Research Article

Mixed-Method Evaluation of a Passive mHealth Sexual Information Texting Service in Uganda

Julian C. Jamison
julison@gmail.com
Senior Economist
Office of Research, Consumer Financial Protection Bureau
1700 G Street NW
Washington, DC 20552
USA
(202) 281-9759

Dean Karlan
dean.karlan@yale.edu
Professor of Economics
Yale University
27 Hillhouse Avenue, Room 23
P.O. Box 208269
New Haven, CT 06520
USA
(202) 432-4479

Pia Raffler
pia.raffler@yale.edu
Graduate Student
Yale University
Rosenkranz Hall
115 Prospect Street
New Haven, CT 06520
USA

Julian C. Jamison
Dean Karlan
Pia Raffler

Abstract

We evaluate the impact of a health information intervention implemented through mobile phones, using a clustered randomized control trial augmented by qualitative interviews. The intervention aimed to improve sexual health knowledge and shift individuals toward safer sexual behavior by providing reliable information about sexual health. The novel technology designed by Google and Grameen Technology Center provided automated searches of an advice database on topics requested by users via SMS. It was offered by MTN Uganda at no cost to users. Quantitative survey results allow us to reject the hypothesis that improving access to information would increase knowledge and shift behavior to less risky sexual activities. In fact, we find that the service led to an increase in promiscuity and no shift in perception of norms. Qualitative focus group discussions support the findings of the quantitative survey results. We conclude by discussing a potential mechanism explaining the counterintuitive findings.

I. Introduction

The rapid adoption of mobile phones in developing countries has created new opportunities for the dissemination of information to large populations at minimal cost. Many technology interventions aim to address societal or economic problems by passively making improved information available to users—for example, by disseminating price and market information to lower transaction costs and allow trades to occur that otherwise would not (e.g., Jensen's [2007] study of market price information for fisherman in India). However, other technology interventions may require more active engagement by service providers and end users to achieve their goals, as Toyama (2008) finds in a case study of computer-based educational programs in India. Although the split between passive and active is not always a clear dichotomy, one way to divide interventions is between those where users make queries to get specific information versus those where a central entity disseminates information widely and without prompting to a large number of individuals.

Many public health organizations have designed projects that use mobile technology to support health services and health education—

typically called mHealth projects (Vital Wave, 2009). MHealth technologies have been adopted in many contexts in developed nations, as the Internet has revolutionized people's access to health information (Lim, Hocking, Hellard, & Aitken, 2008). In less developed countries, where access to mobile phones has become increasingly common even as penetration of Internet access and fixed phone lines remains scarce (Vital Wave, 2009), such interventions have been actively promoted. Reviews of mHealth projects in developing countries (Déglise, Suggs, & Odermatt, 2012; Gurman, Rubin, & Roess, 2012; Kaplan, 2006; Mechael, 2009) have found some positive evidence on the success and cost-effectiveness of using mobile technology. However this literature is young and mostly comprises case studies reporting on operational outcomes and technology use rather than the more rigorous randomized trial methodology (Kahn, Yang, & Kahn, 2010). Nor has the mHealth literature explored how variations in the design of technological interventions may affect users' outcomes. In particular, the question remains: In such interventions, is merely passively improving access to information sufficient to further specific social health goals?

Here we use a mixed-methods approach to examine a passive, user-initiated, mobile phone–based health intervention in Uganda. The goal of the intervention was to provide improved access to sexual health information to improve users' knowledge of safe and unsafe sexual behaviors that would ultimately lead to reductions in risky behavior. The underlying assumption was that lack of information leads individuals to underestimate specific risks that they face and to engage in riskier behavior than they otherwise would have chosen. Thus, better information could make risks more salient and more likely to influence behavior.

Uganda has several features that make it a prime candidate for a technological intervention focused on sexual health. HIV prevalence is high, estimated to be 6.5% among adults aged 15 to 49 in 2009 (UNAIDS, 2010). In addition, knowledge regarding sexual health and HIV/AIDS is low, and risky sexual practices are prevalent (UNAIDS, 2010). The rapid increase of teledensity, from under 3% in 2002 to 33.5% in 2010 (Uganda Communications Commission, 2009, 2011), combined with a total adult literacy rate of 75% (2008) (UNAIDS, 2010), allowed this mHealth intervention to reach a large population.

The sexual health intervention we study was implemented by Google, the Grameen Technology Center, and MTN. The technology was developed primarily by Google and Grameen Technology Center. The technology enabled individuals to send free SMS messages with questions about sexual health, family planning, and local health services. The messaging services were provided by MTN, which is the largest mobile service provider in Uganda, with 60% of the market share in 2008 (Mulira, Kyeyune, & Ndiwalana, 2009/2010).

Studies of SMS-based mHealth interventions in wealthier countries have found evidence of significant improvements in preventive health behaviors, such as smoking cessation (e.g., Free et al., 2011) and self-management of asthma and diabetes (Galant & Maticka-Tyndale, 2004; Istepanian et al., 2009; Quinn et al., 2011). An intervention in Australia with similar aims to the intervention studied here showed that receipt of SMS messages with information on safe sexual practices over a one-year period was associated with improved sexual health knowledge and higher self-reported rates of testing for sexually transmitted infections (STIs) among women (Lim et al., 2012).[1]

In the developing world, the literature on information interventions has shown that providing individuals with information on new practices or technologies can (but does not always) significantly increase adoption of new agricultural practices (Duflo, Kremer, & Robinson, 2009; Foster & Rosenzweig, 1995), cleaner water sources or methods for water purification (Jalan & Somanathan, 2008; Madajewicz et al., 2007), and safer sexual practices (Adetunji & Meekers, 2001; Chong, Gonzalez-Navarro, Karlan, & Valdivia, 2013; Dupas, 2011). SMS-based mHealth interventions more similar to our study have been introduced in developing countries (UNAIDS, 2010), and there is suggestive evi-

1. However, it should be noted that the sexual health information that was presented to users in the Australian case was chosen by a socially minded organization, whereas in our setting information was disseminated in response to questions asked by end users, and the answers provided were factual and did not overtly convey a normative purpose or aim.

dence of positive impact on behavior, although not generated through randomized trials.[2] For example, mobile phone–based health projects in Africa with aims such as supporting community health workers (Mahmud, Rodriguez, & Nesbit, 2010) or improving adherence to antiretroviral treatment for HIV-positive patients (Haberer et al., 2010; Lester et al., 2010; Pop-Eleches et al., 2011) have found some evidence of significant impacts.

A valuable aspect of mobile technology as a health tool is that it allows two-way communication. Here, we examine one of the first technologies in the developing world that exploits that capability, enabling individuals to request information on sexual health from a database of reliable information. To our knowledge, this is the first evaluation of a project that enables individuals to receive SMS responses to direct health questions and the first rigorous evaluation of the impacts of any mobile phone–based health information intervention in a developing country.[3] The closest projects that we are aware of involve user queries followed by responses (via either text or phone) from a trained counselor.[4]

This article is structured as follows. Section II provides an overview of the intervention, and section III discusses the experimental design and the data. Section IV presents counterintuitive empirical findings of the intervention's effects on knowledge, behavior, and outcomes related to sexual and reproductive health. It also discusses potential mechanisms for these effects, informed by focus groups with users. Section V concludes.

II. Intervention

With Google and Grameen Technology Center, MTN developed and implemented a novel, interactive text-messaging platform in Uganda for mobile telephones. The service, which was developed independent of the study and is referred to as 6001 (the phone number to which text messages are sent), allows mobile phone users to text questions on sexual and reproductive health to a server. Once the text message is received, an algorithm-based trigger word search matches the query with a pre-prepared piece of advice from a database. The database of responses was compiled jointly by Marie Stopes International Uganda, an international nongovernmental organization (NGO) working on reproductive health issues, and Straight Talk Foundation, a Ugandan NGO specializing in communication on adolescence and sexuality. The database content consists of approximately 500 unique messages in categories such as HIV/AIDS, other STIs, maternal and neonatal health, body changes and sexuality, and family planning. Messages are about 500 characters long, consist of factual information presented in simple language, and often include an encouragement to use condoms or get tested for HIV. Users can send queries in English or Luganda and receive responses in the respective language. A sample of an SMS exchange in English is as follows:

Sample question 1:
What does HIV reinfection mean?

Response: There are different types (strains) of HIV/AIDS so even if you are already infected you can catch another type of the virus which can make you more sick. HIV reinfection is when somebody who already has HIV gets the virus again by having sex without a condom with an infected person or if infected fluid gets into their body through cuts/unsterilized sharp instruments. Use condoms EVERY TIME to protect yourself + others.

Trigger words: HIV, Aids, reinfection

Sample question 2:
Does urinating after sex kill sperms?

