The Benefits of Knowledge: Mortality Expectations and Sexual Behavior*

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Abstract

Many individuals in low-income settings are overly pessimistic about their own survival, suggesting that better knowledge about survival risk might encourage human capital investment. This paper provides evidence from a randomized controlled trial that provided mature adults with information about population-level mortality in Malawi. Treated individuals are less likely to engage in risky sexual practices one year after the intervention compared to the control group: we find a 19% reduction in the propensity to have multiple partners without condom and a 8% increase in abstinence. These results in isolation would have led us to conclude that more accurate expectations about own survival risk provides incentives for safe sex practice. However, the availability of subjective expectations data reveal a rather different and more complex picture. We find no treatment effect on own survival expectations, but a positive treatment effects on the survival of others, in particular HIV+ individuals. This discrepancy is consistent with a situation in which individuals have private information about their own survival, making expectations about own survival less responsive to new information. The change in risky sex we uncover appears to be driven by the perception that HIV+ people live longer, making the pool of potential partners riskier, as there is a positive treatment effect on the subjective probability of contracting HIV associated with multiple sex partners.

Keywords: Mortality, Subjective expectation, HIV/AIDS, sexual behavior

JEL Codes: I12, J10, C8

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1 Introduction

Theory predicts that improvements in life expectancies encourage human capital investment, as individuals can reap the returns for a longer period (e.g., Ben-Porath [1967]). Life expectancy has increased dramatically in low-income countries recently, even in high HIV-prevalence sub-Saharan African (SSA) countries where previous HIV/AIDS-related adverse trends in adult survival have been reversed (Figure 1A). Despite these improvements, there is evidence that currently many individuals are overly pessimistic about their own survival. For example, mature adults in the Malawi Longitudinal Study of Families and Health (MLSFH) report subjective probabilities of surviving for the next 5 years of about 46–58%, compared to 83–87% suggested by current life-tables [UN Population Division, 2012]. Similar findings emerge in India [Delavande et al., 2017]. This suggests that providing information about survival risk has the potential to increase human capital investment in low-income settings. To date however, we know very little about whether better knowledge about recent gains in health and survival can change individuals' decision-making. In this paper, we investigate the impact of a randomized information intervention about population-level mortality on individuals' choices, with a particular focus on risky sex in SSA. Crucially, we have very detailed information on individuals' subjective expectations about their survival and other important events, which allows us to study the mechanism through which the intervention influences decisions.

In an earlier study [Delavande and Kohler, 2016], we find that subjective expectations about survival, transmission risk and HIV status play an important role in determining the decision to have multiple sexual partners in a high-HIV prevalence environment like Malawi. When simulating the impact of various policies, we show that an information campaign leading individuals to have accurate mortality risk perception would decrease risky sexual behavior on average, whereas accurate beliefs about HIV transmission risks, which tend to be largely overestimated, would actually increase risky sex. Motivated by these findings, we implemented an intervention in rural Malawi that provided mature adults (persons aged 45+) information about population mortality risk using a randomized controlled trial (RCT) design. The intervention had two components. First, respondents watched three videos delivering the narrative that people nowadays live longer in Malawi with an explanations for these gains (e.g., better access to healthcare, availability of Anti-Retroviral Therapy (ART), fewer food shortages). Second, they received visual statistical information about the survival risk of individuals of the same age and sex.

We find a positive effect of the intervention on sexual behavior: treated individuals are less likely to engage in risky sexual practices one year after the intervention compared to the control group. The magnitude of the effect is rather large. For example, the predicted probability of having multiple partners without condom is 7.6% in the control group and 6.4% in the treatment group, i.e. a 19% reduction in the riskiest behavior in terms of HIV transmission. Similarly, the predicted probability of not having sex is 33.3% in the control group and 36.1% in the treatment group, i.e. a 8% increase in the safest behavior. We also find a positive treatment effect on the probability of being married among respondents who were not married as baseline. In this context, marriage is often seen as a risk prevention strategy (e.g., Greenwood et al. [2019]). Looking at the effect of the intervention beyond sexual behavior, we find a positive treatment effects on agricultural inputs (equipment, seeds and fertilizers) as well as livestock.

These interesting results in isolation would have led us to conclude that providing information on population mortality risk is a useful policy tool in the SSA context to curtail the HIV epidemic, as it provides incentives for individuals to engage in safe sex practice; surely driven by more accurate expectations about their own survival risk and the associated motivation to maintain an HIV-negative status. However, our unique subjective expectations data reveal a rather different and more complex mechanism through which the information we provided impacted behavior.

As part of our data collection, we elicited from respondents subjective expectations about their own survival (i.e., the probability that they will be alive in 5 years) as well as "population" survival (i.e., the probability that a hypothetical individual of their age and sex in their context will be alive in 5 years) for different health status (e.g. healthy, HIV+). Central to this research is our ability to measure subjective survival probabilities in a low income country. There has been a growing recent literature on the elicitations of probabilistic beliefs in developing countries (reviewed by [Delavande, 2014a, Delavande et al., 2011]). The dominant conclusion is that respondents are willing to provide expectations in probabilistic formats (often with visual aids, such as those developed for the MLSFH by Delavande and Kohler [2009]), that response rates are typically very high, that the vast majority of respondents respect basic properties of probabilities, that expectations vary with characteristics in the same way, at least qualitatively, as actual outcomes vary with those characteristics, that past outcomes experienced by individuals are correlated with expectations about future outcomes, and that the elicited expectations influence behavior in various domains including health, education, agricultural production and migration.

We find a positive treatment effect of the intervention on population survival expectations one year after the intervention. There is a 6.5% increase in the subjective probability that a healthy individual will survive in 5 years – for a baseline survival expectations of 70%. The magnitude of the effect is similar when looking at the survival expectations for hypothetical individuals who are HIV+ (7.9%), and individuals who are sick with AIDS but on ART (6.4%). There is no treatment effect on the survival expectations for individuals sick with AIDS and are untreated, which is consistent with the intervention convening the importance of ART in improving life expectancy in Malawi. This finding is important and highlights that individuals were able to understand, process and memorize the information we provided. Note that the direction and magnitude of the updating is similar regardless of individuals' prior expectations, which suggests that the narratives delivered by the videos, rather than the precise statistical information, was instrumental in the updating process. So far, so good, as we anticipated our intervention to change these population survival expectations.

However, and contrarily to our priors, the intervention was *not* effective at changing *own* survival expectations, both in the very short-term (2 weeks after the intervention) in which no compensating behaviors driven by the new information could have occurred, as well as in the long-term (one year after the intervention). This null result holds even if we exclude respondents with accurate baseline expectations, or those for whom own survival expectations are different from their population survival expectations (and for whom the information may therefore be irrelevant to own survival). The updating of population survival expectations without updating of own survival expectations is consistent with a situation in which individuals have more private information about their own survival than about the survival of others, making expectations about own survival much less responsive to new information.

One important question remains: why did treated individuals change their behavior since they have not revised upward their own survival risk? The change in risky sex appears to be driven by the externalities of other people living longer. As highlighted earlier, we find that the intervention induced individuals to believe that HIV+ people live longer. This could lead them to infer that the pool of available partners is now riskier. Consistent with this explanation, there is a positive treatment effect on the subjective probability of contracting HIV conditional on having multiple sex partners. Simultaneously, there is no effect on the subjective beliefs related to the technology of HIV transmission, which corroborates the idea that the increase in the perceived transmission risk associated with risky sex is driven by an increase in the perceived HIV prevalence of potential partners. As for the agricultural investments, we speculate that the positive treatment effect is driven by an increase in the perceived survival of other household members who may therefore benefit from these investments for a longer period.

Overall, we conclude that providing information about recent gains in health and survival in SSA can lead to an increase in safe sex practice. However, the effect is not driven by a change in own survival risk, but rather by an upward revision of the HIV transmission risk associated with risky sex, which was already over-estimated to begin with, and that we

(A) 10-year survival probability (males, Malawi)

(B) MLSFH Subjective 5-year survival probabilities

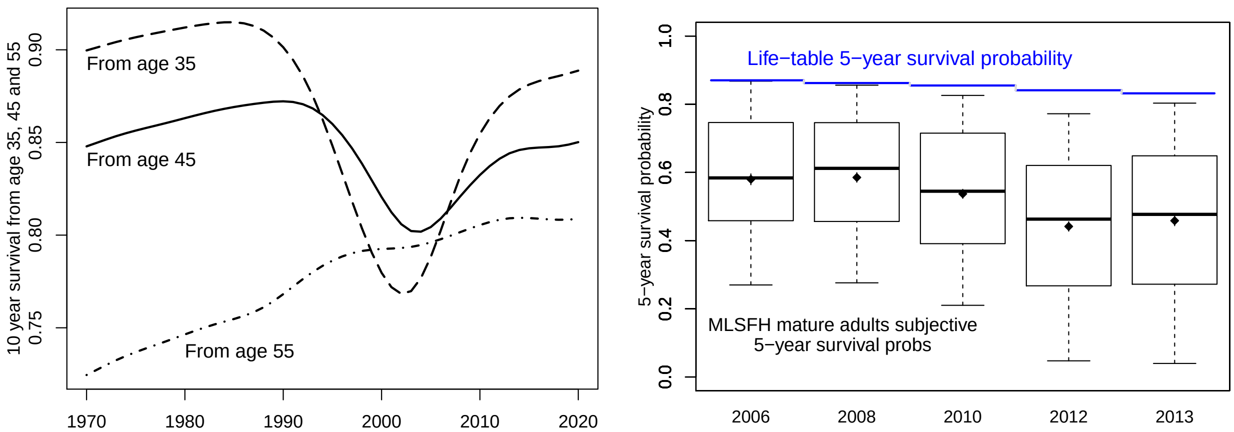


Figure 1: 10-year survival probabilities 1970–2020 (Malawi), and subjective prob. of surviving 5 years for MLSFH mature adults *Panel A:* Based on 2012 UN Word Population Prospects.[Kohler and Kohler, 2015, UN Population Division, 2012] *Panel B:* For MLSFH mature adults (aged 45+ in 2012) who participated in the 2012/13 MLSFH rounds. The boxplot-like graph displays the mean (dot) and median (center line) of the corresponding 5-year survival expectations, as well as the 10th (lower whisker), 25th (bottom of box), 75th (top of box), and 90th (upper whisker) percentiles of the distribution. [Delavande and Kohler, 2009, Kohler et al., 2015] Life-table survival probabilities are merged by age and gender from the UN Malawi 2005–15 lifetables.[UN Population Division, 2012]

did not set out to modify. Understanding the mechanisms of how our intervention changed behavior is made possible only by the availability of a unique and comprehensive set of expectations data. Our results underscore the usefulness of these types of data to better understand in many contexts why programs fail or succeed. More generally, better knowledge about recent gains in health and survival has the potential to change individuals' human capital in other contexts. The effects are likely to be larger if those investments can benefit others, as it is plausible that own survival expectations are less responsive to information in many environments as individuals have private information about their health status.

This paper contributes to the literature on information interventions directed to affect human capital investment. Providing information to students on the returns to education and financial aid has been found to have positive effects on effort, schooling outcomes, and applications to university [Bettinger et al., 2012, Dinkelman and Martínez A., 2013, Fryer, 2013, Hoxby and Turner, 2012, Jensen, 2010, Nguyen, 2008, Wiswall and Zafar, 2015][1]. Positive effects of information interventions have also been documented with respect to health

[1] The story is a little different in Dizon-Ross [2019] that in Malawi reports reduced investment in children whose parents learn of their low ability (and vice versa), which may be efficient but does not imply that more information increases school outcomes.

inputs and outcomes. Related to our context, studies like [Dupas, 2011] have shown that providing information on the relative risk of HIV infection by partner's age leads to decreases in teen pregnancy (a proxy for unprotected sex),that information about HIV status influences subsequent sexual behavior and marriage transitions [De Paula et al., 2014, Delavande and Kohler, 2012, Fedor et al., 2015, Thornton, 2008, 2012] and that circumcision uptake is affected by information about the reductions in HIV risk resulting from male circumcision [Chinkhumba et al., 2014, Godlonton et al., Forthcoming]. More generally, information-based public health campaigns have successfully influenced health behaviors in many important domains (e.g., smoking, blood pressure control, cholesterol consumption, condom use), but not all [Hornik, 2012]. We complement this line of work by focusing on new informational contents, gains in survival, and by providing unique evidence on how the information changes subjective expectations, which in turn change behavior. Our findings are also relevant for the design of information interventions in general, as it emphasizes that the elasticities of beliefs depend on the extent of private information.

This paper also belongs to a recent literature studying how subjective expectations change with randomly provided information, often within surveys that elicit priors and posteriors about economically salient outcomes such as fertility, future earnings, inflation or housing [Armantier et al., 2016, Armona et al., 2018, Delavande, 2008, Wiswall and Zafar, 2014]. The advantage of our current design is that we are able to observe the revised expectations one year after the provision of information -a time lag substantially larger than other studies- and to link the change in expectations to real-life behavior, as opposed to stated behavior or behavior in incentivized lab-style experiments. Our results call for encouragement and cautions: individuals in low income settings use the information we provided to make important lifecycle decisions, but not all expectations are equally malleable.

Our work also adds to a growing literature on the impacts of life expectancy on forward looking behavior that has mostly focused on human capital accumulation (e.g., Baranov and Kohler [2018], Baranov et al. [2015], Fortson [2011], Jayachandran and Lleras-Muney [2009], Oster [2012]). These papers find that actual gains in life expectancy translate in more investments in human capital. The underlying implicit assumption in this work, which we can relax in our application, is that individuals are aware of the actual gains in life expectancy.[2] Relatedly, some work has shown individuals' survival expectations impact health and retirement behavior (e.g., Delavande et al. [2006], Fang et al. [2007], Hurd et al. [2004]), sometimes using an instrumental variable approach to address the potential endogeneity of expectations, as opposed to experimental variation as we do here.

