (upper and lower) are bounds on the coefficients in table 4 using the procedure proposed by Lee (2009). Standard errors in parentheses are bootstrapped and account for village level clustering. *** 1% , ** 5% , * 10% significance.

Table A4. Effects of the lottery incentive intervention on HIV incidence and prevalence by gender

Panel A: Women

	HIV incidence				HIV prevalence	
	OLS	Probit	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.037***	-0.038***			-0.038**	
	(0.013)	(0.013)			(0.017)	
High lottery			-0.045***	-0.048***		-0.041*
			(0.016)	(0.017)		(0.022)
Low lottery			-0.027	-0.027		-0.034
			(0.020)	(0.019)		(0.021)
Mean control group	0.153	0.153	0.153	0.153	0.326	0.326
P-value (T_H=T_L)			0.437	0.396		0.785
Observations	1592	1592	1592	1592	1985	1985

Panel B: Men

	HIV incidence				HIV prevalence	
	OLS	Probit	OLS	Probit	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)
Any lottery	-0.003	-0.003			-0.031	
	(0.014)	0.018			(0.030)	
High lottery			-0.009	-0.013		-0.045
			(0.015)	(0.021)		(0.034)
Low lottery			0.003	0.007		-0.015
			(0.019)	(0.023)		(0.032)
Mean control group	0.045	0.045	0.045	0.045	0.137	0.137
P-value (T_H=T_L)			0.516	0.455		0.262
Observations	830	635	830	635	903	903

Note: See note to table 4. All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table A5. Effects of the lottery incentive intervention on STI prevalence by gender

Panel A: Women				
	(1)	(2)	(4)	(5)
Any lottery	-0.040***	-0.039***		
	(0.013)	(0.013)		
High lottery			-0.043***	-0.042***
			(0.013)	(0.013)
Low lottery			-0.036***	-0.036***
			(0.013)	(0.013)
Mean control group	0.046	0.046	0.046	0.046
Control STI status baseline	No	Yes	No	Yes
P-value (T_H=T_L)			0.18	0.18
Observations	1982	1982	1982	1982
Panel B: Men				
	(1)	(2)	(4)	(5)
Any lottery	-0.013*	-0.014*		
	(0.007)	(0.007)		
High lottery			-0.011	-0.012
			(0.008)	(0.008)
Low lottery			-0.016**	-0.016**
			(0.007)	(0.007)
Mean control group	0.017	0.017	0.017	0.017
Control STI status baseline	No	Yes	No	Yes
P-value (T_H=T_L)			0.20	0.30
Observations	902	902	902	902

Note: See note to table 5. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.

Table A6. MPL design

Task	Lottery: Safe option	Lottery: Risky option	EV^{safe}	EV^{risky}	CRRA ranges	midpoint *r*
1	0	0.5 of 500; 0.5 of 0	0	250	.	.
2	25	0.5 of 500; 0.5 of 0	25	250	r > 0.77	0,77
3	50	0.5 of 500; 0.5 of 0	50	250	0.70 < r < 0.77	0,73
4	75	0.5 of 500; 0.5 of 0	75	250	0.63 < r < 0.70	0,67
5	100	0.5 of 500; 0.5 of 0	100	250	0.57 < r < 0.63	0,60
6	125	0.5 of 500; 0.5 of 0	125	250	0.50 < r < 0.57	0,53
7	150	0.5 of 500; 0.5 of 0	150	250	0.42 < r < 0.50	0,46
8	175	0.5 of 500; 0.5 of 0	175	250	0.34 < r < 0.42	0,38
9	200	0.5 of 500; 0.5 of 0	200	250	0.24 < r < 0.34	0,29
10	225	0.5 of 500; 0.5 of 0	225	250	0.13 < r < 0.24	0,19
11	250	0.5 of 500; 0.5 of 0	250	250	0 < r < 0.13	0,07
12	275	0.5 of 500; 0.5 of 0	275	250	-0.16 < r < 0	-0,08
13	300	0.5 of 500; 0.5 of 0	300	250	-0.36 < r < -0.16	-0,26
14	325	0.5 of 500; 0.5 of 0	325	250	-0.61 < r < -0.36	-0,48
15	350	0.5 of 500; 0.5 of 0	350	250	-0.94 < r < -0.61	-0,78