Response: Pregnancy happens when male sperm meets a female egg. They meet as a result of sex. Sperm have tails to help them swim up to the fallopian tubes + fertilize an egg. Pregnancy can NOT be avoided by having sex standing up or uri-

2. In 2008, the six-week pilot program of Text to Change in Uganda, later also run in Kenya, which administered an incentivized SMS quiz on HIV/AIDS and encouraged STI testing, was associated with a significant increase in the number of people who came to health clinics for STI testing. See http://www.texttochange.org/content/we-created-sms-campaign-increase-hivaids-awareness-uganda.

3. A similar technology with an SMS-searchable database of information on prescription medications has been designed but not evaluated by Langer, Kumar, Mittal, and Subramaniam (2009).

4. See "Text Me! Flash Me!" in Ghana (http://www.comminit.com/node/291748) and "Mobile4Good" in Kenya and Nigeria (http://oneworldgroup.org/mobile4good).

nating after sex. Family planning is the ONLY way to stop pregnancy. ONLY CONDOMS PREVENT HIV/AIDS+STIs. Reply 1 to learn about birth control, 2-emergency contraception, 3-jumping after sex, 4-asprin/panadol after sex to stop pregnancy, 5-signs of pregnancy.

Trigger words: Urinate, kill, sperm
Trigger: Blood, sex, STI, red, after, during

An additional feature of the service is an interactive clinic directory. Users can query clinic locations by sending a text message with a keyword and the location they are interested in and receive a reply with the names, contact information, and services offered by the nearest health facilities.

The initial idea for the service was to capitalize on the expanding reach of mobile networks and Google's technological know-how to improve access to socially beneficial information. After prototyping a number of ideas, the group settled on an SMS-based interactive advice service on sexual and reproductive health for three reasons. First, misconceptions about sexual and reproductive health are widespread in Uganda, and access to reliable information and sexual education is limited. Second, the team deemed sexual and reproductive health an area of health care that lends itself well to giving advice without providing diagnoses. Third, the team thought that the confidentiality and anonymity of a mobile phone–based service would be especially valued. The service was piloted in two suburbs of Kampala and launched in June 2009. The service was open to the public and available to both MTN and non-MTN network users, although it was free for MTN clients and cost the price of a regular text message for non-MTN clients.[5]

Pie charts (Figure A1) in the Appendix summarize categorically the type of information disseminated. Not considering "uncategorized" responses, the modal category of queries was "body changes and sexuality," with 31% of answers.[6] Within this category, 40% were questions on sex (12% of overall answers), and 31% were questions on genital organs (9% of overall answers). The second largest category was miscellaneous (17%), and the third largest category was HIV (10%). Maternal and neonatal health comprised 8% of the questions. Although issues of intellectual property and participant privacy prevented a rigorous test for concordance, in ad hoc testing by the researchers and more rigorous testing by the developers, the English-language information disseminated matched the information requested well. According to anecdotal evidence, the search algorithm performed less well in Luganda. This notwithstanding, among those respondents who reported using the service in our end line survey, 73% responded that they found the information very useful, and another 19% said they found it useful. Responses were similar when restricting the sample to those respondents who reported having used the service in Luganda (69% and 22% said they found the information received from the service very useful or useful, respectively).[7]

III. Experimental Design and Survey and Qualitative Data

Experimental Design

Clustered Encouragement-Design Randomized Evaluation

We conducted a clustered randomized evaluation in 60 villages across the four districts of Masaka, Mpigi, Mityana, and Mubende in central Uganda. Villages were randomly assigned to either the treatment or control group. From August through October 2009, treatment villages were exposed to a targeted, high-intensity marketing campaign by a professional marketing firm. Marketing teams visited trading centers three to six times, depending on population size, and each time spent a full day promoting the service through demonstrations, flyers, and posters in both English and Luganda. This mar-

5. Although MTN's original plan was to charge a nominal fee for the service, it has not yet added the fee, nor are we aware of a plan to add one.
6. Unfortunately, miscellaneous and uncategorized texts make up about one-third of the responses. Due to privacy regulations, we have access only to the categories of sent responses and are therefore unable to categorize these texts.
7. The corresponding survey question read, "How useful would you say was the information you received: very useful, useful, somehow useful, or not useful?" The question was answered by 277 respondents, of whom 180 said they had used the service primarily in Luganda.

keting provided the encouragement to use the service.[8] The new service was presented as an anonymous, objective source of information to which users could send any question related to sexual and reproductive health. No benefit or incentive accrued to respondents in the treatment group other than being informed about the free service and trained in using it, and the marketing was conducted as part of a national marketing push by a well-established marketing firm.

The goal of the targeted marketing campaign was to achieve higher uptake in treatment locations than in control locations. The entire study area was largely blocked off from national marketing media campaigns, such as radio and newspaper ads, to minimize awareness and use of the service in the control group.[9] As shown by the differential in uptake between the treatment and control groups, this was effective (Figure A1 and Table A2 in the Appendix). Although usage is not substantially different between treatment and control groups after November 2009, most of the overall usage in the study area comes before that point and was heavily concentrated in the treatment communities.[10] This allows us to evaluate rigorously the impact of introducing the service, but this is not an estimate of a program that receives ongoing encouragement and marketing, since the program only conducted one large initial marketing effort. The study was approved by three human subjects committees: Yale University, Innovations for Poverty Action, and the Uganda National Council of Science and Technology (#SS2176).

Data Sources

To obtain a more complete picture of the impact of the mHealth intervention, we combine different research methods. Although we primarily use quantitative data to assess the impact of the intervention, we also collected extensive qualitative data to better understand users' perception of the service, to shed light on the mechanisms through which the service had an impact, and to understand its limitations. A flow chart of the evaluation is presented in Figure A2 in the Appendix.

Quantitative Data

The quantitative data come from four sources: an individual survey conducted at baseline, another at end line, a community survey, and metadata on topics queried at 6001 from MTN. All quantitative data were collected using identical procedures in both the treatment and control areas.

The baseline survey was conducted prior to the launch of the intervention by enumerators hired by our research team independent of MTN, the Grameen Technology Center, and Google. A total of 1,791 randomly selected individuals from all 60 study villages were interviewed in February 2009. The household selection was conducted by random walk, and individual respondents were randomly selected from a household roster.[11] Household members were eligible to participate in the survey if they were 18 to 35 years old, had a functioning phone with an MTN SIM card in the household, and had completed a minimum of six years of primary school (because literacy was essential to use the 6001 service).

8. Encouragement designs are often used in social science evaluations where it is difficult or impossible to ensure that all members of the treatment group get fully treated, and no members of the control group receive any treatment (i.e., perfect compliance). Instead, the treatment group is encouraged to participate through information or incentives, and the control group is not encouraged. The estimation depends on the strength of the encouragement to create differential usage in treatment and control groups. This approach estimates the impact only on those whose participation is affected by the encouragement. Those who would have participated regardless of the encouragement are treated in both the treatment and control group, and thus differenced out in the treatment effect estimates. The encouragement design in this study initially creates differential usage, but that usage eventually converges between the treatment and control groups, as shown in Figure 1. Thus, our research design estimates the impact of the initial encouragement marketing push, not that of a program that has ongoing marketing.

9. Although the national launch of the service took place at about the same time as the high-intensity marketing campaign, ads were limited to local newspapers and radio programs that targeted other parts of the country. MTN marketing trucks did not pass through the study districts.

10. From December 1, 2009, to April 1, 2010, the average number of text messages sent per day from all phones associated with the treatment villages was 4.0, compared to an average total number of 1.5 messages sent per day from all phones associated with the control villages. The difference in means is highly statistically significant.

11. For random selection of respondents, field teams drew detailed maps of the village and visited every xth household, where x was dependent on the overall population of the village. If no person was eligible at the selected house-

The follow-up survey was conducted one year after the baseline in February 2010, with a larger sample of 2,424 respondents. One methodological goal of this study was to determine whether being previously surveyed had an effect on mHealth service usage. Therefore, a randomly selected 1,200 baseline respondents were interviewed again for the follow-up,[12] and 1,224 new respondents were chosen from among the sample communities according to the same criteria as in the baseline.[13] Given that the marketing intervention only began in August 2009, the period between the first encouragement to use the service and end line data collection was six months. The plan had been to roll out the intervention immediately following the baseline, but delays occurred on the side of the implementing partners. The follow-up survey could not be extended because of contractual obligations and negotiations with the different parties to this intervention.

The community survey on general community characteristics was conducted with two to four knowledgeable people from each community, including the elected local chairperson, at the same time as the baseline and follow-up surveys. Observable characteristics such as mobile network coverage, distance to the nearest health center, and distance to a tarmac road were verified by enumerators. Finally, we collected data from MTN and Google on the topics queried on 6001 for the entire study period.

Qualitative Data

In addition to the quantitative data sources described above, we conducted eight focus group discussions and 39 individual in-depth interviews in eight treatment villages after the end line was conducted. Two treatment villages from each of the four study districts were randomly selected for inclusion in the qualitative study. Within the villages, researchers interviewed a convenience sample of people who had used the service. Given the gender-sensitive topic, men and women were interviewed separately by an enumerator of their own sex. Topics covered include perception of the service; usage behavior; perceived knowledge, behavior, and attitude changes; and user experience. All interviews, both qualitative and quantitative, were conducted in the local language.