[2] An exception is Baranov and Kohler [2018] and Baranov et al. [2015] who use the same dataset as we do and exploit the roll-out of ART in Malawi.

2 Data

Our analyses are based on the Mature Adult Cohort (MLSFH-MAC) which is part of the Malawi Longitudinal Study of Families and Health (MLSFH). Malawi is a landlocked country in Africa and one of the poorest in the world. GDP per capita in 2017 was 4% of the world average. HIV/AIDS is widespread in Malawi (Malawi DHS [2011]), and access to ART, reaching 67% coverage in 2010, is expanding (Baranov et al. [2015]). Yet, despite the magnitude of the epidemic, the vast majority of the population, more than 85% of adults aged 15–49, and higher among adults aged 50+ (Freeman and Anglewicz [2012], Payne et al. [2013]), is HIV negative. Life expectancy at birth was 51 for men and 55 for women in 2010, and healthy life expectancy was 7–8 years more (Salomon et al. [2012]).

2.1 Malawi Longitudinal Study of Families and Health (MLSFH)

The MLSFH is one of very few long-standing publicly-available cohort studies in a SSA LICs context with currently ten data collection rounds during 1998–2018 for up to 4,000 individuals. The MLSFH cohorts were selected in 1998 (with important additions in 2004 and 2008) to represent the rural population. A Cohort Profile Kohler et al. [2015] provides information on sampling procedures, analyses of attrition, survey methods and instruments. The survey operates in three regions: one in the North (Rumphi), one in the Center (Mchinji) and one in the South (Balaka). Mortality levels among MLSFH respondents, including their recent reversal, correspond to those of the overall population (Payne and Kohler [2015]). Prospective longitudinal data in the MLSFH 1998–2018 include household structure and family change, human capital, sexual behaviors, well-being, and household production and consumption. The study has included probabilistic expectations, i.e. expectations that can be interpreted as probabilities, for health-related outcomes since 2006. HIV testing and counseling has been done repeatedly since 2004.

Starting from 2012, the MLSFH focused on mature adults, that is, all MLSFH respondents aged 45 and older. The MLSFH-MAC includes four rounds of data collected in 2012, 2013, 2017 and 2018. Most of these respondents participated in the 2012 ($N = 1,266$) and 2013 ($N = 1,257$) MLSFH mature adult surveys, and MLSFH respondents who reached age 45 by 2017 were additionally enrolled. Data on mature adults includes a cognitive skills module and extensive information on mental health. The 2017 wave of the MLSFH-MAC serves as the baseline for our intervention.

2.2 Subjective Expectations

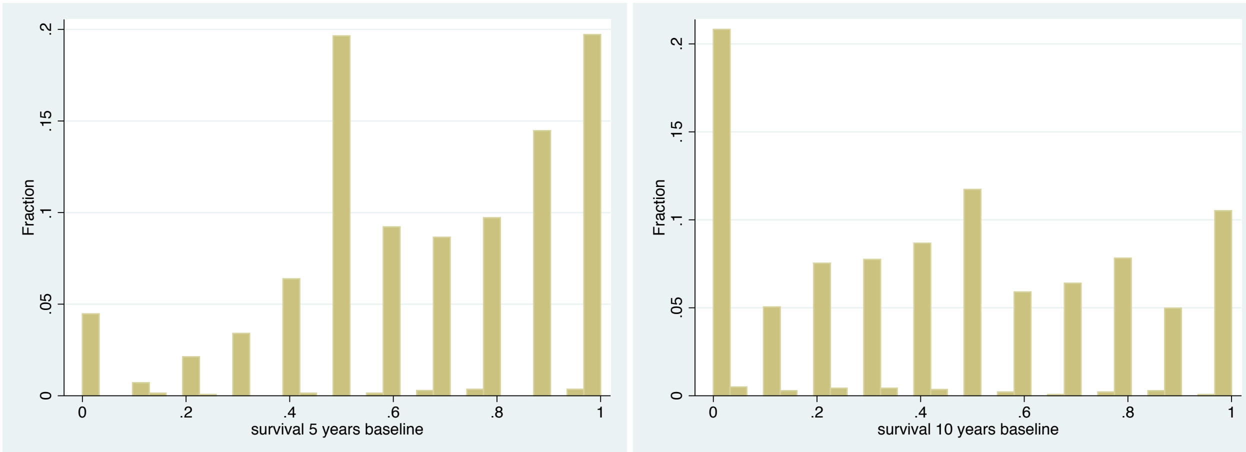
One important component of the MLSFH is the elicitation of subjective expectations. As detailed in Delavande and Kohler [2009], respondents are asked to allocate up to ten beans on a plate to express the likelihood that an event will be realized. As an innovation from the earlier methodology, bean could be split in half to allow respondents to report more precise beliefs.

Survival expectations: Respondents are asked to report their probability that they would die within a 5-year and 10-year time horizon ("*Pick the number of beans to express the likelihood that you will die with a 5-year [10-year] period beginning today.*"). They are also asked about population mortality expectations, i.e. the 5-year mortality risk of the following four hypothetical individuals: (i) a woman/man of the respondent's age who is healthy and does not have HIV; (ii) a woman/man of the respondent's age who is infected with HIV; (iii) a woman/man of the respondent's age who is sick with AIDS and (iv) a woman/man of the respondent's age who is sick with AIDS and is treated with ART. The gender used in the scenarios was the same as that of the respondent. Finally, the survey asks the probability of an individual of their gender dying in 5 years not conditional on a specific health status. In the rest of the paper, we transform those mortality expectations elicited with beans into *own survival* probabilities and *population survival* probabilities (i.e., we use (10-expectation)/10).

HIV-related expectations: Respondents are also asked several HIV-related expectations such as the probability of being currently infected with HIV, the probability that their spouse is currently infected with HIV, and (before 2012) the probability of becoming infected with HIV within the next 12 months conditional on various sexual behavior (if married to someone who is infected with HIV/AIDS; if one has several sexual partners in addition to spouse). Appendix A details the exact wording of the questions.

2.3 Sexual behavior

Another important aspect of the MLSFH is that it includes detailed information on sexual behavior, including having sex in the last 12 months, the number of sexual partners in the last 12 months and whether condom was used in the last intercourse. Using those variables, we define three different variables capturing sexual activities, with increasing levels of riskiness: *Sex 1*: Not sexually active in the last 12 months, sexually active in the last 12 months; *Sex 2*: Not sexually active in the last 12 months, sex with spouse only, sex with multiple partners; *Sex 3*: Not sexually active in the last 12 months, sex with spouse only, sex with multiple partners and condom at last intercourse, sex with multiple partners and no condom at last intercourse. We use self-reported behavior, which may suffer from reporting biases. In a



(a) 5 years

(b) 10 years

Figure 2: Subjective survival probabilities at baseline. Figure (a) shows a histogram of the 5-year own subjective survival probability at the 2017 baseline. Figure (b) shows a histogram of the 10-year own subjective survival probability at the 2017 baseline.

subsample of the MLSFH adolescents, sexually transmitted infection (STI) status (which was collected in 2004) and self-reported behavior have been found to be positively correlated (Mensch et al. [2008]).

2.4 Descriptive statistics

Summary statistics of the 2017 MLSFH mature adult study population at baseline are provided in Columns 1 and 2 of Table 1. Respondents are 59 years old on average, 60% of them are female[3] and 70% have at least some level of schooling.

On average, respondents expect to have a 67% chance of surviving in the next 5 years, and a 44% chance of surviving in the next 10 years. They also expect a hypothetical healthy individual to have a 70% chance to survive in the next 5 years, compared to 62% for someone who is HIV+, 49% for someone who is sick with AIDS and 57% for someone who is treated with ART. Figure 2 shows the distribution of own survival probabilities at baseline for the 5-year and 10-year time horizon. There is substantial variation in survival probabilities with answers taking all values between 0 and 1, and some bunching at 0.5 and 1 for the 5-year horizon, and 0 and 0.5 for the 10-year horizon. Few respondents took advantage of the possibility to split the bean (less than 3%). Interestingly, the panel nature of the data allows us to establish that own survival probability is a good predictor of actual survival.

[3]The higher presence of females in the sample has to do with the original survey design. In the first round of the survey in 1998, the researchers over-sampled females because they were particuarly interested in fertility.

The percentage of respondents dead by 2017 among those who were interviewed in 2010 is clearly a negative function of the 2010 subjective survival probabilities (Figure C.1). Similar findings have been reported in the US (Delavande and Rohwedder [2011]). This suggests that individuals take into consideration factors that are predictive of actual mortality when formulating their survival expectations.

Regarding sexual behavior, Table 1 show that 36% of the respondents did not have sex in the last 12 months, while 49% had sex with their spouse only. Fifteen percent had sex with multiple partners. Condom use is generally quite low (less than 2% used condom and had sex with multiple partners). The HIV prevalence in this sample is 7.5%.

	All					HIV-		
	mean	obs	control	treated	p-val	control	treated	p-val
Age	59.123	1481	58.802	59.450	0.300	59.308	59.890	0.384
Male	0.400	1481	0.400	0.400	1.000	0.405	0.393	0.653
Years of schooling	3.542	1481	3.489	3.596	0.547	3.526	3.600	0.694
Cognitive score	20.326	1481	20.216	20.438	0.415	20.154	20.285	0.651
HIV+	0.075	1442	0.063	0.087	0.088			
Expectations								
Own survival (5 yrs)	0.670	1410	0.669	0.670	0.964	0.673	0.677	0.763
Own survival (10 yrs)	0.441	1407	0.436	0.446	0.577	0.441	0.451	0.586
Pop. survival (healthy)	0.700	1444	0.707	0.694	0.321	0.710	0.699	0.399
Pop. survival (HIV+)	0.620	1439	0.631	0.609	0.093	0.637	0.616	0.123
Pop. survival (AIDS)	0.492	1439	0.502	0.481	0.212	0.509	0.487	0.195
Pop. survival (ART)	0.569	1439	0.577	0.561	0.266	0.584	0.566	0.275
Pop survival (uncond)	0.690	1463	0.688	0.692	0.746	0.690	0.692	0.859
HIV probability	0.186	1469	0.171	0.201	0.022	0.146	0.159	0.253
HIV probability spouse	0.182	1354	0.169	0.195	0.064	0.153	0.164	0.387
Sexual behavior								
no sex	0.355	1481	0.342	0.368	0.294	0.340	0.374	0.195
single partner	0.569	1481	0.576	0.562	0.583	0.579	0.564	0.586
multiple partners, condom	0.012	1481	0.015	0.010	0.366	0.010	0.006	0.405
multiple partners, no condom	0.063	1481	0.067	0.060	0.591	0.070	0.055	0.255

Table 1: Descriptive statistics by treatment status and p-value for difference The table presents summary statistics for the main variables used in the empirical analysis for the whole sample and separately by treatment group and by HIV status. The variables refer to the 2017 baseline survey. Control and treatment show the mean for the control and the treatment group. P-val shows the p-value of a t-test where the null hypothesis is that the difference in means between treatment and control group is zero. The first five coulmns refer to the whole sample while the last 3 refer to those tested negative for HIV during the HTC.

3 Information Intervention

We implemented in 2017 a *Benefits-of-Knowledge Health-Information* intervention. The information intervention randomized 50% of the study population in a treatment group that received detailed information about recent mortality trends. Randomization was at the village-level for logistical reasons and to avoid spill-over effects between treatment and control group. At the randomization stage, we ordered villages by size in each of the 3 regions and then we paired the first two villages, the third and fourth village and so on. Then we randomly assigned treatment status to one village in each pair. The procedure guaranteed a similar sample size in the treatment group ($N = 779$) and control group ($N = 774$). Migrant respondents at baseline, i.e. those who moved from the original village in which they were inittially surveyed, were excluded from the intervention sample.

The health-information intervention was implemented subsequent to the 2017 MLSFH survey. A well-trained survey team returned to MLSFH mature adults surveyed in 2017 and residing in treatment villages within two weeks from the day the respondent was surveyed by the main MLSFH questionnaire team. The response rate for the intervention was more than 98% with 770 respondents that completed the intervention survey. After the information intervention, a HIV Testing and Counselling (HTC) team visited the respondents to give them the opportunity to be tested for HIV[4]. Own survival expectations were elicited again from control and treated group at that visit. As discussed in Section 4, the revelation of the HIV status give us the opportunity to investigate the treatment effect of own expectations conditional on HIV status, a variable we have not directly elicited. A year after, the 2018 MLSFH round provides follow-up data including information on survival expectations and sexual behavior.

For our analysis, we exclude individuals assigned to the treatment group who did not receive the intervention. We end up with 1,481 respondents who completed all the required surveys (the 2017 and 2018 surveys and the intervention if in treatment group). Attrition from 2017 to 2018 was less than 5%, and attrition rates are similar by treatment status.[5] Figure 3 shows the timeline of the surveys we use, including information on sample size and key variables collected.

[4]In 2013 and 2017, the HTC team also screened for blood pressure before the HIV test and for blood sugar a day after. Those who were measured with high blood pressure or high blood sugar were given a referral card for seeking care. Around 17% of the respondents received this card. The share of respondents who got the referral card for the first time in 2017 is not statistically different between treatment and control (a t-test for equality of the means gives a p-value equal to 0.19).

[5]Using a dummy equal to 1 if the respondent was interviewed in 2018, we ran a t-test to see if there was any difference between treatment and control and obtained a p-value of 0.15. The sample includes respondents interviewed in 2017, who were not migrants and were interviewed by the intervention team if part of the treatment group.