Note: For each decision row (task), respondents were asked to choose between a safe option (a certain amount) or a risky lottery. EV^{safe} is the expected value of the safe option and EV^{risky} is the expected value of the risky lottery. All prizes and values are in expressed in Maloti (10 Maloti is approximately $1). CRRA ranges are constructed following the discussion in Andersen et al. (2008) and *r* is the CRRA risk coefficient.

Table A7. Baseline characteristics of the risk loving vs risk-averse participants

	Risk lover	Risk averse	Difference	P-value
Panel A: Biomarkers				
HIV positive	0,192	0,154	0,038	0,032
STI positive	0,169	0,138	0,030	0,165
Panel B: Household Characteristics				
Female	0,686	0,671	0,015	0,615
Age	23,6	23,3	0,300	0,064
Single	0,490	0,488	0,002	0,949
No education	0,013	0,011	0,002	0,676
Primary education	0,438	0,470	-0,032	0,206
Some secondary education	0,400	0,401	-0,001	0,970
Durable goods	3,137	2,969	0,168	0,013
Panel C: Sexual behavior				
Extramarital sex last intercourse	0,140	0,111	0,029	0,418
Condom used last intercourse	0,427	0,342	0,085	0,081
N. of partners in lifetime	2,46	1,96	0,500	0,000
High likelihood HIV last partner	0,167	0,133	0,034	0,245
Practice safe sex (difference)			-0.072	0.076
			(0.041)	

Note: Sample of individuals aged 18-32 at baseline who responded to the hypothetical risk aversion question. Mean outcomes for the sample of risk loving and risk-averse individuals. Individuals are "Risk loving" if, at baseline, they preferred a lottery with 50% chance of winning 500 Maloti instead of a fixed amount of money above the expected value of 250 Maloti. Individuals are "Risk-averse" if, at baseline, they preferred a fixed amount of money less than 250 maloti instead of a lottery with 50% chance of winning 500 Maloti. The P-values for the null hypothesis that the means are equal are calculated using village-clustered standard errors. See table 2 for variables' definition. "Practice safe sex" is the average standardized difference between risk-loving and risk-averse individuals in "Extramarital sex last intercourse", "Condom used last intercourse", "N. of partners in lifetime", and "High likelihood HIV last partner", reversing the sign of "Extramarital sex", "N. of partners in lifetime", and "High likelihood HIV last partner".

Table A8. Robustness check on measure of risk attitudes

	HIV incidence				
	(1)	(2)	(3)	(4)	(5)
Any lottery×Risk-lover			-0.056**	-0.049*	-0.047*
			(0.024)	(0.025)	(0.024)
Risk-lover	0.037*	-0.018	0.038**	0.034*	0.033*
	(0.019)	(0.023)	(0.017)	(0.017)	(0.017)
Any lottery			0.013	0.010	0.022
			(0.019)	(0.019)	(0.137)
Sample	Control	Treatment	All	All	All
Mean group of risk-averse	0.087	0.103	-	-	-
Mean control group	-	-	0.112	0.112	0.112
Baseline controls	No	No	No	Yes	Yes
Baseline control×treatment	No	No	No	No	Yes
Observations	922	1427	2349	2349	2349

Note: See notes to table 7. Sample includes all respondents of the MLP question including those that always chose the safe option (coded as risk-averse, 0) and respondents always choosing the risky option (coded as risk-lovers , 1). All regressions include village fixed effects. Robust standard errors in parentheses, clustered at the village level. *** 1% , ** 5% , * 10% significance.