Quantitative Measures

As main outcome variables from the survey, we use composite indices of HIV knowledge, contraception knowledge, attitudes toward condom use, nonpromiscuity, safe sexual behavior, sexual health outcomes, health-seeking behavior, and perceived own risk compared to others.[14]

We use a list randomization technique (Corstange, 2009; Karlan & Zinman, 2012) to obtain

hold, enumerators went to the immediate next household. Once they had identified an eligible respondent, they continued to the xth next household.

12. A total of 385 selected respondents had to be replaced with other randomly selected respondents from the baseline because they could not be located for the interview at end line. Attrition is balanced across the treatment and control groups.

13. That is, aged 18 to 35, current MTN phone ownership in the household (i.e., at time of the end line), and completed at least six years of primary education. The households were chosen within villages in the same random walk manner.

14. Index components are equally weighted and had been standardized prior to index construction. Missing values resulted in list-wise deletion. Respondents receive one point for each "good" response. The indices presented in Table 2 consist of the following components: (1) Contains variables on HIV transmission during pregnancy, delivery, breastfeeding, and nontransmission by sharing food or through mosquito bites. (2) Contains variables on named contraception methods (pills, injections, female condoms, foam, IUD, implants, male condoms, emergency pill, female sterilization, male sterilization). (3) Contains variables on agreement with the statements, "A male condom should always be put on before intercourse" and "It is not embarrassing to buy or ask for a condom." (4) Contains: Never been unfaithful in past 3 months, number of sexual partners in past 3 months, relationship to last sexual partner was neither casual acquaintance nor commercial sex worker, interacted with recent sex, used any type of contraceptives during last sex, interacted with recent sex and used condom during last sex, interacted with recent sex. (5) Contains: Never been unfaithful in past 3 months and number of sexual partners in past 3 months. (6) Contains: Relationship to last sexual partner was neither casual acquaintance nor commercial sex worker interacted with recent sex, used any type of contraceptives during last sex interacted with recent sex and used condom during last sex, interacted with recent sex. (7) Contains: Ever had a sexually transmitted disease (STD), ever had a bad-smelling discharge, ever had genital sore or ulcer, current (or partner's) pregnancy is unwanted and currently pregnant (or partner). (8) Contains: Ever tested for HIV, ever sought treatment for an STD, and ever visited health center/worker for an issue related to sexual and repro-

more truthful answers on sensitive topics, such as condom use, the number of sexual partners, unfaithfulness, and attitude changes with respect to the social acceptability of these behaviors. A randomly selected half of the sample was asked the sensitive question in the form of a true or false statement (direct elicitation). In addition, we asked how many of four innocuous statements were true for them, without telling us which ones. The other half of the sample was not asked the sensitive question, but rather we asked how many of five statements consisting of the same four innocuous ones plus the sensitive statement were true for them, without telling us which ones (indirect elicitation). Since respondents were randomly assigned to either elicitation method, the number of the four innocuous statements that are true for them is expected to be the same. Randomization to the direct or indirect elicitation group was repeated for each survey question asked this way. Subtracting the mean number of true statements in the direct elicitation group from the mean number of true statements in the indirect elicitation group then gives us an unbiased estimate of the percentage of our sample for whom the sensitive statement was true, without, however, being able to tell for which individual it was true. For an indirect measure of the number of sexual partners, we asked respondents assigned to the indirect elicitation group to roll a playing die and add the number of sexual partners in the past three months to the number rolled and to only report the sum of the two values. Subtracting 3.5, the average face value of a rolled fair die, yields the average number of sexual partners reported by individuals in the indirect elicitation group.

One advantage of these methods is that they elicit responses to sensitive questions that are less biased by social desirability. Another advantage is that they allow us to estimate the impact of the intervention on changes in perceptions of social norms by comparing the difference between direct and indirect responses—that is, a measure of social desirability across the treatment and control groups—of specific behaviors. To our knowledge, the use of indirect elicitation techniques to estimate the impact of an intervention on attitudes, on perceptions of what one *should* answer, is novel.

Orthogonality and Treatment Compliance

Table 1 shows that the assignment to treatment was orthogonal to key demographic variables, mobile phone use, community characteristics, and baseline values for key outcomes measures.[15] Of particular relevance for the intervention is the ability to read. Over 80% of respondents were able to read without difficulty in either English or Luganda, as observed by enumerators. Literacy levels are balanced across the treatment and control groups.

Table A2 in the Appendix shows the usage data from both self-reports and from MTN data that confirm the success of the encouragement design in generating large differences in use between treatment and control areas. Seven percent of respondents in the control group had ever sent a text message to the service's short code 6001, compared to 40% in the treatment group. The difference between treatment and control groups in the number of text messages sent remains significant after the end of the marketing campaign, although we do see a marked drop in use of the service after the marketers left the villages. In qualitative interviews, respondents in treatment villages said they would have liked to be reminded about the existence of the service for a longer time. Usage trends are displayed in Figure 1. Among those who used the service, the median number of text messages sent to 6001 is four. Figure 2 displays the distribution of the number of text messages sent to the service. About 40% of the users sent messages on only one day, 21% on two days, 23% on three to five days, and 16% on six or more days. The median number of days between first and last use of the service is six days. Among those above median in terms of usage frequency, usage was over an extended time: the median number of days between first and last use is 35. Users were more likely to be male, young, married, to own a personal phone, have slightly higher education levels, and to be wealthier (proxied by number of meals eaten per day); see Table A3. High-frequency users had comparatively low levels of knowledge of sexual and reproductive health at baseline (see Tables A4 and A5 in the Appendix).

ductive health. (10) Contains variables on perceived risk taking relative to other people and perceived own HIV risk. Average treatment effects on each index component are presented in Tables A4 to A10 in the Appendix.

15. Balance tests for additional variables are presented in Table A1 in the Appendix.

Table 1. Summary Baseline Values and Balance Tests

	Treatment		Control		*p* value
	N	**Mean**	***N***	**Mean**	***T* vs. *C***
			Demographics		
Male	894	0.49	897	0.50	0.59
Age	894	25.37	896	25.26	0.67
Years of education	892	8.14	893	8.11	0.80
Respondent owns a mobile phone (%)	894	0.72	897	0.71	0.67
Ever sent a text message or SMS? (%)	887	0.63	886	0.61	0.30
			Community characteristics		
MTN coverage (scaled 1–5)	30	4.07	30	4.00	0.82
Distance to next tarmac road (km)	30	14.79	30	16.09	0.75
			Main outcomes		
HIV knowledge index	894	0.00	895	0.00	1.00
Contraceptive knowledge index	894	0.00	895	0.00	0.96
Condom use attitudes index	891	0.09	887	0.00	0.05
SRH outcome index	894	−0.07	897	0.00	0.12
SRH service seeking index	894	−0.03	897	0.00	0.48
Ever had sex in past 12 months (%)	891	0.81	892	0.80	0.73
Perceived relative nonriskiness index	886	−0.03	891	0.00	0.48

Note. SRH stands for sexual and reproductive health.

IV. Empirical Results

We use survey data to measure different outcomes Y for estimating intention-to-treat effects with the ordinary least squares specification:

$$Y_i = \beta_0 + \beta_1 * T_i + \beta_2 * BY_i + \beta_2 * Endlineonly_i + \beta_4 * X_i + \varepsilon_i,$$

where Y_i denotes an outcome variable, T_i is a dummy variable that takes the value 1 if individual i lives in a village assigned to the treatment group, BY_i captures the baseline value of outcome variable Y_i for respondents on which we have both baseline and end line observations, and takes the value 0 otherwise. $Endlineonly_i$ is a dummy variable that takes the value 1 if a respondent was in the end line only. X_i is a vector of control variables including demographics and the stratification variables. The robust error term ε_i is calculated allowing for clustering at the village level, which is the unit of randomization. In addition, we analyze whether impact was heterogeneous with respect to gender, as many interventions on sexual health target by gender in particular (although this intervention had no such focus).

Our primary theory was that the intervention effectively improved access to reliable information about sexual health, and that this would lead to higher knowledge. With the assumption that low levels of information lead individuals to underestimate the riskiness of unsafe sex, the theory of change then posits that higher knowledge will change attitudes and then lead to less risky sexual behavior. We now proceed through this theory of change step by step.