3.1 Intervention Design

The intervention was conducted with one respondent at a time in a one-on-one session. It started by reminding the respondent about the 5-year and 10-year own mortality expectations that s/he had reported in the 2017 interview a few days earlier and asking a few introductory questions. Appendix Table B1 shows that 45% of respondents reported noticing that people lived longer than they did five or 10 years ago. Among those, the most common reasons for these improvements were that AIDS treatment have become available nearby (44% of respondents) and that health services have improved (36%).

The information intervention had then two components:

1. Narratives provided by 3 videos. In those short videos, local people (i.e. trained actors reading a script we wrote) explained how they noticed people live longer nowadays in rural Malawi. The actors are mature adults chosen from villages similar to those of the respondents. The first video depicts a carpenter in his workshop, the second a woman with a sewing machine and the third an old man sitting in front of his house. The videos emphasize overall that people live longer due to better access to food, health care, and availability of ART.

2. Statistical information. Interviewers presented an information sheet with information on 5-year and 10-year survival probabilities for individuals the same age and gender of the respondent based on recent estimates for Malawi. Data on survival by age and gender in Malawi were retrieved by the Institute for Health Metrics and Evaluation which combines several sources of data including Demographic Health Surveys and Census[6]. Given the low level of education of the respondents, a visual aid was used to represent the mathematical survival probabilities (Figure B.1). The sheet first shows 10 men-like figures colored in blue that represent 10 persons, the same age and sex of the respondents that are alive today. The second figure has again 10 men but some are now partially or fully colored in red. The probability of dying in 5-years from now is represented by how many men-like figures are colored red out of 10 and the survival probability is represented by how many men-like figures are colored blue out of 10. The third figure represented the 10-year survival probabilities with the same technique.

The videos provide general information about the increasing survival trends taking place in Malawi together with their underlying mechanisms, while the statistical information delivers individual-specific (by age and gender) information about the magnitude of these changes. We include videos as there is evidence that narratives are a useful way to convey scientific

[6]Global Burden of Disease Collaborative Network. Global Burden of Disease Study 2016 (GBD 2016) Results. Seattle, United States: Institute for Health Metrics and Evaluation (IHME), 2017. Available from http://ghdx.healthdata.org/gbd-results-tool.

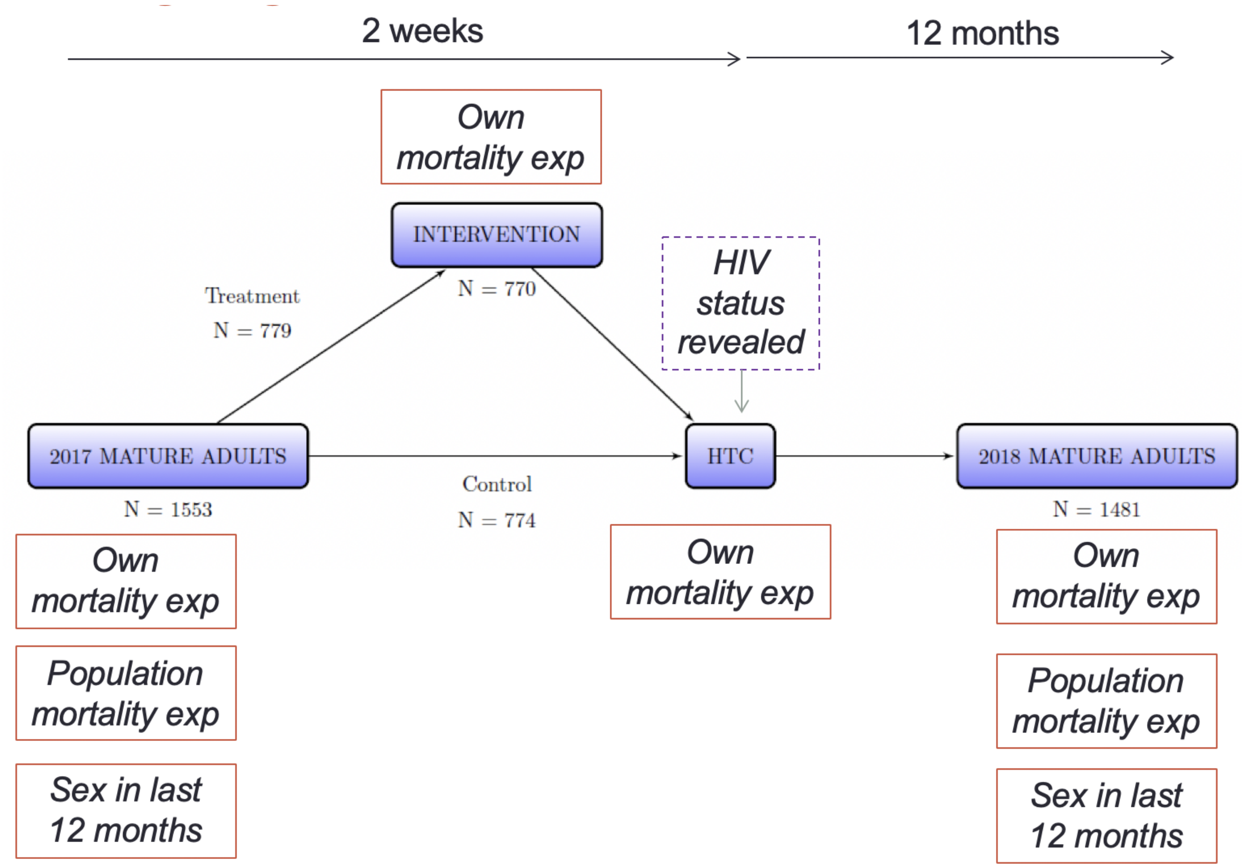


Figure 3: Research design The figure illustrates the timeline of the surveys. Red boxes show in which surveys the key variables of interest are asked. During the HTC (HIV Testing and Counseling) survey, individuals are tested for HIV.

information to non-experts by increasing comprehension, interest, and engagement (Bruner [2009]; Dahlstrom [2014]). There is further evidence that facts presented via narratives are more likely to be memorized (Schank and Berman [2002]; Avraamidou and Osborne [2009]). We use a visual format to convey the statistical information as visual aids have been generally useful to elicit probabilistic information in low-income contexts (Delavande [2014b]).

After providing the information, we asked several questions to verify whether respondents understood the information they received and elicited again their 5 and 10-years subjective mortality probabilities as well as population mortality probabilities. 94% of the respondents reported that the information we provided reflect correctly or somewhat correctly what happens to peopple of their age and sex in their communities. The appendix provides the heath-information sheets provided to respondents (figure B.1), the video scripts as well as the questionnaire guide that was used by interviewers. Table B.1 shows the survival probabilities we provided by age and gender. Tablets with *Redcap* software was used to administer the survey and to show the videos.

3.2 Balance at baseline

Columns 3 and 4 of Table 1 shows the average characteristics of respondents by treatment status. Overall, treatment and control groups are comparable. Importantly, own and population survival probabilities are very similar and the sample is well balanced on age, gender, sexual behavior, years of schooling and cognitive ability as measured by a modified version of the International Cognitive Assessment score adapted to a low schooling population[7]. HIV prevalence is slightly higher in the treatment group (8.7% versus 6.3%, statistically significant at the 10% level), and as a result we observe a slight imbalance in the subjective probability of being infected with HIV and also in the survival probability conditional on being HIV+. This is likely due to chance. When we restrict our analysis to individuals tested negative to HIV, all variables are well balanced including beliefs about HIV status and survival probability condotional on being HIV+ (columns 6 and 7 of Table 1). In most of our analysis, we show results for HIV- individuals as well as the entire sample.

4 Conceptual framework

In this section we provide a conceptual framework highlighting the potential implications for subjective beliefs and sexual behavior of the information intervention. Consider an individual living for three periods. In period 1, which is divided in four stages, the decision-maker is endowed with prior beliefs that may be updated upon receipt of new information (stages 0 to 2), and engages in sexual behavior a based on updated beliefs (stage 3). For tractability we consider two levels of sexual behavior: safe sex such as sex with spouse only, ($a = 0$) and risky sex, such as sex with extra-marital partners in addition to spouse, ($a = 1$). The decision-maker enjoys utility $V(a)$ in period 1. In period 2 and 3, the decision-maker makes no further decision and enjoys utility if still alive. The period 2 and 3 utility is health-dependent and equal to $U^- > 0$ if the individual is HIV- and $U^+ = U^- - c$, with $0 < c < U^-$, if the individual is HIV+. We explain below what happens at every period and then discuss the possible treatment effects.

4.1 Revision to expectations and decision-making

Period 1

Stage 0 (*Baseline*)

Each individual is endowed with a set of individual-specific subjective beliefs P_0 about:

[7]The assessment covers six cognitive domains: basic language ability, orientation, visual/constructional skills, attention/working memory, executive functions, and delayed memory recall.

- Survival to the next period: (*i*) own survival S_0^+ conditional on being currently HIV+ and own survival S_0^- conditional on being currently HIV-; (*ii*) population survival S_0^{pop+}conditional on being currently HIV+ and population survival S_0^{pop-}conditional on being currently HIV-.[8]

- HIV status and prevalence: (*i*) the probability f_0 of being currently infected with HIV; (*ii*) the probability f_0^s that the spouse/main partner is infected with HIV; (*iii*) HIV population prevalence f_0^{pop}.

- HIV transmission risks: (*i*) the probability $\pi_0(a)$ of becoming HIV+ in the next period associated with sexual behavior a; (ii) the probability Π_0 of contracting HIV if having regular sex with an HIV+ partner. The transmission risk $\pi_0(0)$ is a function of f_0^s and Π_0, while the transmission risk $\pi_0(1)$ may be a function of beliefs about the population HIV prevalence,which itself may depend on population survival conditional on being HIV+ and HIV- (e.g., HIV prevalence may be perceived to be higher for individuals who think HIV+ people live longer).

In a Bayesian set-up, an individual's own survival expectations S_0 is given by:

$$S_0 = f_0 S_0^+ + (1 - f_0) S_0^-.$$

It is useful to distinguish prior expectations Ψ_0 about outcomes for which the decision-maker has *no* control (e.g., population survival for HIV- individuals) versus prior expectations Θ_o about outcomes for which the decision-maker has *some* control (e.g., own HIV status which is influenced by past sexual behavior). This is because the revisions of expectations from the latter group will include feedbacks from individual behaviors. The set Ψ_0 includes beliefs about population survival conditional on various health status, the transmission risk associated with having extra-marital partners, and the transmission risk if having regular sex with HIV+ individuals. The set Θ_o includes beliefs about own survival, probability of being infected with HIV and probability of the spouse being infected with HIV.

Stage 1 (*Intervention Stage*)

Respondents allocated in the treatment group T received an information intervention that presents a general narrative that people live longer combined with precise statistical information about population survival (unconditional on HIV status). This information may have led individuals to revise any of the prior beliefs in the set P_0 to P_1^T. Because the

[8]We abstract from aging for simplicity so the subjective survival to the next period is the same in period 1 and in period 2.

information treatment took place a few days after the baseline, we assume that individuals in the control group did not update their beliefs between stages 0 and 1: $P_1^G = P_0$.

Stage 2 (*HTC stage*)

Respondents were provided with objective information about their HIV status. We assume respondents believe the HIV test result and update their probability of being infected with HIV accordingly, i.e. those who were told they are HIV- have $f_2 = 0$ while those who were told they are HIV+ have $f_2 = 1$. Individuals' own stage 2 survival expectations are therefore different by HIV status and given by:

$$\begin{array}{lcc} & \text{Treated} & \text{Control} \\ HIV- \;\text{ at stage 2:} & S_2^{-T} = S_1^{-T}; & S_2^{-C} = S_0^{-}; \\ HIV+ \;\text{ at stage 2:} & S_2^{+T} = S_1^{+T}; & S_2^{+C} = S_0^{+}; \end{array}$$

Stage 3 (*Sexual behavior*)

In stage 3 of period 1, individuals decide the sexual behavior a they will engage in for the remaining of the period. A decision-maker's expected lifetime utility at the end of stage 2 is given by:

$$V(a) + (1 - f_2)\, S_2^- \left[U^- + (1 - \pi_2(a))\left(S_2^- U^-\right) + \pi_2(a)\left(S_2^+ U^+\right)\right] + f_2 S_2^+ \left[U^+ + S_2^+ U^+\right].$$

In stage 3, a decision-maker will choose risk sex $a = 1$ if and only if the expected lifetime utility associated with risky sex is greater than that associated with safe sex, i.e. if and only if:

$$V(1) - V(0) + (1 - f_2)\, S_2^- \left(\pi_2(1) - \pi_2(0)\right)\left(S_2^+ U^+ - S_2^- U^-\right) > 0. \tag{1}$$

Risky sex may increase the direct pleasure from sex in period 1 but, by potentially increasing the (subjective) risk of becoming HIV-positive, it may also decrease the (subjective) probability of surviving to in the future, and therefore of enjoying future period utility at all, while also decreasing the probability of enjoying U^- rather than U^+.

Period 2

In period 2, the decision-maker revises his set of beliefs to P_3^T for the treatment group and P_3^C for the control group. Beliefs in the set Θ will be revised as a result of past behavior -which may vary by treatment status- as well as possible new information available to both treatment and control groups. For example, the probability of being infected with HIV, and hence own survival, may be updated as a result of stage 3 sexual behavior. Beliefs in the set Ψ may be updated by possible new information available to both treatment and control groups. The decision-maker enjoys the health-specific period 2 utility.

Period 3

In period 3, the decision-maker enjoys the health-specific period 3 utility.