Hypothesis 1: Access to the texting service increases knowledge on HIV and/or contraception. Although respondents reported that "those who used the service learned how to protect themselves against diseases like AIDS, syphilis, and other diseases" in qualitative interviews, in the quantitative survey data we do not find a measurable impact on knowledge relative to the control group. Table 2 Panel A presents results for H1 with respect to knowledge regarding possible modes of HIV transmission and regarding contraception methods and use, respectively. We find no support for H1 in

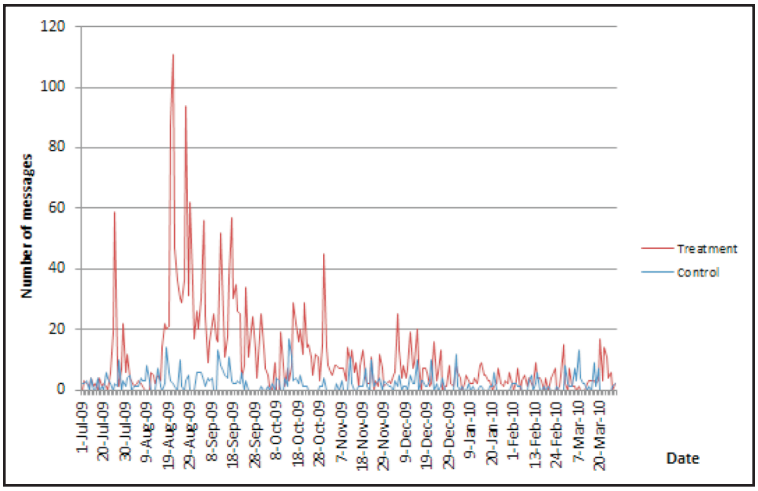

Figure 1. Usage trends by treatment status.

Note. The graph shows the number of messages sent to 6001 from survey respondents' phone numbers by treatment status, for a total of 3,192 messages from 279 phones, over the course of the study period. Marketing started on August 17, 2010. The usage data displayed here is based on institutional data from MTN. The service was launched prior to the high-intensity marketing intervention, explaining the nonzero usage before August 17.

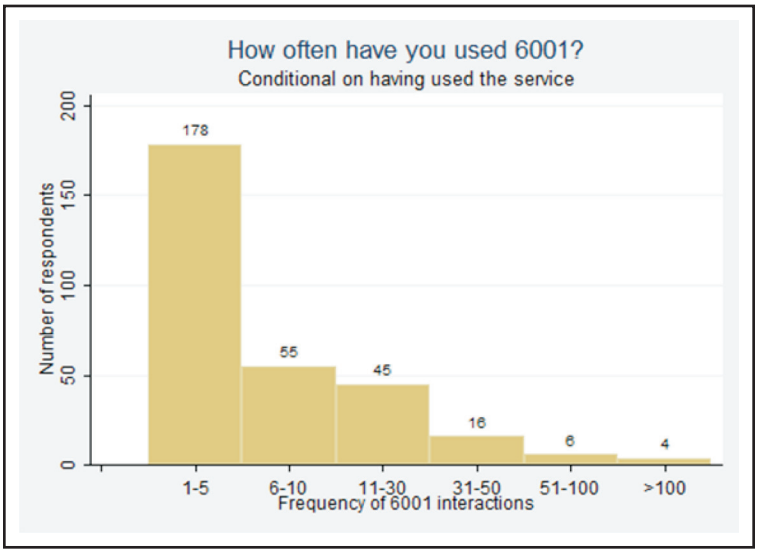

Figure 2. Self-reported number of interactions with service among users.

aggregate for either outcome index. We also do not find heterogeneity with respect to gender.

Hypothesis 2: Access to the texting service changes attitudes toward safer sexual practices with respect to condom use. The theory of change predicts that increased knowledge would shift attitudes toward less risky sexual attitudes toward condom use. However, since knowledge did not increase, we do not expect to see a change in attitudes. Table 2 Panel B presents results for H2, and, indeed, we find no support for H2 in aggregate or by gender.

Hypothesis 3: Access to the texting service, through an increase in HIV knowledge, leads to safer sex and less promiscuous sexual activity. The observed impact on sexual behavior is the opposite of what we expected. Our theory of change predicts that increased knowledge would shift attitudes, which would then shift behavior. Since H1 and H2 were rejected, we do not expect to find support for H3. Table 2 Panel C presents results for sexual behavior. No support is found for H3, and, in fact, the results are the opposite: We find the composite index of nonrisky behavior decreases (i.e., shifts toward riskier behavior), as does the index of nonpromiscuity. The overall behavioral index decreases by 0.11 standard deviations ($p = 0.017$). The treatment effect for men is two and three times larger, respectively, than that for women; however, this gender difference is not significant statistically (p value of the test of equality of the coefficients for men versus women is 0.53 for the aggregate index, 0.17 for the nonpromiscuity index, and 0.75 for the safe sex index). One possible explanation for this finding is that people learned from the service how to protect themselves. As one respondent put it in a qualitative interview:

> If men learned through this service that there is a way of minimizing the chances of being infected with an STI—say, by using a condom—they may

find the courage to begin having more relationships outside the one they are already having.

However, we believe the evidence suggests that people engaging in promiscuous behavior were no more likely to use condoms.[16]

Table 3 reports results on direct versus indirect elicitation (i.e., employing a list randomization technique [Corstange, 2009]) on three key behaviors: use of condoms during last occurrence of sexual intercourse, unfaithful behavior in last 90 days, and number of sexual partners in last 90 days. Again, we find little support for hypothesis H3. Using indirect elicitation, we find no significant improvements in sexual behavior, but rather the opposite.

In fact, for two of the three outcome measures, we find the opposite of the intended effect. For infidelity, we find an increase overall from 12% to 27% (*p* value of 0.02). Infidelity is defined as ever having been unfaithful to one's current partner in the past three months. Single respondents are recorded as not having been unfaithful. For number of sexual partners, we find an overall increase from 0.62 to 0.85 (*p* value of 0.04). Men increase the number of partners from 0.63 to 1.04 (*p* value of 0.02), whereas women increase the number of partners from 0.61 to 0.69 (*p* value of 0.59). One might have expected at least women to underreport their number of partners, but given that the averages are below 1, our result is less surprising.

Hypothesis 4: Individuals are more aware of the risks associated with their behavior. The theory of change starts with improving access to information, leading individuals to be more informed about sexual health. This measure combines knowledge with a potential change in actual behavior and examines whether individuals change their perception of the riskiness of their behavior. Table 2 Panel D presents the results for H4. We find in aggregate a decrease in perception of one's own nonriskiness (i.e., safeness) compared to others. This finding is also confirmed by qualitative interviews. Respondents reported that they became more sensitive to the risks associated with different sexual behavior, summarized by one young man as "I felt that unprotected sex was riskier, and protected sex was safer," and were more likely to advise friends and relatives whom they considered at risk to go for HIV testing.

Hypothesis 5: Access to the texting service changes individual behavior and perception around norms toward safer and less promiscuous sex—that is, individuals perceive that it is more acceptable socially to engage in safe sex relative to risky sex and to engage in less promiscuous behavior. Table 3 presents the results for testing H5, and we find support for it. Here we use the comparison between direct and indirect elicitation (list randomization and roll of the die) on the survey to infer a change in norms. We compare what individuals tell our surveyors during follow-up data collection about their behavior in direct elicitation questions (which may suffer from social desirability bias) compared to what the respondents reveal on average to be their true behavior (through the list randomization and die-rolling techniques). The empirical test is a difference-in-difference estimator, comparing the treatment minus control for direct compared to indirect elicitation. The three outcome measures are no condom use at last sexual intercourse, unfaithful in past 3 months, and number of partners in past 3 months.

On the self-reported direct elicitation of risky behavior, we find few, if any, changes. However, as shown for H3, we find large increases in risky sex and promiscuous behavior when asked indirectly. This difference between direct and indirect elicitation is important, and revealing, about changes in norms among the studied population. It implies that either norms for those in our study did not change (i.e., the direct elicitation reveals what people believe they *should* do) or through increased knowledge individuals learned what they are supposed to say (i.e., a shift in norms toward safer behavior, despite a shift toward riskier actual behavior).

16. We do not find any evidence that the service led people to use condoms (the coefficient on condom use during last sex interacted with having had sex in the past year is small, negative, and not significant; see Appendix Table A7, column 6). Since we find evidence that the service resulted in some users being more promiscuous, any increase in condom use among people who became more promiscuous would have needed to be accompanied by a decrease in condom use by other respondents in the treatment group to result in the overall null finding on condom use. While we cannot rule this out, we believe this is unlikely, implying that there was no increase in condom use by those engaging in more promiscuous behavior.

Table 2. Main Outcome Variables

	Overall			By Gender						
				Men		Women		*F* test: Men = Women		
Treatment effects on	**β**	***SE***	***n***	**β**	***SE***	**β**	***SE***	***F* stat**	***p***	***n***
A. Knowledge										
(1) Composite HIV knowledge index	0.0575	0.04	2,274	0.0347	0.05	0.0793	0.06	0.34	0.56	2,274
(2) Composite contraception knowledge index	0.0196	0.03	2,275	−0.0124	0.05	0.0501	0.04	1.00	0.32	2,275
B. Attitudes										
(3) Condoms use attitudes index	0.0064	0.04	2,266	0.0465	0.04	−0.0318	0.05	1.91	0.17	2,266
C. Behavior										
(4) Composite current behavior index*	−0.01128**	0.05	2,275	−0.1552**	0.06	−0.0723	0.06	1.03	0.32	2,275
(5) Non-promiscuity index*	−0.1096**	0.04	2,266	−0.1679***	0.06	−0.0543	0.06	1.90	0.17	2,266
(6) Safe sex behavior index*	−0.0521	0.04	2,270	−0.0797	0.06	−0.0258	0.08	0.25	0.62	2,270
(7) Composite outcome index	−0.0400	0.04	2,275	−0.0425	0.05	−0.0377	0.06	0.00	0.96	2,275
(8) Health services index	−0.0210	0.04	2,275	−0.0369	0.06	−0.0059	0.05	0.21	0.65	2,275
(9) Ever had sex in past 12 months	−0.0393**	0.02	2,264	−0.0142	0.03	−0.0631***	0.02	2.25	0.14	2,264
D. Risk Perception										
(10) Perceived relative nonriskiness index	−0.1010**	0.04	2,267	−0.1754***	0.06	−0.0300	0.06	2.99	0.09	2,267

*Note. All regressions include controls for baseline values unless indicated with *. Robust standard errors are clustered at the village level. Controls for stratification variables are included. Index composition:*
(1) Contains variables on HIV transmission during pregnancy, delivery, breast-feeding, and nontransmission by sharing food or through mosquito bites.
(2) Contains variables on named contraception methods (pills, injections, female condoms, foam, IUD, implants, male condoms, emergency pill, female or male sterilization).
(3) Contains variables on agreement to "A male condom should always be put on before intercourse" and "It is not embarrasing to buy or ask for a condom."
(4) Contains: Never been unfaithful in past 3 months, number of sexual partners in past 3 months, relationship to last sexual partner was neither casual acquaintance nor commercial sex worker interacted with recent sex, used any type of contraceptives during last sex interacted with recent sex and used condom during last sex, interacted with recent sex.
(5) Contains: Never been unfaithful in past 3 months and number of sexual partners in past 3 months.
(6) Contains: Relationship to last sexual partner was neither casual acquaintance nor commercial sex worker interacted with recent sex, used any type of contraceptives during last sex interacted with recent sex and used condom during last sex, interacted with recent sex.
(7) Contains: Ever had an STD, ever had a bad-smelling discharge, ever had genital sore or ulcer, current (or partner's) pregnancy is unwanted and currently pregnant (or partner).
(8) Contains: Ever tested for HIV, ever sought treatment for an STD and ever visited health center/worker for an issue related to SRH.
(10) Contains variables on perceived risk-taking relative to other people and perceived own HIV risk.
**p < 0.10. **p < 0.05. ***p < 0.01.*

Table 3. Difference-in-Difference Between Direct and Indirect Responses.

	No condom at last sex				Unfaithful				Number of partners			
	Direct proportion	**Indirect proportion**	**Diff: Direct-Indirect**	**Diff in Diff**	**Direct proportion**	**Indirect proportion**	**Diff: Direct-Indirect**	**Diff in Diff**	**Direct proportion**	**Indirect proportion**	**Diff: Direct-Indirect**	**Diff in Diff**
Overall												
Treatment	0.649	0.681	−0.032		0.129	0.268	−0.139***		1.195	0.854	0.341***	
	(0.02)	(0.04)	(0.05)	−0.063	(0.01)	(0.05)	(0.04)	−0.157***	(0.04)	(0.08)	(0.09)	−0.171
Control	0.667	0.635	0.031	(0.06)	0.137	0.119	0.018	(0.06)	1.131	0.619	0.512***	(0.12)
	(0.02)	(0.04)	(0.04)		(0.01)	(0.05)	(0.05)		(0.03)	(0.08)	(0.09)	
Diff: *T-C*	−0.018	0.046	0.063*		−0.008	0.149**	−0.157***		0.064	0.235**	−0.171*	
	(0.03)	(0.06)	0.05		(0.02)	(0.06)	(0.05)		(0.05)	(0.12)	(0.09)	
N	1,220	1,175	2,396		1,242	1,123	2,365		1,241	1,154	2,395	
Male												
Treatment	0.578	0.715	−0.137**		0.197	0.270	−0.072		1.318	1.037	0.281*	
	(0.03)	(0.06)	(0.07)	−0.146**	(0.02)	(0.07)	(0.06)	−0.091	(0.07)	(0.12)	(0.14)	−0.263
Control	0.586	0.576	0.009	(0.08)	0.196	0.178	0.018	(0.09)	1.172	0.628	0.544***	(0.18)
	(0.03)	(0.06)	(0.06)		(0.02)	(0.07)	(0.07)		(0.05)	(0.13)	(0.14)	
Diff: *T-C*	−0.008	0.138**	−0.146**		0.001	0.092	−0.091		0.146*	0.409**	−0.263*	
	(0.04)	(0.08)	(0.07)		(0.03)	(0.09)	(0.07)		(0.09)	(0.18)	(0.14)	
N	581	573	1,154		610	524	1,134		608	544	1,152	
Female												
Treatment	0.711	0.649	0.062		0.061	0.266	−0.205***		1.076	0.691	0.385***	
	(0.03)	(0.06)	(0.06)	0.007	(0.01)	(0.06)	(0.06)	−0.219**	(0.05)	(0.10)	(0.11)	−0.096
Control	0.743	0.688	0.055	(0.08)	0.081	0.067	0.014	(0.09)	1.092	0.611	0.481***	(0.15)
	(0.02)	(0.06)	(0.06)		(0.02)	(0.06)	(0.06)		(0.05)	(0.10)	(0.11)	
Diff: *T-C*	−0.032	−0.039	0.007		−0.020	0.199**	−0.219***		−0.016	0.080	−0.096	
	(0.04)	(0.08)	(0.06)		(0.02)	(0.09)	(0.06)		(0.06)	(0.15)	(0.11)	
N	639	603	1,242		632	599	1,231		633	610	1,243	

Note. Simple difference in means comparison. The third column compares respondents who were directly or indirectly (using ListIt methods) asked, within a treatment group. The third row compares respondents between treatment and control group, within an interview method. The fourth column presents the difference-in-difference, i.e. the difference between the two differences (Direct-Indirect and Treatment-Control). Standard errors are presented in parentheses.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

Importantly, we are able to reject the opposite of H5: that behavior shifted toward riskier, more promiscuous behavior because norms likewise shifted toward riskier, more promiscuous behavior. Had this been true, we would have observed increases in the direct elicitation method as well as the indirect method. This is consistent with the qualitative interviews, in which respondents throughout stressed individual considerations in engaging in safer or more risky sexual practices, but did not refer to norms shifting.

Why Did 6001 Not Have the Intended Effects? Qualitative Evidence

Qualitative interviews shed light on the reasons why the 6001 service had such a counterintuitive impact. For information provision to result in behavior changes and improved health outcomes, people must use the service, obtain useful information from the service, and be willing and able to act on the information. While a number of respondents said that they learned about risk prevention and STI symptoms from the service and thus changed their behavior, others mentioned reasons for not using the service or not acting on the information received. We summarize the two most common responses below.

As shown in Figure 1, use of the service dropped markedly after the marketing period. This appears to have been driven by two factors. First, many people said they missed being reminded about the service:

> When there is a new thing introduced, we all get excited about it, but after a while, we tend to forget. That is what happened to me, I used the service for a while, then soon forgot about it, and if you hadn't come to ask about it, I don't think I was going to think about it for a long time. But since you have come, I think I will try it again . . . by the way, is it still working?

Second, some respondents said that they were dissatisfied with the quality of the search algorithm in Luganda, which was chosen by most users: "That was the issue: you would ask one question, but receive another answer." One respondent highlights negative social feedback loops amplifying the effect:

> This service confused people [by] giving inappropriate responses to their questions, and yet it was the newest service at the time. You see when something has just come, people try it and if they get dissatisfied with it they leave it very fast. . . . Now the reason why most people stopped using the service was that whenever they would ask their friends whether they received an appropriate response to their query, the answer they would receive was no—which would resonate with their own experience. That is where it would end, and the service died like that.

In sum, our qualitative interviews underline the importance of constant reminders, positive social feedback loops, and a positive user experience in the beginning to achieve sustained use of new technology. Recall also that the majority of respondents claimed to have found the service either "very useful" or "useful," so it is difficult to know exactly how much weight to place on stories of initially confusing or inappropriate responses.

Respondents also suggested that they faced constraints on their ability to change their behavior, even after receiving accurate information on sexual and reproductive health, for two main reasons. First, lack of access to resources could pose a stumbling block. One respondent poignantly asked:

> Now you have the information, and you are even told where to get further tests and treatment, but you don't have money for treatment, or even transport to the place you have been referred to. Now have you been helped at all?