4.2 Treatment effects

4.2.1 Treatment effects on revision to expectations

We are interested in the treatment effect of revision to expectations between time t and baseline (stage 0), i.e. $(P_t^T - P_0^T) - (P_t^C - P_0^C)$. For own survival expectations, we observe a *short-term* treatment effect between baseline (stage 0) and the HTC (stage 2). For own survival expectations and all other expectations, we observe a *long-term* treatment effect between baseline (stage 0) and the follow-up one year later (period 2). The revisions to expectations induced by the information treatment is complex as, depending on the outcomes considered and timing, the revision may capture updating solely due to the exogenous provided information or due to a combination of the exogenous information and behavioral change. We distinguish these two revision processes below.

Revision from the information intervention only Expectations Ψ_0 about outcomes for which the decision-maker has *no* control over are measured at baseline (stage 0) and the follow-up survey (period 2). Those expectations are unaffected by any change in individual behavior that occured within the two measurements. Any new information available to both treatment and control groups between the baseline and the follow-up survey will be differenced out. For those expectations, the long-term treatment effect captures only the impact of the information intervention and is given by:

$$\Psi_3^T - \Psi_3^C = \Psi_1^T - \Psi_0^C.$$

We expect a positive long-term treatment effect of the intervention on population survival conditional on health status. The increase in beliefs about the survival of HIV+ individuals may lead to an increase in beliefs about the HIV prevalence in the pool of potential partners, which would result in a positive long-term treatment effect on the transmission risk of HIV conditional on having multiple partners $\pi(1)$. The information intervention provided no information on the biological pathways of transmission so we expect a zero treatment effect on the probability Π of contracting HIV if having regular sex with an HIV+ partner.

While expectations about own survival is affected by behavioral change, we take advantage of the extra-measurement that took place at the HTC stage to make inference on the role of the information on own survival. Because the HTC and baseline were separated by less than two weeks, it is reasonable to assume away feedbacks from individual behavior on beliefs about own survival. Due to the new information provided by the HIV test, the short-treatment effect about own survival is different by HIV status as follows:

$$\begin{array}{ll} HIV- \text{ at stage 2:} & {S_1^-}^T - S_0^- \\ HIV+ \text{ at stage 2:} & {S_1^+}^T - S_0^+ \end{array}$$

The treatment effect among respondents who learned they were HIV- at stage 2 provides the effect of the intervention on own survival conditional on being HIV-, while the treatment effect among respondents who learned they were HIV+ at stage 2 provides the effect of the intervention on own survival conditional on being HIV+. Since there is a general underestimation of survival risk in the population, we expect overall a positive treatment effect for both groups in the short-term.

Revision from the information intervention and feedbacks from behavior Expectations Θ_o about outcomes for which the decision-maker has *some* control over are measured at baseline (stage 0) and the follow-up survey (period 2). The revision in expectations from this set is based on information provided by the intervention and as well as past endogenous decision-making (e.g., risky sex) that took place between stage 0 and period 2 and may be different between the control and treatment group. The long-term treatment effect is given by:

$$\Theta_3^T - \Theta_3^C.$$

The sign of the treatment effect depends on the impact the intervention had on sexual behavior as well as revealed HIV status at stage 2. For example, if the information intervention reduced risky sex in the treatment group compared to the control group, we expect a negative long-term treatment effect on the revision to the probability of being infected with HIV among those who learned they were HIV- at stage 2.

4.2.2 Treatment effect on sexual behavior

We investigate the potential effect of the information intervention on the propensity to engage in risky sex. For individuals learning they are HIV- at stage 2, equation (1) becomes:

$$V(1) - V(0) - (1 - f_2)S_2^- \left(\pi_2(1) - \pi_2(0)\right) \left((S_2^- - S_2^+)U^- + S_2^+ c\right) > 0. \quad (2)$$

There are three ways the information treatment could affect the propensity to engage in risky sex:

1. *Transmission risk*: an increase in the relative HIV transmission risk $\pi_2(1) - \pi_2(0)$, triggered by an increased perception of the HIV prevalence in the pool of available partners, would reduce the propensity to engage in risky sexual behavior.

2. *Overall survival*: a general improvement in survival, i.e. a joint increase of both survival probabilities, increases the weight of the second period relative to the

   first period thus increasing the cost of risky behavior (forward looking behavior).

3. *Relative survival:* the difference in survival probabilities $(S_2^- - S_2^+)$ reduces risky behavior because the expected utility of being healthy increases with respect to the expected utility of being hiv+.

5 Main Results

We start by presenting the main results on sexual behavior. Then, we look at the update in survival expectations to shed light on the mechanisms through which the intervention affected sexual behavior.

5.1 Sexual behavior

We now investigate the effect of the information intervention on risky sexual behavior. We use the four definitions of sexual behavior presented in section 2. Let y be risky sex in the 2018 follow-up for individual i in village j, and T_j be a dummy equal to 1 for whether village j was in the treatment group, and 0 otherwise. Because the variables are categorical, we use an ordered probit specification and estimate the following:

$$P(y_{ij}) = \Phi\left(\beta T_j \ + \sum_k \delta_k y_{ij-1}^k + X_i\gamma + \sum_{s=1}^{S} \tau_s I_{j\epsilon s}\right)$$

where $\sum_k \delta_k y_{ij-1}^k$ are dummies for riskiness of sex at baseline, τ_s are strata fixed effects, $I_{j\epsilon s}$ is an indicator for whether village j is in strata j and S is the total number of strata (see Bruhn and McKenzie [2009]). The village pairs are the strata in our setting and therefore we control for pair fixed effects. Conditioning on covariates X should not change the estimate of β_1 but may improve precision. We include dummies for each age group we used to condition

	Had sex		Number of partners (0,1,2+)		Risky sex index	
	(1)	(2)	(3)	(4)	(5)	(6)
treatment	-0.140**	-0.136*	-0.156***	-0.135**	-0.159***	-0.136**
	(0.067)	(0.077)	(0.057)	(0.067)	(0.056)	(0.066)
HIV+		0.007		0.168		0.149
		(0.343)		(0.268)		(0.264)
treatment × HIV+		-0.253		-0.445		-0.421
		(0.408)		(0.350)		(0.337)
Observations	1479	1440	1479	1440	1479	1440

Table 2: Sexual risky behavior The table reports regression coefficients for ordered probit models used to estimate the treatment effect of the intervention on several measures of risky sexual behavior at the 2018 follow-up. Had sex is a dummy equal to 1 if sexually active during the year prior to the survey. Number of partners is a dummy variable taking value 0 if sexually passive, 1 if having sex with the spouse only, 2 if having multiple sexual partners. Risky sex index is a dummy variable taking value 0 if sexually passive, 1 if having sex with the spouse only, 2 if having multiple sexual partners and using condom during the last intercourse, 3 if having multiple sexual partners and not using condom during the last intercourse. HIV+ is a dummy equal to 1 if the individual is tested positive for HIV during the HTC. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

	control	treatment	difference
no sex	.333	.361	.028
single partner	.579	.564	-.015
multiple partners w/ condom	.013	.011	-.002
multiple partners w/o condom	.076	.064	-.012

Table 3: Predicted probabilities The table shows the predicted probabilities of being in each risky sex state by treatment status calculated using the ordered probit model with four different states for risky sex.

the information on survival. Additionally, we control for gender and years of schooling. Standard errors are clustered at the level of the randomization, i.e at the village level.

Having received the information reduces the propensity to engage in risky sexual behavior. Table 2 shows both a negative effect of the information intervention on the propensity to have sex and negative effects on the propensity to not use condom and to have multiple sexual partners. The magnitude of the effect is rather large. To illustrate this, we present in Table 3 the predicted probabilities of sexual behavior for the treatment and control groups. For example, the predicted probability of having multiple partners with no condom is 7.6% in the control group and 6.4% in the treatment group, i.e. a reduction of 1.2 percentage point, or 19% with respect to baseline proportion. Similarly, the predicted probability of not having sex is 33.3% in the control group and 36.1% in the treatment group, i.e. an increase of 3 percentage point, or 8% with respect to baseline proportion. Conditional on having sex, the probability of having multiple sex partners is 1.2 percentage points lower in the treatment group or 13.8% lower with respect to baseline proportion. We get similar results for HIV- and HIV+ individuals. The interaction of treatment with HIV status is never statistically significant (even columns in Table 2).

A possible strategy to reduce risky sexual behavior is through marriage (Greenwood et al. [2019]). We find a positive treatment effect of 1.6 percentage points on the probability of being married in the follow-up controlling for being married at baseline (Table 4). The effect comes mostly from people who were not married at baseline (see column 2), i.e. individuals decided to marry possibly as a strategy to reduce risky sexual behavior.

	(1) married	(2) married
treatment	0.016**	0.060**
	(0.007)	(0.024)
married 2017	0.859***	0.889***
	(0.020)	(0.021)
treatment × married 2017		-0.060**
		(0.028)
Observations	1479	1479
R^2	0.822	0.823

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 4: Married The table shows regression coefficients for the treatment effect of the intervention on the likelihood of being married. The dependent variable is a dummy for being married at the 2018 follow-up. Married 2017 is a dummy for being married at the 2017 baseline. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

We can conclude that the intervention was effective in reducing risky sexual behavior.

To learn the mechanisms through which the intervention was effective, we need to look at survival expectations.

5.2 Revision in expectations from the intervention

We now investigate the treatment effect on revision in expectations. We start with the analysis of expectations that have been revised based on the information provided by the intervention only. Let $\Delta y_{ij} = y_{ij1} - y_{ij0}$ be the difference between follow-up and baseline expectation y for individual i in village j, and T_j be a dummy equal to 1 for whether village j was in the treatment group, and 0 otherwise. The main specification focuses on the effect of the treatment on the revision in expectations and is given by:

$$\Delta y_{ij} = \beta_0 + \beta_1 T_j \ + \sum_{s=1}^{S} \tau_s I_{j\epsilon s} + \beta_2 X_i + \varepsilon_{ij}$$

where τ_s are strata fixed effects, $I_{j\epsilon s}$ is an indicator for whether village j is in strata j and S is the total number of strata. We include village pair fixed effects and dummies for each age group we used to condition the information on survival. Additionally, we control for gender and years of schooling. Standard errors are clustered at the level of the randomization, i.e at the village level.

Population survival. Table 5 shows the coefficient β_1 associated with being allocated to the treatment group for each population survival expectations. The revision here is between the 2017 and 2018 wave for survival in the next 5 years. The results show a positive and statistically significant effect of the intervention, increasing around 4 percentage points the survival probability for those who are healthy, who have HIV and those treated with ART. This represents a 6 to 7% increase with respect to the baseline probabilities. Interestingly, the effect is not significant for those sick with AIDS who are not treated. This is a plausible result since the videos shown to the respondents emphasize how ART has been effective in raising life expectancy in Malawi. Finally, we look at the effect on the population survival probability not conditional on a particular health status. Somewhat surprisingly the effect is not significantly different from zero. The result may look initially at odds with the increase in survival expectations conditional on health status. However, a plausible explanation is that respondents understand that if more HIV+ individuals survive, the HIV prevalence increases, thus compensating for the gains in survival.[9]

[9] Let $S^{pop} = p_{HIV} S^{pop+} + (1 - p_{HIV})\, S^{pop-}$ where S^{pop} is the survival expectations in the population and p_{HIV} is the beliefs about the HIV prevalence. An increase in p_{HIV}, S^{pop+} and S^{pop-} may result in no increase in S^{pop}.

	Subj. prob. of surviving for individuals who are				
	(1)	(2)	(3)	(4)	(5)
	healthy	hiv	aids	art	unconditional
treatment	0.042***	0.042***	0.016	0.036***	-0.015
	(0.011)	(0.013)	(0.016)	(0.013)	(0.011)
Observations	1421	1418	1419	1415	1446
R^2	0.057	0.049	0.061	0.062	0.049

Table 5: Population survival probabilities The table reports regression coefficients for the treatment effect on population subjective probabilities of surviving in the next 5 year. The dependent variables are the update of each probability from baseline to the 2018 follow-up by health status. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

The average treatment effect presented in Table 5 may combine a mixture of upward revisions among respondents whose prior beliefs were below the new statistical information, downward revisions among respondents whose prior beliefs were above the new statistical information and no revisions among respondents whose prior beliefs were very similar to the new statistical information. We therefore investigate whether there is heterogeneous treatment effects depending on the accuracy of prior beliefs (i.e., the gap between the objective population survival probability presented in the statistical information and the baseline unconditional subjective population survival). Table C.7 in the appendix shows heterogeneous treatment effects by adding to our main specification an interaction between treatment and the gap described below, as well as the gap itself. We also look at an indicator for the intervention presenting good news (i.e. a positive gap). The results reveal similar treatment effects for respondents with different accuracy of prior beliefs, or for whom the statistical information consisted good or bad news. This suggests that the narratives delivered by the video had more impact on the revision process about population survival expectations than the stastical information. As expected there is no difference in revision by HIV status (Table C.6). We also do not find any substantial difference in revision by age, gender, schooling and cognitive skills which are the four individual characteristics we indicated for our pre-analysis plan on heterogeneity (Table C.8).

Own survival. We next turn to the effect of the information intervention on own survival probabilities in the short-term, i.e, between the HTC and the 2017 baseline wave. Table 6 shows the coefficients for 5 and 10-year survival probabilities. There is no effect of the intervention on own survival probabilities both in the 5-year and 10-year time horizon. The coefficient associated with the treatment is more than twice as small as the one for the healthy population survival expectations, and it is not precisely estimated.