Second, since risky sexual behavior inherently involves more than one person, respondents may not have been able to stop engaging in risky practices due to the power balance in their relationship. Specifically, it can be difficult for Ugandan women to stand up to their male partners:

> You may tell him that let's start using condoms to protect ourselves, after getting advice from these messages . . . because I am worried about our situation. He then asks why you are worried, how come; all along you had never gotten worried. When you tell him the source of the information, trouble then starts. For example, saying that MTN does not live in my house so cannot decide for me what to or not to do.

Based on the qualitative interviews, this effect is even more pronounced for younger, unmarried women of lower socioeconomic status.

Considering that a small number of people used the service in a sustained manner, only some of whom received the relevant information and were then willing and able to act on it, it is not surprising that we see many null effects.

V. Discussion and Conclusion

We evaluate a novel mobile phone–based health program in Uganda, developed and implemented by partner organizations, in which treatment communities were randomly assigned to learn about a service providing individually initiated access to information on sexual and reproductive health via text messages. We find no increase in health knowledge regarding HIV transmission or contraception methods and no change in attitudes. Rather than seeing reductions in risky sexual behavior, we actually find higher incidence of risky sexual behavior and more infidelity, although more abstinence as well. Overall, individuals perceive their behavior as being riskier, which could be an indication of better probabilistic assessments but is also likely a result of the riskier (self-reported) behavior and possibly a desire to answer the surveyor in a socially desirable way.

Mechanisms of change are typically difficult to isolate, and this evaluation is no different. This was a fairly dynamic intervention, with different and endogenous intensities of treatment, likely heterogeneous treatment effects, a limited (albeit still large) sample frame for analysis, and highly sensitive outcomes. That said, we posit two mechanisms that may have been influential: a change in norms toward risky behavior and sexual sorting. Using a novel application of the indirect list randomization methodology to estimate a treatment effect on social desirability bias, we find no evidence that individuals in the treatment group perceive risky sexual behavior as more socially acceptable.

We believe the sexual sorting mechanism is more likely and worthy of further research to isolate and measure it more fully. In particular, qualitative interviews suggest sexual sorting as a possible mechanism for change. Both men and women respondents reported that married women learned from the service about the risks associated with having an unfaithful partner and that women used the service to highlight what they already knew and, as a result, insisted that their husbands be faithful and go for testing with them. Some husbands complied, and others did not, leading women to deny them sex and men to seek it elsewhere. One woman summarized this situation as, "Once he wants sex, he means it, yet the woman is dodging him around [because she became aware of the risks], so he decides to get another one to satisfy his desires."

Sexual sorting is also supported by the finding that there was, on average, a 4-percentage-point reduction in the likelihood of recently having had sex (p value of 0.02). This is largely driven by women, who are 6.3 percentage points less likely to have had sex in the past 12 months (p value of 0.00), compared to a decrease of 1.4 percentage points for men (p value of 0.58). Although technically we cannot reject the null hypothesis that treatment effects are the same for men and women, we do have suggestive evidence that the increase in promiscuity was driven by men (p value of 0.17), and the decrease in sexual activity was driven by women (p value of 0.14).

Naturally, since the type of information individuals receive depends on the questions they pose and there is much variety, there should be no surprise that the impacts indicate a multitude of uses and mechanisms. Previous work on sexual health in East Africa (Madajewicz et al., 2007) has found that young women responded to information about HIV risks by switching to lower-risk partners, but only in the context of an NGO-led program with a clear message and face-to-face interaction.

In our setting, individuals must first choose whether to access the service, then what to ask, and finally what (if anything) to do with the information received. We find that easing access to this information is insufficient to induce safer behavior and may, directly or indirectly, lead to riskier choices. It may be that only in the presence of a guiding hand, such as a local health worker, can this category of information improve outcomes, but our study does not vary that feature so we can only suggest this as a potentially important mechanism. Additional work is needed to study whether such first-order interventions work on particular demographics, and what changes to the intervention—for example, inclusion of a personalized component—are necessary for other demographics. We also find evidence from a variety of sources suggesting sexual sorting as a potential mechanism, which generates distributional impacts over and above the average impacts. We believe that further research should focus on understanding such differential responses to information campaigns. Finally, as in any evaluation, the findings may be contingent on the specific setting in which it occurred and the specifics of the partner organization's implementation. Thus, one should not draw extreme conclusions from this study about the

efficacy of *any* technology-driven information intervention; rather, it would be appropriate to learn from this study that the mere introduction of an information technology, designed by development experts but left to individuals to self-direct in terms of their use, does not necessarily lead to the socially desired impacts set out in the original intention of a program. ■

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Appendix

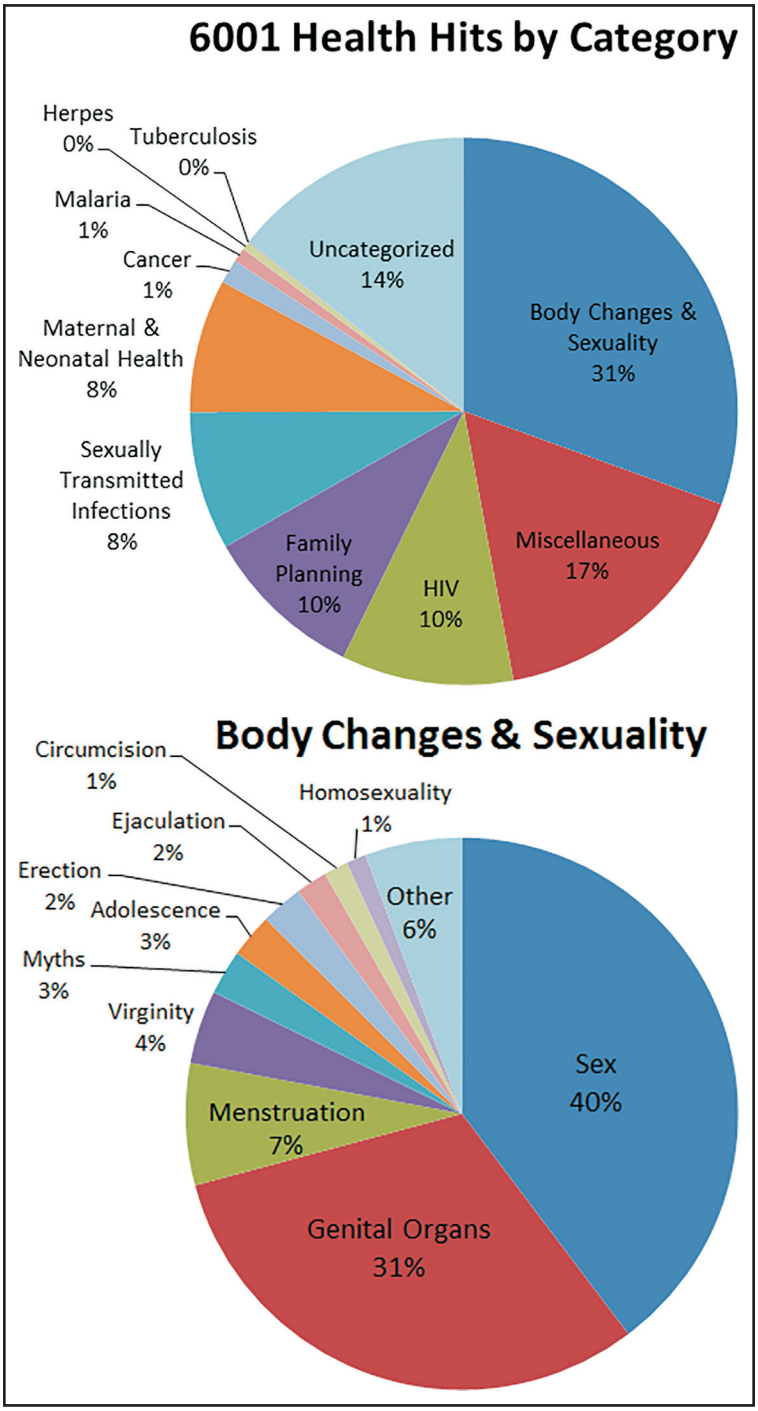

Figure A1. 6001 hits by topic according to metadata, nationwide.

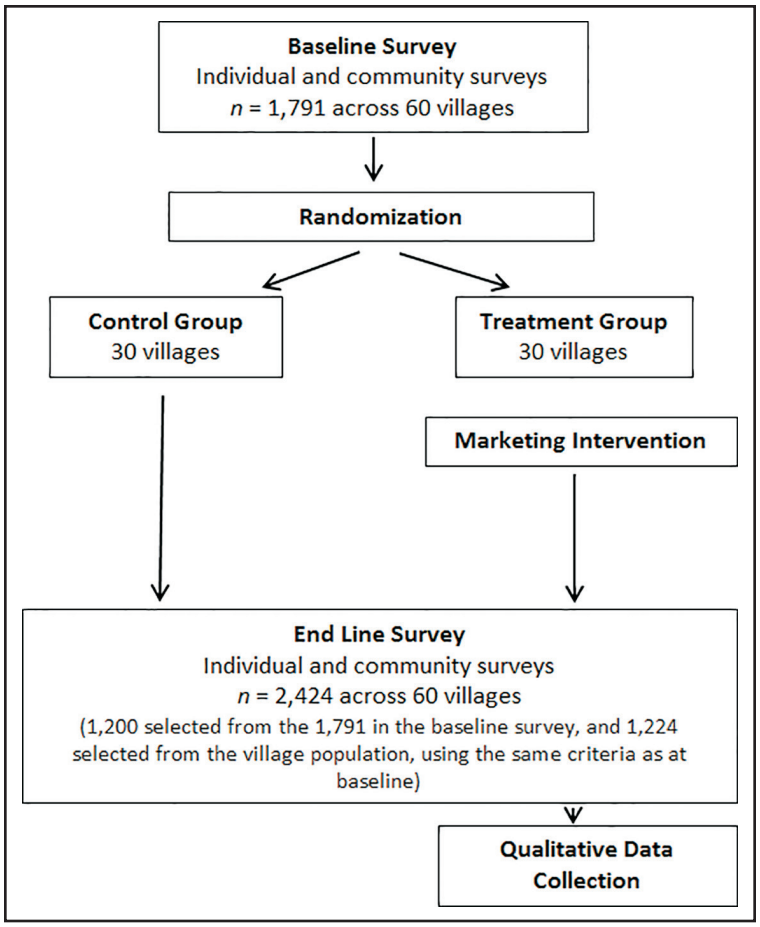

Figure A2. Evaluation flow chart.

Table A1. Additional Baseline Values and Balance Tests.

	Treatment		Control		*p* value
	N	Mean	N	Mean	T vs. C
			Demographics		
Married or cohabiting (%)	891	0.59	895	0.57	0.41
Has partner, but not cohabiting (%)	894	0.18	897	0.17	0.78
Low perceived relative HIV risk	848	0.49	858	0.49	0.81
Can read without difficulty (%)	893	0.84	894	0.81	0.22
Total number of mobile phones in household	886	1.51	883	1.51	0.84
Some difficulty charging in trading center (%)	886	0.33	887	0.31	0.28
			Community characteristics		
Total number of households	30	381.50	30	370.30	0.89
Remote	30	0.20	30	0.27	0.55
Rural-urban scale (scaled 1–5)	28	3.04	25	2.84	0.49
Average percentage of Muslims	30	0.18	30	0.20	0.63
Distance to next periodic market (km)	30	2.10	30	3.36	0.24
			Outcomes		
Never had STD (%)	885	0.65	881	0.64	0.60
Partner or respondent is currently pregnant (%)	894	0.12	897	0.12	0.79
Partner or respondent is currently unwantedly pregnant (%)	894	0.03	897	0.03	0.58
Has ever tested for HIV (%)	894	0.57	897	0.59	0.36
Any ANC visits if currently pregnant, women only (%)	357	0.20	372	0.17	0.25
Number of ANC visits if currently pregnant, women only	327	0.78	357	0.69	0.50

Note. Stratification variables include number of households, distance to tarmac road, distance to next periodic market, remoteness by category, urbanity by category, MTN network coverage, average education level, average SRH knowledge level, average SRH behavior score and predominant religion. SRH stands for sexual and reproductive health, ANC for Antenatal Care.

Table A2. 6001 Awareness and Usage.

Question		Control	Treatment	*n*	*p* value *t* test
Respondent has ever heard of Google SMS	Yes	46%	57%	2,410	0.00
Respondent has ever heard of 6001 service	Yes	24%	48%	2,405	0.00
Respondent has heard of 6001/ Google SMS through . . .	Radio	14%	13%	2,405	0.51
	Vantage	4%	27%	2,405	0.00
	Friends	2%	2%	2,405	0.40
	Family	0.1%	0.4%	2,405	0.10
	Champion	0%	1%	2,405	0.00
	Teacher	0%	0.3%	2,405	0.04
	Other	4%	4%	2,405	0.61
	Had not heard of it	76%	52%	2,405	0.00
Respondent has ever sent a message to 6001	Self-reported	3%	22%	2,424	0.00
	Self-reported and observed	7%	40%	2,424	0.00
Median number of messages sent to 6001 if ever used	Self-reported and observed	3	4	574	
Median number of different days on which service was used if ever used	Observed	5	4	236	
Median number of days between first and last use if ever used	Observed	3	6	236	
Median number of days between first and last use if used on 4 or more different days	Observed	47	35	236	
Respondent has used 6001 in . . .	English	66%	26%	303	0.00
(conditional on having used 6001)	Luganda	34%	68%	303	0.00
	Both	0%	5%	303	0.15
Most frequently mentioned reasons for not using 6001 service	Not interested	8%	12%	2,424	0.00
(conditional on having heard of 6001)	Don't know how to text	2%	4%	2,424	0.02
	Don't have phone	1%	2%	2,424	0.02
	Afraid of fees	2%	1%	2,424	0.16
	Know how to text, but instructions unclear	6%	6%	2,424	0.40
	Don't speak English or Luganda	0%	0%	2,424	0.32

Table A3. Determinants of Use of 6001
Dependent Variable: Ever Used 6001 (Observed and Self-Reported).

Sample frame:	Full sample	Men only	Women only	Full Sample
Coefficient reported below for:	Covariate	Covariate	Covariate	Covariate interacted with treatment
Male	0.0561***			−0.0186
	[0.02]			[0.03]
Own HIV risk perceived as low at baseline	0.0419	0.0580	0.0305	−0.0487
	[0.03]	[0.04]	[0.04]	[0.03]
Married or cohabiting at baseline	0.0502**	0.0618*	0.0348	0.0258
	[0.02]	[0.04]	[0.03]	[0.05]
Age	−0.0038*	−0.0070**	−0.0011	−0.0019
	[0.00]	[0.00]	[0.00]	[0.00]
Education	0.0069*	0.0112**	−0.0002	−0.0131*
	[0.00]	[0.01]	[0.01]	[0.01]
Number of siblings	0.0002	0.0006	−0.0002	0.0004
	[0.00]	[0.00]	[0.00]	[0.00]
Father's education	0.0003	0.0075	−0.0041	−0.0046
	[0.00]	[0.01]	[0.01]	[0.01]
Meals eaten per day	0.0244*	0.0253	0.0158	0.0331
	[0.01]	[0.02]	[0.02]	[0.02]
Condition of footwear	−0.0108*	−0.0177	−0.0087	0.0151
	[0.01]	[0.01]	[0.01]	[0.01]
Ability to read	−0.0156	0.0275	−0.0049	0.0468
	[0.01]	[0.02]	[0.02]	[0.03]
Owns personal phone	0.0656***	0.1874***	0.0089	−0.0983*
	[0.02]	[0.03]	[0.03]	[0.05]
Frequency of using text messages	0.0067	0.0071	0.0100	−0.0413***
	[0.01]	[0.01]	[0.01]	[0.01]
Remoteness (community)	−0.0196	−0.0478	−0.0016	0.0140
	[0.07]	[0.08]	[0.07]	[0.06]
MTN coverage (community)	0.0254	0.0359	0.0153	0.0313*
	[0.03]	[0.03]	[0.02]	[0.02]
Average SRH knowledge at baseline (community)	0.0805	0.0743	0.0818	0.0974
	[0.11]	[0.14]	[0.09]	[0.07]
Average SRH behavior at baseline (community)	−0.0981	−0.0837	−0.1152	−0.0409
	[0.15]	[0.19]	[0.14]	[0.11]
Percentage of Muslims (community)	−0.2171	−0.0406	−0.3444**	0.1281
	[0.18]	[0.19]	[0.17]	[0.13]
Number of households (community)	−0.0000	−0.0000	−0.0000	−0.0001**
	[0.00]	[0.00]	[0.00]	[0.00]
Distance to next tarmac road (community)	0.0016	0.0027*	0.0008	−0.0004
	[0.00]	[0.00]	[0.00]	[0.00]
Distance to next periodic market (community)	−0.0081	−0.0104	−0.0054	0.0013
	[0.01]	[0.01]	[0.00]	[0.01]
Observations	2,276	1,099	1,167	2,276

Note. Probit regression reporting marginal effects, robust standard errors clustered at the village level are reported in brackets.
$*p < 0.10$. $**p < 0.05$. $***p < 0.01$.

Table A4. Components of HIV Knowledge Index.