As discussed in Section 4, we expect different treatment effects by HIV status revealed at the HTC stage. Splitting the sample reveals similar patterns of limited revisions. This result is important as it provides information on the revisions about own survival probability conditional on HIV status, which we have not directly elicited. So while respondents have updated their beliefs about population survival, their own conditional survival appear much less responsive to new information.

	Subj. prob. of surviving			
	5 years		10 years	
	(1)	(2)	(3)	(4)
treatment	0.016	0.018	0.014	0.028
	(0.013)	(0.014)	(0.016)	(0.017)
HIV+		-0.003		0.059
		(0.041)		(0.050)
treatment × HIV+		0.005		-0.102
		(0.062)		(0.080)
Observations	1391	1369	1388	1366
R^2	0.051	0.052	0.051	0.053

Table 6: Own Survival Probabilities. The table reports regression coefficients for the treatment effect on own subjective survival probabilities. The dependent variables are the update of each probability from baseline to the HTC stage. HIV+ is a dummy for being tested positive during the HTC exercise. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors in parentheses are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

This result is surprising at first so we further investigate the underlying reasons for the limited effect of the intervention on own survival expectations despite the revisions of population survival expectations. We first investigate whether there are heterogeneous treatment effects depending on the accuracy of prior beliefs. Individuals who have downward-biased priors might update upward while other individuals with upward-biased priors might update downward, resulting in a close to zero average treatment effect. However, Table C.9 shows no heterogeneous effect by initial gap between the information and the unconditional survival and by receiving good news. We investigate two additional potential explanations. The first explanation is *information irrelevance*. The information we provide may be less relevant to the own survival expectations of people who feel they are different from the population. However, when focusing on the respondents for whom the initial difference between own and population survival is small enough[10], i.e. on the respondents for whom the information is likely to be relevant, we still do not see a positive treatment effect (Table C.10). The second

[10]Baseline population survival is constructed as: healthy survival * HIV probability + HIV survival * (1-HIV probability).

explanation is related to the *tightness of the prior expectations* for own survival. If individuals have tight priors (i.e. if the underlying distribution of beliefs about the probability of surviving is very concentrated), any new information would lead to only limited updating. Unfortunately, we have not collected information on the prior distribution of the probability of survival. We nevertheless take advantage of the panel aspect of the data to construct a proxy for tight priors. We speculate that individuals who report 0 and 1 repeatedly have tighter priors compared to others, and construct a binary indicator for reporting expressed extreme beliefs (0 or 1) at least half of the time in the past waves of the MLSFH either for the 5-year or 10-year survival.[11] When looking at the treatment effects excluding the 20% of the sample who have tight prior according to this definition, we see a precisely estimated treatment effect of 4 percentage points for the 10-year time horizon. There is however no effect for the 5-year time horizon. We acknolwedge that this indicator of tightness is crude but interpret these results as suggestive evidence of the importance of private information in the updating of own survival.

Similarly to population survival, we fail to find substantial differences in the update of own survival probabilities by age, gender, schooling and cognitive skills once we adjust p-values for multiple hypothesis testing (Table C.11). Overall, we conclude that change in own survival expectations cannot be the main driver of behavioral change.

	Subj. prob. of contracting HIV in the next 12 months if sex with			
	(1)	(2)	(3)	(4)
	HIV+ partner	spouse only $\pi_2(0)$	multiple partners $\pi_2(1)$	$\pi_2(1) - \pi_2(0)$
treatment	0.017	-0.002	0.048***	0.053***
	(0.020)	(0.005)	(0.016)	(0.016)
Observations	1417	1299	1418	1298
R^2	0.060	0.082	0.061	0.078

Table 7: Update in the beliefs over HIV probability and transmission risk. The table shows regression coefficients for the treatment effect on beliefs over HIV transmission risk. Spouse risk ‖ HIV is the update from baseline MLSFH survey in 2010 to the follow-up survey in 2018 in the probability of becoming infected with HIV having sex with an HIV+ spouse over a year. $\pi_2(0)$ is the product of Spouse risk ‖ HIV and the subjective probability of the spouse being HIV+ at baseline. $\pi_2(1)$ is the update from baseline MLSFH survey in 2010 to the follow-up survey in 2018 in the probability of becoming infected with HIV having sex with multiple partners over a year. $\pi_2(1) - \pi_2(0)$ is the difference in transmission risk betweeen having sex with multiple partners and having sex with the spouse only. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

Transmission risk. We now look at the revision process of transmission risks, which is an important factor in the decision to have risky sex. Table 7 shows the treatment effect on the revision to the risk of becoming HIV+ associated with various behaviors. We use

[11] We exclude individuals with less than 3 observations.

2010 as baseline for the subjective probability Π that one would become HIV+ if married to a HIV+ spouse and for the subjective probability $\pi_0(1)$ if one has other partners in addition to spouse as those were not elicited in 2017. Again, our focus is on the revisions to expectations before any potential feedbacks from the respondent's own sexual behavior. Column 1 shows there is no treatment effect on the subjective probability Π of contracting HIV if married to a HIV+ spouse. This suggests that, as anticipated, there has been no change in the perception of the technology of transmission of HIV when holding constant the partner's HIV status. The transmission risk of having sex with spouse only is given by $\pi_2(0) = f_2^s \times \Pi_2$. We use the spouse's perceived probability of being HIV+ from baseline. The results show that there is no treatment effect on the subjective probability that one would become HIV+ if one has sex with spouse only. However, we see a positive and precisely estimated treatment effect on the subjective probability $\pi_2(1)$ that one would become HIV+ when having multiple sex partners. The magnitude is of 5 percentage point, or 7% of the average baseline. This is consistent with individuals being aware that the pool of potential sexual partners includes more HIV+ individuals. The conceptual framework highlights that it is the difference in transmission risk that is important for the decision to engage in risky sex. Column (4) of table Table 7 shows a positive and precisely estimated treatment effect for this difference. Overall, the information intervention changed individuals' perception such that having extra-marital partner is now perceived as riskier. This is likely to have important ramifications for the decision to engage in risky sex.

Note that the 2010 subjective transmission risks are not well balanced between treatment and control groups (Table C.12). We assess the robustness of the results presented in Table 7 in two different ways. First, we show that all our main results are unaffected (Table C.13) when we drop a village pair that causes most of the imbalance (Table C.12). Second, we reweight the sample using entropy weights to balance the sample on transmission risk and show again very similar results (Table C.14)

5.3 Revision to expectations from intervention and sexual behavior

The reduction in risky sex may have added a feedback effect on individual's expectations belonging to the set Θ. We start by looking at the probability of being HIV+. We do indeed find a negative and precisely estimated treatment effect about the chance of being infected with HIV (column 1 in Table 8) from baseline to the 2018 follow-up, which is consistent with the reduction in risky sexual behavior documented in the previous section. The magnitude is of 4.2 percentage point, or 23% of baseline belief. There is also a negative treatment effect in the probability that the spouse is HIV positive, but it is imprecisely estimated (column 3).

	HIV probability				Subj. prob. of surviving (long-term)			
	own		spouse		5 years		10 years	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
treatment	-0.042***	-0.034**	-0.023	-0.022	0.003	-0.009	0.018	0.007
	(0.013)	(0.014)	(0.018)	(0.018)	(0.014)	(0.014)	(0.016)	(0.016)
HIV+		0.002		-0.105		-0.062		-0.023
		(0.070)		(0.093)		(0.051)		(0.065)
treatment × HIV+		-0.070		0.022		0.091		0.042
		(0.084)		(0.109)		(0.063)		(0.080)
Observations	1454	1417	1240	1207	1380	1345	1375	1340
R^2	0.053	0.057	0.048	0.053	0.056	0.063	0.063	0.071

Table 8: Beliefs potentially affected by behavior The table shows regression coefficients for the treatment effect on beliefs potentially affected by changes in sexual behavior. The first four columns refer to the update in the subjective probability of being HIV+ for the respondent and the spouse. The last four columns refer to the update in the subjective survival probability in 5 and 10 years. HIV+ is a dummy equal to 1 if the individual is tested positive for HIV during the HTC. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

Consistent with the lack of short-term treatment effect, and despite the downward revision of the probability of being infected with HIV, there is no treatment effect on the revision to survival expectations of own survival expectations between 2017 and 2018 (column 5 and 7). This is also true when we differentiate those who found out they were HIV+ or HIV- at the HTC stage (column 6 and 8). Consistent with the larger and more precisely estimated treatment effect among those with extreme prior in the short-term, Table C.10 shows similar results for the long-term. This confirms again that own survival expectations are somewhat inelastic.

6 Treatment Effects for other forward-looking decisions

Sexual behavior is not the only outcome that can be affected by changes in survival expectations. In Table 9, we show treatment effects for different types of outcomes. In particular, we look at savings and investments, labor supply in weekly hours, income, expenditure for children, mental health, whether respondents consume alcohol or tobacco and expenditure for themselves. The variable for savings and investments is a factor score composed using monetary savings, expenditure on agricultural inputs and animals. The variable for mental health is a factor score using a depression score, anxiety score and mental health score[12]. The detailed description of each variable is in the table. We use an ANCOVA specification as we did for sexual behavior where we look at the effects of treatment on 2018 follow-up data and we control for the 2017 baseline. To correct the standard errors for multiple hypothesis testing we also show Q-values using the method developed by Benjamini et al. [2001] which can be interpreted the same way as P-values. We also include sexual behavior in the multiple hypothesis testing. Adjusting for multiple hypothesis testing, the treatment effect is statistically significant only for sexual behavior and savings and investments. Investments and savings are life-cycle decisions that depend on the temporal horizon. If the life of the respondent or of the household is longer, it may induce more forward-looking behavior. In Table 10, we look at each variable that was included in the savings and investments index separately. The effect on monetary savings is positive but not statistically significant. All investments variables are related to agriculture as it is the main economic activity in rural Malawi. The intervention increased expenditure in equipment, seeds and fertilizers. The effect is also positive and very precisely estimated for animals and in particular chicken. The intervention produced 1.3 more chicken per respondent and 1.6 more animals. Indeed, one easy way to save and invest in rural Malawi is animals and poultry is the cheapest option.

If respondents believe members of the household live longer, then they may be induced to invest and save more. The intervention was clear in focusing on people who have the same age and sex of the respondents. Nonetheless, it is possible that they associate gains in life expectancy to other categories of individuals. It is actually true that gains in life expectancy have been particularly high for young adults who were more affected by the AIDS epidemics and who benefited the most from the rollout of ART.

[12]Factor analysis allows to reduce multiple variables to one (or more) latent factor that explains most of the variation. For savings and investments, we construct a factor score using the inverse hyperbolic sine transformation of monetary savings, the inverse hyperbolic sine transformation of expenditure on agricultural tools, seeds and fertilizers and the number of animals owned by the respondent. For mental health we construct a factor score using the SF-12 mental health score, the Patient Health Questionnaire-9 depression score and the General Anxiety Disorder-7 anxiety score.

	(1) risky sex	(2) savings and investments	(3) labor supply	(4) income	(5) children expenditure	(6) mental health	(7) alcohol and tobacco	(8) own expenditure
treatment	-0.159	0.072	2.072	0.246	0.096	0.001	-0.030	-0.073
	(0.056)	(0.020)	(0.988)	(0.237)	(0.126)	(0.034)	(0.012)	(0.137)
Q-value	(0.047)	(0.011)	(.208)	(1)	(1)	(1)	(.105)	(1)
Observations	1475	1479	1479	1478	1478	1479	1479	1478

Table 9: Other outcomes. This table shows regression coefficients for the treatment effect on several outcomes. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. Risky sex is a dummy variable taking value 0 if sexually passive, 1 if having sex with the spouse only, 2 if having multiple sexual partners and using condom during the last intercourse, 3 if having multiple sexual partners and not using condom during the last intercourse. Savings and investments is a factor score constructed using the inverse hyperbolic sine transformation of monetary savings, the inverse hyperbolic sine transformation of expenditure on agricultural tools, seeds and fertilizers and the number of animals owned by the respondent. Labor supply is the number of hours worked during the last week. Income is the inverse hyperbolic sine transformation of annual income. Children expenditure is the inverse hyperbolic sine transformation of medical expenditure, school fees and clothes for children. Mental health is a factor score constructed using the SF-12 mental health score, the Patient Health Questionnaire-9 depression score and the General Anxiety Disorder-7 anxiety score. Alcohol and tobacco is a dummy equal to 1 if the respondent currently smokes or consumes alcohol. Own expenditure is the inverse hyperbolic sine transformation of medical expenditure and expenditure in clothes for the respondents themselves. All monetary variables are measured in Malawian Kwacha. Q-values for multiple testing are calculated using Benjamini et al. [2001].

	(1) savings	(2) tools	(3) seeds and fertilizers	(4) cattle	(5) goat	(6) pig	(7) chicken	(8) animals
treatment	0.194	0.480***	0.494***	0.240***	-0.093	0.215**	1.313***	1.647***
	(0.200)	(0.152)	(0.180)	(0.079)	(0.070)	(0.099)	(0.367)	(0.418)
Observations	1479	1478	1476	1476	1477	1478	1459	1454
R^2	0.076	0.056	0.076	0.073	0.063	0.062	0.069	0.060

Table 10: Savings and investments. This table shows regression coefficients for the treatment effect on several measures of savings and investments in agriculture. We use an inverse hyperbolic sine transformation for agriculture expenditure to not exclude observations with zero. Animals are the number of animals owned by the household. All regressions include village pair fixed effects, dummies for age categories used in the intervention by gender and level of schooling. Standard errors are clustered at village level. * (p¡0.1), ** (p¡0.05), *** (p¡0.01).