HIV Knowledge	Respondents knows HIV can be transmitted . . .			Respondents knows HIV cannot be transmitted . . .	
	During pregnancy	During delivery	During breast-feeding	Through sharing food	Through mosquito bites
	(1)	(2)	(3)	(4)	(5)
Full sample from follow-up survey					
A. Overall					
Full sample	0.0025	0.0094	0.0044	0.0328	0.0290
	[0.03]	[0.01]	[0.02]	[0.02]	[0.03]
Number of observations	1,092	1,092	1,092	1,092	1,091
B. By Gender					
Men	−0.0508	0.0150	0.0102	0.0458	0.0203
	[0.04]	[0.01]	[0.02]	[0.03]	[0.03]
Women	0.0576	0.0036	−0.0016	0.0192	0.0379
	[0.04]	[0.01]	[0.02]	[0.02]	[0.05]
F test: Men = Women	3.00	0.58	0.11	0.62	0.09
F test: *p* value	0.09	0.45	0.74	0.43	0.77
Number of observations	1,092	1,092	1,092	1,092	1,091

Note. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets.
$*p < 0.10$. $**p < 0.05$. $***p < 0.01$.

Table A5. Components of Contraceptive Knowledge Index.

	Respondents knows . . .									
	The pill	Injections	Female condoms	Foam	IUDs	Implants	Male condoms	Emergency pill	Female sterilization	Male sterilization
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Full sample from follow-up survey										
A. Overall										
Full sample	0.0045	0.0046	−0.0151	−0.0019	−0.0310	0.0231	−0.0161	−0.0059	−0.0089	−0.0300**
	[0.01]	[0.03]	[0.02]	[0.01]	[0.03]	[0.03]	[0.03]	[0.01]	[0.02]	[0.01]
Number of observations	1,092	1,092	1,081	1,080	1,084	1,082	1,090	1,082	1,081	1,081
B. By Gender										
Men	−0.0036	−0.0094	−0.0000	0.0077	0.0112	0.0228	−0.0183	−0.0042	−0.0219	−0.0317
	[0.02]	[0.04]	[0.03]	[0.01]	[0.04]	[0.03]	[0.04]	[0.01]	[0.02]	[0.02]
Women	0.0128	0.0192	−0.0308	−0.0120*	−0.0746*	0.0234	−0.0137	−0.0076	0.0045	−0.0282
	[0.02]	[0.03]	[0.03]	[0.01]	[0.04]	[0.005]	[0.04]	[0.01]	[0.03]	[0.02]
F test: Men = Women	0.36	0.47	0.66	5.11	2.13	0.00	0.01	0.05	0.49	0.02
F test: *p* value	0.55	0.50	0.42	0.03	0.15	0.99	0.92	0.82	0.49	0.89
Number of observations	1,092	1,092	1,081	1,080	1,084	1,082	1,090	1,082	1,082	1,081

Note. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

Table A6. Components of Attitudes Indices.

	Perceived relative nonriskiness		Condom use attributes	
			Respondent agrees to the statement that . . .	
	Relative to others, I do *not* take risks in my life	Perceived own HIV risk compared to a typical person (1 larger, 3 smaller)	A male condom should always be put on before intercourse	It is *not* embarrasing to buy or ask for a condom
	(1)	(2)	(3)	(4)
Full sample from follow-up survey				
A. Overall				
Full sample	[0.04]	[0.04]	[0.01]	[0.02]
Number of observations	2,267	2,209	2,206	2,258
B. By Gender				
Men	−0.1621***	−0.0247	0.0314**	−0.0173
	[0.05]	[0.05]	[0.01]	[0.02]
Women	−0.0278	−0.0203	0.0061	−0.0305
	[0.06]	[0.06]	[0.01]	[0.02]
F test: Men = Women	2.99	0.00	2.06	0.22
F test: *p* value	0.09	0.95	0.16	0.64
Number of observations	2,267	2,209	2,206	2,258

Note. The higher the value of the dependent variable in (1), (2) and (3), the more comfortable disagreeing. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets.
$*p < 0.10$. $**p < 0.05$. $***p < 0.01$.

Table A7. Components of Behavior Indices and Related Variables.

	Ever had sex with two or more different partners in same week during past 3 months (negative sign)	Never been unfaithful in past 3 months (no control on baseline values)	Number of sexual partners in past 3 months (no control on baseline values) (negative sign, i.e., a negative effect means more partners)	Relationship to last sexual partner was *neither* casual acquaintance nor commercial sex worker, interacted with recent sex	Used any type of contraceptives during last sex, interacted with recent sex	Used condom during last sex, interacted with recent sex (no control on baseline values)	Currently married or cohabiting^	Currently has partner, but not married/ cohabiting^
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Full sample from follow-up survey								
A. Overall								
Full sample	−0.0195	−0.0658*	−0.1345*	−0.0053	−0.0985*	−0.0232	0.0064	−0.0338**
	[0.02]	[0.03]	[0.07]	[0.466]	[0.05]	[0.03]	[0.01]	[0.01]
Number of observations	998	2,199	2,247	2,270	461	2,218	2,270	2,275
B. By Gender								
Men	−0.0331	−0.0527	−0.2827***	−0.0075	−0.0587	−0.0511	0.0231	−0.0480**
	[0.03]	[0.05]	[0.10]	[0.012]	[0.07]	[0.04]	[0.02]	[0.02]
Women	−0.0062	−0.0781	0.0059	−0.0033	−0.1336**	0.0030	−0.0095	−0.0202
	[0.02]	[0.05]	[0.09]	[0.008]	[0.07]	[0.04]	[0.02]	[0.01]
F test: Men = Women	0.60	0.14	5.28	0.09	0.61	0.75	1.96	1.34
F test: *p* value	0.44	0.71	0.03	0.76	0.44	0.39	0.17	0.25
Number of observations	998	2,199	2,247	2,270	461	2,218	2,270	2,275

Note. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets.
^not an index component.
**p < 0.10. **p < 0.05. ***p < 0.01.*

Table A8. Components of Outcome Index.

	Ever had STD	Ever had bad-smelling discharge	Ever had genital sore or ulcer	Current (or partner's) pregnancy is unwanted	Currently pregnant (or partner)
	(1)	(2)	(3)	(4)	(5)
Full sample from follow-up survey					
A. Overall					
Full sample	0.0076	−0.0086	0.0366**	0.0085	0.0051
	[0.02]	[0.01]	[0.02]	[0.01]	[0.01]
Number of observations	2,228	2,267	2,259	1,093	1,093
B. By Gender					
Men	−0.0073	0.0010	0.0183	0.0219	0.0055
	[0.03]	[0.02]	[0.02]	[0.01]	[0.02]
Women	0.0218	−0.0178	0.0540**	−0.0053	0.0048
	[0.03]	[0.02]	[0.03]	[0.02]	[0.02]
F test: Men = Women	0.60	0.40	0.96	1.09	0.00
F test: *p* value	0.44	0.53	0.33	0.30	0.99
Number of observations	2,228	2,267	2,259	1,093	1,093

Note. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.

Table A9. Components of Treatment Seeking Index and Related Variables.

	Ever tested for HIV	Ever sought treatment for an STD	Ever visited health center/ worker for issue related to SRH	Ever had STD (symptoms) and did not seek treatment	Any ANC visit during current pregnancy (females only)	Number of ANC visits during current pregnancy (females only)
	(1)	(2)	(3)	(4)	(5)	(6)
Full sample from follow-up survey						
A. Overall						
Full sample	−0.0136	−0.0202	0.0122	−0.0048	−0.0330	−0.0204
	[0.02]	[0.01]	[0.02]	[0.01]	[0.031]	[0.106]
Number of observations	2,275	2,275	2,265	2,275	1,090	863
B. By Gender						
Men	−0.0322	0.0009	−0.0063	0.0066		
	[0.03]	[0.02]	[0.04]	[0.02]		
Women	0.0042	−0.0403*	0.0298	−0.0157		
	[0.03]	[0.02]	[0.02]	[0.01]		
F test: Men = Women	1.13	1.26	0.86	1.24		
F test: *p* value	0.29	0.27	0.36	0.27		
Number of observations	2,275	2,275	2,265	2,275		

Note. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets. SRH stands for sexual and reproductive health. ANC stands for Antenatal Care.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.*

Table A10. Information on Health Services.

	Knows place to get an HIV test	Knows place to get free HIV test	Knows place to get STD test	Knows place to get free STD test
	(1)	(2)	(3)	(4)
Full sample from follow-up survey				
A. Overall				
Full sample	−0.076	0.0192	−0.0014	−0.0343
	[0.01]	[0.03]	[0.02]	[0.03]
Number of observations	1,090	1,093	1,091	1,093
B. By Gender				
Men	−0.0104	0.0423	0.0059	0.0081
	[0.01]	[0.04]	[0.02]	[0.04]
Women	−0.0047	−0.0047	−0.0091	−0.0786*
	[0.01]	[0.04]	[0.02]	[0.04]
F test: Men = Women	0.10	0.85	0.19	2.92
F test: *p* value	0.76	0.36	0.67	0.09
Number of observations	1,090	1,093	1,091	1,093

Note. All regressions include controls for baseline values of the dependent variable and for stratification variables. Robust standard errors clustered at the village level are reported in brackets.
*$p < 0.10$. **$p < 0.05$. ***$p < 0.01$.