7 Conclusions

Survival perceptions are an understudied but potentially important and modifiable determinant of health behaviors and other life-cycle decisions in sub-Saharan Africa (SSA). This is particularly the case in populations experience rapid changes in development or health, or are affected by major epidemics. There has been an emerging literature documenting the role of subjective expectations on life-cycle behaviors. Yet, to date there is no RCT-based evidence about the updating of survival expectations after a health-information intervention targeted towards reducing misperceptions about mortality risks.

This study fills this gaps. Specifically, the 2017 and 2018 Mature Adults survey and the 2017 BenKnow health-information intervention allow us to investigate for the first time how individuals in a Sub-Saharian country form their expectations on survival, and on how they update their beliefs once provided with information on mortality trends in their context. The experiment also allows to look at the causal effect of subjective life expectancy on health and individual behavior.

The intervention was effective in increasing subjective survival probabilities of the population, but had limited effect on own mortality expectations. Moreover, the intervention induced a change in risky sexual behavior by reducing the likelihood of having sex with multiple partners and increasing the likelihood of using a condom. Additionally, as the intervention incentivized forward looking behavior, we observe some evidence of higher savings and investments.

The external validity of our results limit to mature adults in a low income country but we speculate that they apply to younger cohorts that are sufficiently uncertain about their short term survival because of epidemics.

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A Appendix A: Expectations Questions

2018Main Questionnaire. Chewa RESPONDENT ID:[____________________________] 16-38

Section 12: Expectations Questions

INTERVIEWER: Recount the number of peanuts and check that you have 10 peanuts in the plate [__]. As you provide the explanation below, add the peanuts into the plate to illustrate what you say.

Ndikufunsani mafunso angapo okhudzana mwayi wa momwe zinthu zina zitha kuchitikira. Apa pali mtedza khumi. Ndikupemphani kuti mutenge wina mwa mtedzawu ndipo muuyike mu mbale. Mtedza omwe mutayike mbalemu uyimilira mwayi wakuti chithu china chake chitha kuchitika. Mtedza umodzi ukutanthawuza kuti pali mwayi wochepa zedi kuti chithu chinachake chitha kuchitika. Ngati simuyika mtedza wina uliwonse mbalemu zikutanthawuza kuti mukudziwa kuti palibiletu mwayi wina uliwonse kuti chithu chinachake chitha kuchitika. Mukamawonjezera mtedza mbalemu ndiye kuti mwayi wakuti chithu china chake chitha kuchitika ukuwonjezekeranso. Mwachitsanzo, ngati muyike m'mbalemu mtedza umodzi kapena uwiri, zikutanthawuza kuti pali kutheka kochepa kuti chinthucho nkuchitika ngakhale kuti mwayi woti chinthucho chitha kuchitika ngochepa. Ngati muyike mtedza usanu zikutanthawuza kuti pali kutheka kofanana kuti chinthu chitha kuchitika kapena ayi. Ngati mwayika mtedza usanu ndi umodzi (6) zikutanthawuza kuti pali mwayi ochulukirapo pang`ono kuti chinthu chitha kuchitika kuyelekezera ndi kusachitika. Ngati muyike mtedza onse, khumi, zikutanthawuza kuti muli ndichikhulupiriro kuti chinthu chichitika basi. Palibe yankho lokhoza kapena lolakwa, ndingofuna ndiwone m'mene mumaonera zinthu.

Mwachitsanzo ngati inu ndi ine tikusewera bawo ndipo mwafunsidwa kuti ndi kotheka bwanji kuti mutha kuwina bawoyo ndipo mwayika mtedza usanu ndi uwiri (7) m'mbalemu ndiye kuti zikutanthawuza kuti pa bawo khumi (10) zinazilizonse zomwe tisewere mukukhulupirira kuti mupambanapo bawo zisanu ndi ziwiri (7), titasewera kwa nthawi yayitali. Ngati mukukhulupirira kuti mupambana bawo zopitilira pang'ono zisanu ndi ziwiri koma zochepera bawo zisanu ndi zitatu, mutha kuswa mtedza umodzi pakati-ndi-pakati ndipo muika mtedza usanu ndi uwiri komanso ndi theka la mtedza womwe mwaswa uja m'balemu

"I will ask you several questions about the chance or likelihood that certain events are going to happen. There are 10 peanuts in the cup. I would like you to choose some peanuts out of these 10 peanuts and put them in the plate to express what you think the likelihood or chance is of a specific event happening. One peanut represents one chance out of 10. If you do not put any peanuts in the plate, it means you are sure that the event will NOT happen. As you add peanuts, it means that you think the likelihood that the event happens increases. For example, if you put one or two peanuts, it means you think the event is not likely to happen but it is still possible. If you pick 5 peanuts, it means that it is just as likely it happens as it does not happen (fifty-fifty). If you pick 6 peanuts, it means the event is slightly more likely to happen than not to happen. If you put 10 peanuts in the plate, it means you are sure the event will happen. There is not right or wrong answer, I just want to know what you think.

Let me give you an example. Imagine that we are playing Bawo. Say, when asked about the chance that you will win, you put 7 peanuts in the plate. This means that you believe you would win 7 out of 10 games on average if we play for a long time. If you think that you will win slightly more than 7 games but less than 8 games on average, then you can break the peanut in half and put 7 ½ peanuts on the plate.

INTERVIEWER: Report for each question the NUMBER OF PEANUTS put in the PLATE. After each question, replace the peanuts in the cup (unless otherwise noted).

Interviewer: Remind respondent that he/she can put ½ bean if respondent wants to pick value between two whole peanuts (e.g., respondent thinks 1 and 1/2 peanuts (1.5) is the best answer). If respondent is not able to break the peanut in ½, help him/her with this.

For question X1: If respondent puts 10 (or 0) peanuts, prompt "Are you sure that this event will almost surely (not) happen?" CIRCLE 1 in column P if you prompted the respondent, and report the final answer only.

X1 **Tengani mtedza womwe uyimire m'mene mukuganizira kuti….** *Pick the number of peanuts that reflects how likely you think it is that…*	**# of peanuts in plate**	**Prompt for 0 or 10?**
For men: **Mwamuna wofanana naye zaka mudera lanu lino amwalira mkatikati mwa zaka zisanu** **For women:** **Mzimayi wofanana naye zaka mudera lanu lino amwalira mkatikati mwa zaka zisanu** *A person of your sex and age in your community will die within 5 years.*	[____]	1

For the subsequent questions, no longer prompt for "0" and "10" answers

X2 **Tengani mtedza womwe uyimire m'mene mukuganizira kuti….** *Pick the number of peanuts that reflects how likely you think it is that…*	**# of peanuts in plate**
a) **Muli ndi kachilombo koyambitsa EDZI pakalipano.** *you are infected with HIV/AIDS now*	[____]
b) **INTERVIEWER**: for polygamous men, ask for most recent spouse **Amuna/akazi anu kapena wachikondi wanu ali ndi kachilombo koyambitsa matenda a EDZI panopa** *your spouse or romantic partner is infected with HIV/AIDS now* **(INTERVIEWER: If no spouse or romantic partner, write 66)**	[____]

X3 **Tsopano tiganizire za mamuna/mkazi wathanzi wa m'mudzi mwanu yemwe alibe kachilombo koyambitsa EDZI. Tengani mtedza omwe uyimire m'mene mukuganizira kuti mwamunayu atenga kachilombo koyambitsa matenda a EDZI.** **Consider a healthy man/woman in your village who currently does not have HIV. Pick the number of**	**# of peanuts in plate**

peanuts that reflects how likely you think it is that he will become infected with HIV...	
c) **Ngati akwatirane ndi munthu yemwe ali ndi kachilombo koyambitsa EDZI m'miyezi khumi ndi iwiri(12)ikubwerayi** *within the next 12 months if he/she is married to someone who is infected with HIV/AIDS*	[____]
d) **M'miyezi khumi ndi iwiri(12) ikubwerayi ngati pali anthu ena omwe amagonana nawo kuphatikizirapo akunyumba kwawo** *within the next 12 months if he/she has several sexual partners in addition to his/her spouse*	[____]

Ndikufuna kuti muganizire kuti ndi kotheka bwanji kuti inuyo mumwalira mtsogolo muno. Tili ndichikhulupiliro kuti palibe chilichonse choipa chimene chikuchitikireni, komabe, zoipa zina zitha kuchitika m'zaka zikubwerazi ngakhale mutapewa kuti zisachitike. Ngati simukufuna, mutha kukana kuyankha funso limeneli.

I want you to think how likely it is that you will die in the near future. We believe that there is nothing bad that will happen to you. But something bad might happen in the near future years to come, even though you prevent it to happen. If you don't want, you can refuse to answer these questions.

INTERVIEWER: If respondent refuses to answer, skip to **GS1**

PICK THE NUMBER OF PEANUTS THAT REFLECTS HOW LIKELY YOU THINK IT IS THAT YOU WILL:	**# OF PEANUTS in plate**
X7 **Tengani mtedza womwe uyimire m'mene inu mukuganizira kuti** *Pick the number of peanuts that reflects how likely you think it is that you*	
a) mumwalira m'zaka zisanu (5) zikubwerazi kuyambira lero *will die within a <u>five-year</u> period beginning today* **(LEAVE PEANUTS ON PLATE)**	[____] **if 10 → SKIP to X8a**
Add the number of peanuts that reflecs how likely you think it is that you: b) **wonjezerani mtedza m'balemu womwe uyimirire m'mene inu mkuganizira kuti mumwalira m'zaka khumi(10) zikubwerazi kuyambira lero** *will die within a <u>ten-year</u> period beginning today* **(IT IS POSSIBLE TO ADD ZERO ADDITIONAL PEANUTS)**	[____]

Pomaliza, ndikufuna muganizire kuti nkotheka bwani kuti munthu wina amwalire pamene nthawi ikudutsa. Ndikufunsani zokhudza munthu ongopeka yemwe akukhala mdera lanu, ndipo ndimulongosola munthuyu kwa inu.

Finally, I would like you to consider the likelihood that somebody else dies as time goes by. I am going to ask you about an imaginary person living in the same context like you, and I am going to describe him/her to you.

INTERVIEWER: <u>For each of questions X8a to X8d start with an empty plate and 10 peanuts</u>. Do not leave peanuts on plate.

Tengani mtedza umene uyimire mmene mukuganizira kuti nkotheka bwanji kuti mmodzi mwa anthu awa akhoza kumwalira mu zaka zisanu kuchokera lero: *Pick the number of peanuts that reflects how likely you think it is that one of the following persons will die within a <u>five-year period</u> beginning today:*	**# of peanuts in plate**
X8a **<u>For men:</u>** **Mwamuna wa zaka ngati inu wa thanzi ndipo alibe kachilombo ka HIV?** *A man your age who is healthy and does not have HIV?* **<u>For women:</u>** **Mkazi wa zaka ngati inu wa thanzi ndipo alibe kachilombo ka HIV?** *A woman your age who is healthy and does not have HIV?*	[____]
X8b **<u>For men:</u>** **Mwamuna wa zaka ngati inu amene ali ndi kachilombo ka HIV koma sanayambe kudwala?** *A man your age who is infected with HIV?* **<u>For women:</u>** **Mkazi wa zaka ngati inu amene ali ndi kachilombo ka HIV koma sanayambe kudwala?** *A woman your age who is infected with HIV?*	[____]

X8c	**For men:** **Mwamuna wa zaka ngati inu amene ali ndi kachilombo ka HIV ndipo akudwala Edzi?** *A man your age who sick with AIDS?* **For women:** **Mkazi wa zaka ngati inu amene ali ndi kachilombo ka HIV ndipo akudwala Edzi?** *A woman your age who is sick with AIDS?*	[____]
X8d	**For men:** **Mwamuna wa zaka ngati inu amene akudwala Edzi ndipo akulandira mankhwala otalikitsa moyo a ARV?** *A man your age who is sick with AIDS and who is treated with antiretroviral treatments (ART)?* **For women:** **Mkazi wa zaka ngati inu amene akudwala Edzi ndipo akulandira mankhwala otalikitsa moyo a ARV?** *A woman your age who "is" sick with AIDS and who is treated with antiretroviral treatments (ART)?*	[____]

		# of peanuts in plate
	Pa funso lomalizira, ndinakufunsani za mpata woti mamuna [mkazi] wa msinkhu wanuwu amene ali wa thanzi ndipo alibe HIV angamwalire mu zaka zisanu [5] zikubwerazi. Ndipo mwayika mtedza okwana XX [=answer from X8a] mu mbale. In a previous question I asked you about the chances that a man [woman] your age who is healthy and does not have HIV dies within 5 years. You have put XX peanuts [=answer from X8a] on the plate. **[INTERVIEWER: Put XX peanuts [=answer from X8a] on the plate]** **Tsopano ndikufuna kukufunsani za mpata okuti munthu ameneyu angamwalire mu zaka zisanu [5] zikubwerazi atakhala kuti alibe HIV koma ali ndi matenda ena.** I'd now like to ask you about the chances of dying within 5 years for this person if he [she] is HIV negative but has some other diseases. **Tengani mtedza umene uyimire mmene mukuganizira kuti nkotheka bwanji kuti mmodzi mwa anthu awa akhoza kumwalira mu zaka zisanu kuchokera lero:** Pick the number of peanuts that reflects how likely you think it is that one of the following persons will die within a five-year period beginning today:	
	X8e **For men:** **Mwamuna wa zaka ngati inu amene amadwala kuthamanga kwa magazi [high blood pressure] koma samamwa mankhwala a matendawa?** A man your age who has hypertension or high blood pressure and does not take medication for this condition? **For women:** **Mkazi wa zaka ngati inu amene amadwala kuthamanga kwa magazi [high blood pressure] koma samamwa mankhwala a matendawa?** A woman your age who has hypertension or high blood pressure and does not take medication for this condition?	[____]
	X8f **For men:** **Mwamuna wa zaka ngati inu amene amadwala kuthamanga kwa magazi [high blood pressure] ndipo amamwa mankhwala a matenda a kuthamanga kwa magazi?** A man your age who has hypertension (or high blood pressure) and now takes medication to treat high blood pressure? **For women:** **Mkazi wa zaka ngati inu amene amadwala kuthamanga kwa magazi [high blood pressure] ndipo amamwa mankhwala a matenda a kuthamanga kwa magazi?** A woman your age your age who has hypertension (high blood pressure) and and now takes medication to treat high blood pressure?	[____]
	X8g **For men:** **Mwamuna wa zaka ngati inu amene amadwala shuga koma samamwa mankhwala a matendawa?** A man your age who has diabetes or high blood sugar and does not take medication for this condition? **For women:** **Mkazi wa zaka ngati inu amene amadwala shuga koma samamwa mankhwala a matendawa?** A woman your age your age who has diabetes or high blood sugar and does not take medication for this condition?	[____]

B Appendix B: Information Intervention

B.1 Intervention video scripts

I would like to show you a video showing that people in Malawi are living longer nowadays than 5 or 10 years ago. These videos have been recorded by actors and the information in these videos is consistent with recent health and mortality trends in Malawi.

Video 1 (Story 1—Davie the carpenter): A middle-aged man, working it his carpenter's shop, talks: Hi, my name is Davie and I have a bit of land where I grow maize. I also know how to work with wood. I am lucky because both my parents are still alive. They are both in their 70ies and are doing well. They are taking care of themselves: they have enough food, they are in good health and they don't need to go often to the hospital and they actively participate in village activities. They also teach important things about life to me and my children. They knew that they could live longer than their parents and with the little they were earning they bought some livestock to support themselves in their old days. My brothers and I also help them sometimes. My aunties and uncle also died very old. They were more than 65. And I see a lot of other families in our village with old family members that are still alive. My grand-parents were not so lucky and they were dead when they were my age. Yes, I really notice that people are living longer nowadays. And it is a good thing for everyone.

Interviewer: continue with Video 2 –Rose Video 2 (Story 2 – Rose): A middle-aged woman, working in her tailoring shop , talks: Hi, my name is Rose. I work in the field to plant cassava. When I have time, I do a bit of tailoring. I am married and I have four children who also help me in the field. The younger two go to school if they do not help at home. Five years ago, my husband got tested for HIV and he found out that he was HIV-positive. This was really a shock, and I was worried about the future of the family. How could we manage if my husband died soon? However, we have been lucky because my husband has had access to antiretroviral treatment (ART) in the local clinic. He takes his medicine regularly as the doctor explained him and I make sure he does not forget. He also often goes to the clinic for refill and check-ups. He looks really healthy and fit and does not show any sign of the disease. We do not know what will happen but we are very grateful for the availability of treatment. Ten years ago, my brother had HIV and he became very sick very quickly and died rapidly. Nowadays, there is more hope for people with HIV thanks to the availability of treatment. They can expect a longer life.

Video 3 (Story 3 – old man): An old man seating at home: I am lucky because I am more than 60 years old and I am still alive and feel healthy. I am not the only luck one. My neighbor next door is more than 70. And think about the popular musician Giddes Chalamanda. He is over 85 years old, and is still performing for the people. Last year, he even made is long-held dream of going to America come true, giving several shows across the USA. My parents were not so lucky because they died when they were in their 40ies. I think things are better nowadays. The kids, they do not die so frequently anymore. They get their immunization and many sleep under bed nets. They do not get sick so often. The adults, they do not die from HIV so rapidly anymore. The treatments, they really help. Also, people are not so hungry anymore and they eat more. When I was a kid, we were often hungry. My children and grand-children, they have almost always their meal on the table. It helps to build your health and keep you strong and prevent you from being unwell. Yes, things have changed quite a lot and people are less sick and live longer. END OF VIDEO

B.2 Statistical Information

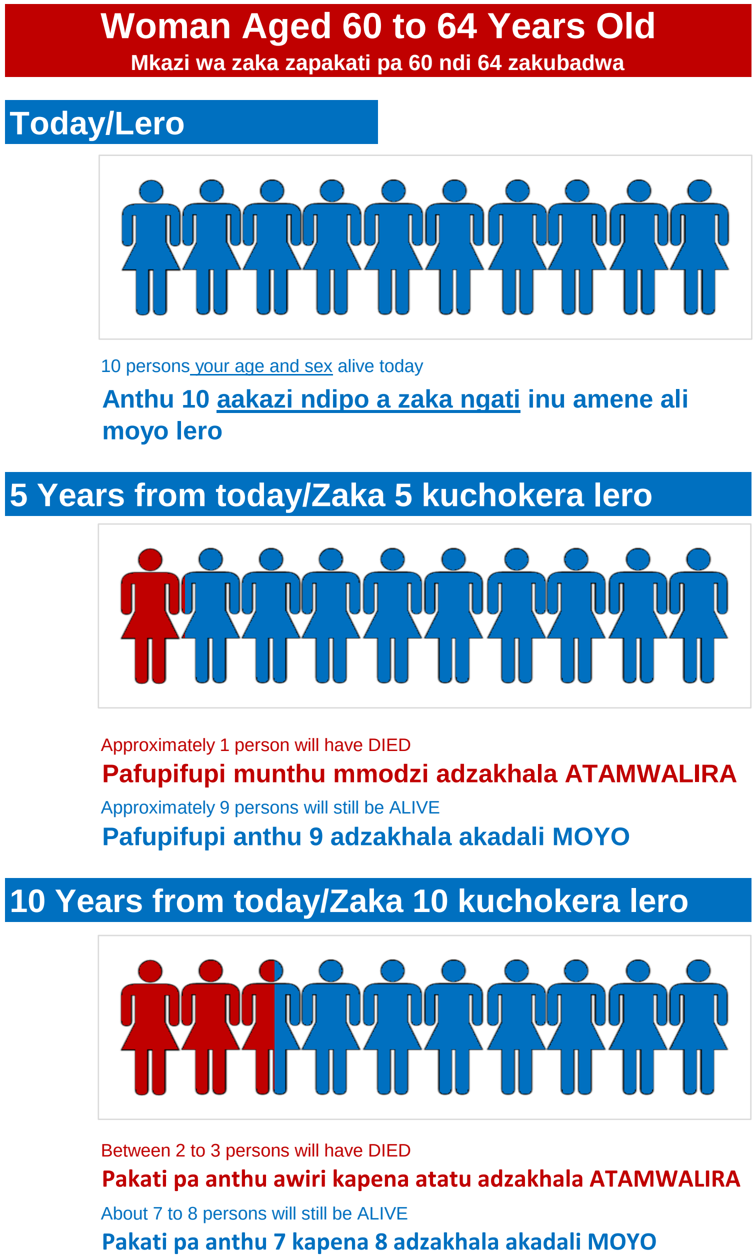
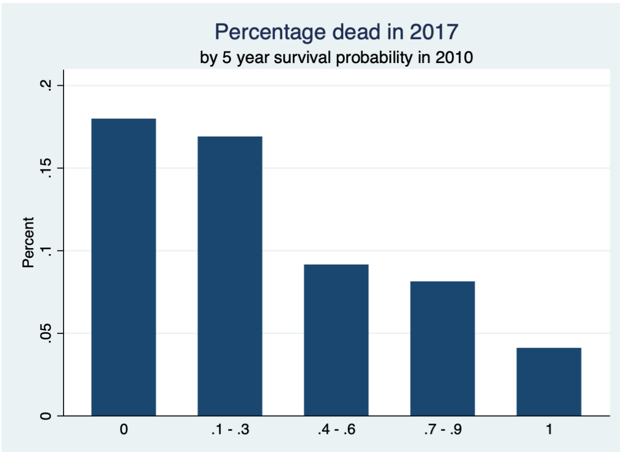


Figure B.1: Benefits-of-Knowledge Health-information Intervention: Health information sheet providing life-table-based information about 5-year and 10-year mortality probabilities for a woman aged 60-64 years old.

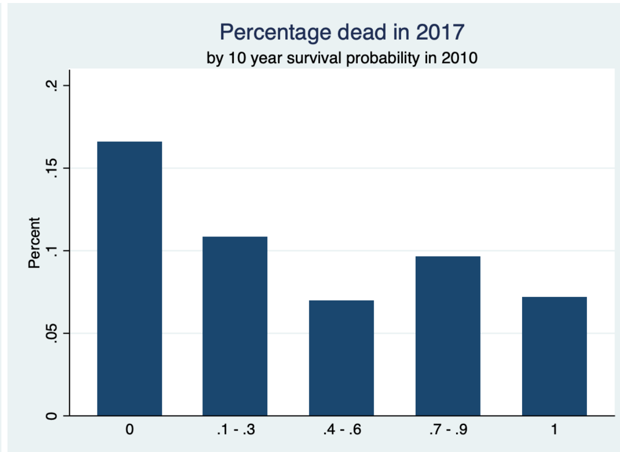
gender	age group	5 years	10 years
male	< 45	0.06	0.13
male	45-49	0.07	0.15
male	50-54	0.08	0.18
male	55-59	0.1	0.23
male	60-64	0.14	0.31
male	65-69	0.2	0.43
male	70-74	0.28	0.58
male	75-79	0.41	0.71
male	80+	0.51	0.76
female	< 45	0.04	0.08
female	45-49	0.05	0.1
female	50-54	0.06	0.13
female	55-59	0.07	0.17
female	60-64	0.11	0.25
female	65-69	0.16	0.37
female	70-74	0.24	0.53
female	75-79	0.38	0.68
female	80+	0.49	0.74

Table B.1: Statistical Information. The table reports mortality probabilities for each demographic group that were conveyed during the Benefits-of-Knowledge Health-information Intervention using informations sheets like the one shown in Figure B.1

C Appendix C: Additional Tables and Figures



(a) 5 years



(b) 10 years

Figure C.1: Predictive power of subjective survival probabilities. The figures show the percentage of respondents who are dead in 2017 by different levels of subjective survival probabilities elicited in 2010. The left figure uses 5 year survival probabilities while the right figure uses 10 year survival probabilities.

	mean	obs
Have you noticed that people live longer	0.453	733
How did you notice?		
funerals	0.157	287
friends/relatives	0.106	303
older	0.087	298
AIDS treatment	0.443	393
health services	0.355	361
other	0.028	290
information reflects what happens in the community	0.944	732

Table C.1: Descriptive statistics of qualitative questions in the intervention. The table shows the proprtion of respondents in the treatment group who answer yes to the question "Have you noticed that nowadays people live longer?" during the intervention and how they noticed that people live longer.

	control	treatment	difference
no sex	.334	.356	.022
single partner	.581	.569	-.012
multiple partners w/ condom	.01	.009	-.001
multiple partners w/o condom	.075	.066	-.009

Table C.2: Predicted probabilities. HIV negative The table shows the predicted probabilities of being in each risky sex state calculated using the ordered probit model with five different states. The sample includes only respondents who were tested negative for HIV during the HTC.

	control	treatment	difference
no sex	.373	.409	.036
single partner	.617	.584	-.033
multiple partners w/ condom	.002	.001	-.001
multiple partners w/o condom	.009	.006	-.003

Table C.3: Predicted probabilities - Females The table shows the predicted probabilities of being in each risky sex state calculated using the ordered probit model with five different states. The sample includes only females.

	control	treatment	difference
no sex	.166	.206	.04
single partner	.685	.679	-.006
multiple partners w/ condom	.025	.021	-.004
multiple partners w/o condom	.124	.095	-.029

Table C.4: Predicted probabilities - Males The table shows the predicted probabilities of being in each risky sex state calculated using the ordered probit model with five different states. The sample includes only males.

	(1) female	(2) male	(3) >= 60	(4) < 60	(5) no schooling	(6) schooling	(7) low cognitive	(8) high cognitive
Sexual behavior								
treatment	-0.201***	-0.246***	-0.196*	-0.111*	-0.039	-0.128*	-0.257**	-0.213***
	(0.074)	(0.091)	(0.104)	(0.064)	(0.112)	(0.071)	(0.102)	(0.079)
Q-value	(0.051)	(0.051)	(0.259)	(0.259)	(1)	(0.259)	(0.066)	(0.051)
Observations	889	590	632	847	449	939	674	805

Table C.5: Heterogeneity in the Update of Sexual Behavior - Individual Characteristics The table shows regression coefficients for the effect of treatment on risky sexual behavior using an ordered probit specification for different sub-samples. The dependent variable is a variable taking value 0 if sexually passive, 1 if having sex with the spouse only, 2 if having multiple sexual partners and using condom during the last intercourse, 3 if having multiple sexual partners and not using condom during the last intercourse. First 2 columns show results by gender. Columns 3 and 4 show results for younger (age less than 60) and older respondents. Columns 5 and 6 show results by whether individuals completed primary schooling. Columns 7 and 8 show results below and above the median in the cognitive score. Q-values are calculated using Benjamini et al. [2001] to correct for multiple hypothesis testing.

	(1) healthy	(2) hiv	(3) aids	(4) art	(5) unconditional
treatment	0.041***	0.042***	0.010	0.032**	-0.020
	(0.013)	(0.015)	(0.017)	(0.015)	(0.012)
HIV+	0.056	0.033	0.054	0.016	-0.033
	(0.048)	(0.051)	(0.074)	(0.073)	(0.047)
treatment × HIV+	-0.030	0.010	0.010	-0.004	0.051
	(0.060)	(0.067)	(0.091)	(0.084)	(0.057)
Observations	1387	1384	1384	1380	1409
R^2	0.059	0.055	0.063	0.063	0.053

Table C.6: Update Population Survival Probability - Interactions with HIV status The table shows regression coefficients for the effect of treatment on population subjective survival probabilities and interactions of treatment with HIV status. HIV+ is a dummy equal to 1 if the respondent was tested positive for HIV during the HTC. Standard errors clustered at village level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	healthy		HIV-		AIDS		ART		Unconditional	
	(1) good news	(2) gap	(3) good news	(4) gap	(5) good news	(6) gap	(7) good news	(8) gap	(9) good news	(10) gap
treatment	0.056*	0.059**	0.071**	0.067***	0.038	0.026	0.039	0.033	-0.004	-0.020
	(0.033)	(0.023)	(0.035)	(0.025)	(0.039)	(0.039)	(0.035)	(0.031)	(0.027)	(0.018)
treatment × characteristics	-0.021	-0.066	-0.047	-0.114	-0.043	-0.068	-0.010	0.001	-0.026	0.022
	(0.043)	(0.090)	(0.047)	(0.095)	(0.048)	(0.125)	(0.046)	(0.104)	(0.036)	(0.062)
Observations	1272	1272	1268	1268	1269	1269	1267	1267	1300	1300
R^2	0.082	0.076	0.085	0.072	0.083	0.078	0.077	0.066	0.228	0.324

Table C.7: Update Population Survival Probability - Accuracy The table shows regression coefficients for the effect of treatment on population subjective survival probabilities and interactions of treatment with measures of accuracy of prior beliefs. Gap is the gap between the objective population survival probability presented in the statistical information and the baseline unconditional subjective population survival. Good news is a dummy equal to 1 if the gap is negative. Characteristic corresponds to good news in odd columns and to gap in even columns. Each regression includes also the characteristic not interacted with treatment as well as pair fixed effects, gender and years of schooling. Standard errors clustered at village level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

	(1) female	(2) male	(3) >= 60	(4) < 60	(5) no schooling	(6) schooling	(7) low cognitive	(8) high cognitive
Healthy								
treatment	0.011	0.077	0.084	0.014	0.090	0.023	0.045	0.047
	(0.016)	(0.017)	(0.017)	(0.017)	(0.017)	(0.015)	(0.015)	(0.018)
Q-value	(1)	(0.0001)	(0.0001)	(1)	(0.0001)	(0.49)	(0.023)	(0.042)
Observations	851	567	590	826	427	894	627	789
HIV+								
treatment	0.046	0.029	0.041	0.047	0.082	0.029	0.052	0.040
	(0.019)	(0.022)	(0.021)	(0.015)	(0.030)	(0.018)	(0.021)	(0.021)
Q-value	(0.079)	(0.507)	(0.204)	(0.039)	(0.079)	(0.355)	(0.079)	(0.204)
Observations	849	566	588	824	425	893	626	787
AIDS								
treatment	0.012	0.008	-0.005	0.036	0.046	0.005	0.058	-0.014
	(0.022)	(0.025)	(0.028)	(0.016)	(0.029)	(0.024)	(0.025)	(0.021)
Q-value	(1)	(1)	(1)	(0.332)	(0.871)	(1)	(0.332)	(1)
Observations	852	564	594	820	427	893	628	786
ART								
treatment	0.028	0.041	0.008	0.068	0.080	-0.000	0.076	0.016
	(0.021)	(0.025)	(0.023)	(0.018)	(0.025)	(0.019)	(0.021)	(0.021)
Q-value	(0.752)	(.551)	(1)	(.005)	(.014)	(1)	(.007)	(1)
Observations	846	566	589	821	425	891	622	788
Unconditonal								
treatment	-0.005	-0.025	-0.026	-0.002	-0.002	-0.014	-0.022	-0.007
	(0.014)	(0.019)	(0.021)	(0.014)	(0.027)	(0.017)	(0.021)	(0.016)
Q-value	(1)	(1)	(1)	(1)	(1)	(1)	(1)	(1)
Observations	865	578	602	839	429	917	646	796

Table C.8: Update Population Survival Probability - Individual Characteristics The table shows regression coefficients for the effect of treatment on population subjective survival probabilities for different sub-samples. First 2 columns show results by gender. Columns 3 and 4 show results for younger (age less than 60) and older respondents. Columns 5 and 6 show results by whether individuals completed primary schooling. Columns 7 and 8 show results below and above the median in the cognitive score. Q-values are calculated using Benjamini et al. [2001] to correct for multiple hypothesis testing.

	Short run				Long run			
	5 years		10 years		5 years		10 years	
	(1) good news	(2) gap	(3) good news	(4) gap	(5) good news	(6) gap	(7) good news	(8) gap
treatment	0.014	0.007	-0.008	0.016	-0.010	0.010	-0.010	0.023
	(0.037)	(0.030)	(0.047)	(0.035)	(0.038)	(0.027)	(0.049)	(0.034)
treatment × characteristics	0.001	0.036	0.047	0.044	-0.002	-0.081	0.017	-0.070
	(0.047)	(0.109)	(0.057)	(0.119)	(0.047)	(0.094)	(0.059)	(0.116)
Observations	1256	1256	1254	1254	1234	1234	1231	1231
R^2	0.062	0.060	0.068	0.058	0.077	0.069	0.113	0.086

Table C.9: Update Own Survival Probability - Accuracy The table shows regression coefficients for the effect of treatment on own subjective survival probabilities and interactions of treatment with measures of accuracy of prior beliefs. Gap is the gap between the objective population survival probability presented in the statistical information and the baseline unconditional subjective population survival. Good news is a dummy equal to 1 if the gap is negative. Characteristic corresponds to good news in odd columns and to gap in even columns. Each regression includes also the characteristic not interacted with treatment as well as pair fixed effects, gender and years of schooling.

	Relevance				Extreme prior			
	Short run		Long run		Short run		Long run	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	5 years	10 years	5 years	10 years	5 years	10 years	5 years	10 years
treatment	0.007	0.015	0.014	0.027	0.020	0.040**	0.007	0.036**
	(0.015)	(0.018)	(0.013)	(0.017)	(0.016)	(0.019)	(0.014)	(0.018)
Observations	921	919	911	907	982	981	976	973
R^2	0.069	0.080	0.063	0.080	0.051	0.063	0.078	0.079

Table C.10: Update Own Survival Probability - Relevance The table shows regression coefficients for the effect of treatment on the update in own subjective survival probabilities for individuals more likely to consider the information provided relevant for their own survival. The first four columns only include individuals for whom the difference between baseline 5-year own survival and the baseline population survival is less than 20ppt. Baseline population survival is constructed as: healthy survival * HIV probability + HIV survival * (1-HIV probability). The second four columns exclude individuals who expressed extreme beliefs (0 or 1) at least half of the time in the past waves of the MLSFH either for 5-year or 10-year survival or they have less than 3 past observations. Short run refers to the update from baseline to the HTC while long run refers to the update from baseline to the 2018 MLSFH round. Standard errors clustered at village level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	(1) female	(2) male	(3) >= 60	(4) < 60	(5) no schooling	(6) schooling	(7) low cognitive	(8) high cognitive
Short Run 5 years								
treatment	-0.020	0.068	-0.005	0.028	0.044	-0.005	0.008	0.019
	(0.015)	(0.022)	(0.020)	(0.017)	(0.028)	(0.019)	(0.018)	(0.017)
Q-value	(.964)	(.051)	(1)	(.904)	(.904)	(1)	(1)	(1)
Observations	833	555	582	804	398	891	611	776
Short Run 10 years								
treatment	-0.005	0.041	-0.013	0.034	0.064	-0.015	0.028	-0.002
	(0.019)	(0.024)	(0.024)	(0.020)	(0.033)	(0.022)	(0.022)	(0.022)
Q-value	(1)	(0.676)	(1)	(0.676)	(0.676)	(1)	(1)	(1)
Observations	830	555	579	803	398	888	610	774
Long Run 5 years								
treatment	-0.010	0.020	0.000	0.008	0.059	-0.031	-0.005	0.010
	(0.020)	(0.023)	(0.020)	(0.018)	(0.028)	(0.016)	(0.026)	(0.020)
Q-value	(1)	(1)	(1)	(1)	(0.578)	(0.578)	(1)	(1)
Observations	829	548	571	804	400	880	601	775
Long Run 10 years								
treatment	0.011	0.030	0.006	0.032	0.086	-0.022	0.049	-0.010
	(0.017)	(0.030)	(0.023)	(0.019)	(0.027)	(0.020)	(0.028)	(0.025)
Q-value	(1)	(1)	(1)	(0.701)	(.046)	(1)	(0.701)	(1)
Observations	825	547	567	802	400	875	600	771

Table C.11: Update Survival Probability - Individual Characteristics The table shows regression coefficients for the effect of treatment on population subjective survival probabilities for different sub-samples. First 2 columns show results by gender. Columns 3 and 4 show results for younger (age less than 60) and older respondents. Columns 5 and 6 show results by whether individuals completed primary schooling. Columns 7 and 8 show results below and above the median in the cognitive score. Q-values are calculated using Benjamini et al. [2001] to correct for multiple hypothesis testing.

	control	obs	treatment	obs	p-value
Panel A: all respondents					
spouse	0.787	731	0.762	705	0.033
multiple partners	0.760	731	0.731	704	0.007
Panel B: drop a pair					
spouse	0.787	679	0.772	655	0.208
multiple partners	0.757	679	0.737	654	0.070

Table C.12: Balance transmission risk in 2010. The table shows the balance between treatment and control group for the transmission risks variables measured in 2010. p-value shows the p-value of a t-test where the null hypothesis is that the difference in means between treatment and control group is zero. Panel A shows results for all respondents while panel B shows results excluding individuals living in the second biggest village pair which causes most of the imbalance.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	healthy	hiv	5 years	10 years	risky sex	$\pi_1 - \pi_0$	HIV prob
treatment	0.037***	0.047***	0.015	0.012	-0.187***	0.037***	-0.038***
	(0.011)	(0.014)	(0.014)	(0.017)	(0.046)	(0.013)	(0.014)
Observations	1320	1318	1303	1300	1373	1203	1354

Table C.13: Main results. Drop village pair that causes imbalance. The table shows regression coefficients for the effect of treatment on selected outcomes excluding individuals living in the second biggest village pair which causes most of the imbalance. Healthy and hiv refer to the update in population survival probabilities. 5 years and 10 years refer to the update in own survival probabilities. Risky sex is a dummy variable taking value 0 if sexually passive, 1 if having sex with the spouse only, 2 if having multiple sexual partners and using condom during the last intercourse, 3 if having multiple sexual partners and not using condom during the last intercourse. $\pi_2(1) - \pi_2(0)$ is the difference in transmission risk betweeen having sex with multiple partners and having sex with the spouse only. HIV prob is the update in the subjective probability of being HIV+ from baseline to the 2018 followup. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. Standard errors clustered at village level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	healthy	hiv	5 years	10 years	risky sex	$\pi_1 - \pi_0$	HIV prob
treatment	0.039***	0.042***	0.015	0.010	-0.151***	0.032*	-0.044***
	(0.011)	(0.014)	(0.012)	(0.016)	(0.046)	(0.017)	(0.014)
Observations	1379	1377	1349	1346	1429	1298	1409

Table C.14: Main results with entropy weights The table shows regression coefficients for the effect of treatment on selected outcomes reweighting the sample using entropy weights to balance treatment and control group on transmission risk having sex with multiple partners. Healthy and hiv refer to the update in population survival probabilities. 5 years and 10 years refer to the update in own survival probabilities. Risky sex is a dummy variable taking value 0 if sexually passive, 1 if having sex with the spouse only, 2 if having multiple sexual partners and using condom during the last intercourse, 3 if having multiple sexual partners and not using condom during the last intercourse. $\pi_2(1) - \pi_2(0)$ is the difference in transmission risk betweeen having sex with multiple partners and having sex with the spouse only. HIV prob is the update in the subjective probability of being HIV+ from baseline to the 2018 followup. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. Standard errors clustered at village level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

	(1) spouse risk ‖ HIV	(2) spouse risk $\pi_2(0)$	(3) extra-marital risk $\pi_2(1)$	(4) $\pi_2(1) - \pi_2(0))$
treatment	0.019	-0.001	0.039**	0.039**
	(0.020)	(0.005)	(0.017)	(0.017)
HIV+	0.043	-0.064***	0.020	0.030
	(0.055)	(0.022)	(0.063)	(0.046)
treatment × HIV+	-0.105	-0.039	0.039	0.144*
	(0.075)	(0.043)	(0.072)	(0.077)
Observations	1383	1267	1384	1266
R^2	0.061	0.109	0.064	0.089

Table C.15: Update Transmission Risk - Interactions with HIV status Update in the beliefs over HIV probability and transmission risk.The table shows regression coefficients for the treatment effect on beliefs over HIV transmission risk and for interactions with HIV status. HIV+ is a dummy equal to 1 if the respondent is tested positive for HIV during the HTC. Spouse risk ‖ HIV is the update from baseline MLSFH survey in 2010 to the follow-up survey in 2018 in the probability of becoming infected with HIV having sex with an HIV+ spouse over a year. $\pi_2(0)$ is the product of Spouse risk ‖ HIV and the subjective probability of the spouse being HIV+ at baseline. $\pi_2(1)$ is the update from baseline MLSFH survey in 2010 to the follow-up survey in 2018 in the probability of becoming infected with HIV having sex with multiple partners over a year. $\pi_2(1) - \pi_2(0)$ is the difference in transmission risk betweeen having sex with multiple partners and having sex with the spouse only. All regressions include village pair fixed effects, dummies for age categories used in the intervention, gender and years of schooling. Standard errors are clustered at village level. Standard errors clustered at village level in parentheses * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$