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Effect of Text Messaging to Deter Early Resumption of Sexual Activity after Male Circumcision for HIV Prevention: A Randomized Controlled Trial

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Abstract

BACKGROUND—Resumption of sex before complete wound healing after male circumcision may increase risk of post-operative surgical complications, and HIV acquisition and transmission. We aimed to determine the effect of text messaging to deter resumption of sex before 42 days post-circumcision.

METHODS—We conducted a randomized trial where men >18 years old who owned mobile phones and had just undergone circumcision were randomized to receive a series of text messages

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Conflicts of Interest

All authors report that they have no conflicts of interest related to this work.

List of Supplemental Digital Content

Supplemental Digital Content 1. Table showing baseline characteristics of participants without outcome data (lost to follow-up) versus those retained. pdf

Authors' contributions

TAO participated in conceptualizing, designing, and conducting the study, analysing and interpreting the data, and drafting the manuscript. RCB originally conceived of the study. RCB, KKH and RSM further conceptualized the study, participated in study design, provided mentorship during study conduct, and made substantial contributions to interpretation of the results and drafting of the manuscript. EB and JS participated in study design, provided mentorship during study conduct, contributed to data interpretation, and reviewed the manuscript. KT and KY contributed to statistical analysis, data interpretation, and drafting of the manuscript. All authors read and approved the final manuscript.

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($n=600$) or usual care ($n=600$). The primary outcome was self-reported resumption of sex before 42 days.

RESULTS—Sex before 42 days was reported by 139/491 (28.3%) men in the intervention group and 124/493 (25.2%) in the control group (relative risk=1.13, 95% CI 0.91-1.38, $p=0.3$). Men were more likely to resume early if they were married or had a live-in sexual partner (adjusted relative risk [aRR] 1.57, 95% CI 1.18-2.08, $p<0.01$); in the month before circumcision had one (aRR 1.50, 95% CI 1.07-2.12, $p=0.02$) or >1 (aRR 1.81, 95% CI 1.24-2.66, $p<0.01$) sexual partner(s); had primary school or lower education (aRR 1.62, 95% CI 1.33-1.97, $p<0.001$); were employed (aRR 1.35, 95% CI 1.05-1.72, $p=0.02$); or were 21-30 years old (aRR 1.58, 95% CI 1.01-2.47, $p=0.05$); 31-40 (aRR 1.91, 95% CI 1.18-3.09, $p<0.01$) or >40 years old (aRR 1.76, 95% CI 1.04-2.97, $p=0.03$) compared to <21 years old.

CONCLUSIONS—Text messaging as used in this trial did not reduce early resumption of sex after circumcision. We identified key risk factors for early resumption that need to be considered in circumcision programs.

Keywords

SMS text messaging; mobile phone; male circumcision; sexual behavior; HIV prevention; Africa

INTRODUCTION

Efforts are under way to greatly expand medical male circumcision (MC) for HIV prevention in sub-Saharan Africa.¹⁻⁶ Male circumcision reduces the risk of female-to-male HIV transmission by about 60%,¹⁻³ and may reduce the risk of male-to-female transmission by 46%.⁷ Resumption of sexual activity during the healing period may increase the risk for HIV acquisition in HIV-negative men.⁸ Similarly, in HIV-positive men, early resumption of sexual activity may increase risk for transmission to sex partners.^{9,10} Following MC, men are advised to abstain from sexual activity for at least six weeks to allow for complete wound healing.^{11,12} Earlier resumption of sexual activity may also increase the risk of post-operative surgical complications.¹³ Despite these risks, the proportion of circumcised men reporting resumption of sexual activity before the end of the recommended six-week abstinence period has been high. For example, approximately 31% of circumcised men reported resuming sex early in Kenya, and 24% in Zambia.^{10,14}

The low cost of mobile phone communication in resource-limited settings presents a unique avenue to potentially change behavior, improve health outcomes, and magnify the impact of public health interventions.¹⁵ During the past decade, access to mobile phones has increased substantially in developing countries. The International Telecommunications Union estimates that approximately 79% of the population in developing countries has access to a mobile phone. The use of mobile phone technology to complement public health interventions (mHealth)^{16,17} is gaining traction across Africa, especially as part of larger health communication strategies. Although no empirical data were available to support it, the Joint United Nations Programme on HIV/AIDS (UNAIDS) recommends the use of short messaging service (SMS) as part of strategic communication towards accelerating the scale-up of MC and providing high-quality services.^{18,19} Mobile phones are also acceptable for providing HIV-related information.²⁰ Text messages have been effective in varied settings for a variety of interventions, including increasing adherence to antiretroviral treatment,^{21,22} reducing HIV risk behaviors²³, improving uptake of vaccination,^{24,25} promoting smoking cessation,²⁶ and shortening notification times for infant HIV test results.²⁷ We previously reported that text messaging improves attendance at post-operative clinic appointments after male circumcision for HIV prevention.²⁸ However, SMS interventions per se have not been

universally successful. For example, the Cameroon Mobile Phone SMS (CAMPS) trial found no effect of text messaging on antiretroviral adherence.²⁹

Our aim was to determine whether a series of one-way educational and reminder SMS messages could significantly reduce the frequency of self-reported resumption of sexual activity before 42 days after MC compared to a control condition of usual care.

METHODS

Trial design and participants

We conducted a two-arm, parallel, randomized controlled trial conducted at 12 sites in Nyanza province, Kenya. There were two main endpoints: 1) attendance at the scheduled seven-day post-operative clinic visit, and 2) self-reported resumption of sexual activity before 42 days after MC. Results related to the first endpoint have been reported elsewhere.²⁸

Men who had undergone MC were approached during the 30-minute post-circumcision recovery period and assessed for eligibility. Those who were at least 18 years old, owned mobile phones, had the phone in their possession at enrolment, and were willing to respond to a phone interview after six weeks were randomized in a 1:1 ratio to receive either text messages or usual care.

Randomisation and masking

An independent biostatistician generated a block randomization scheme with variable block sizes of 4 to 16 participants, stratified by clinic. Consecutive, sequentially-numbered, sealed, opaque envelopes were used to assign participants to study arms. Because the intervention arms included receiving SMS versus not receiving study SMS messages, participants were not masked to study group assignment. However, clinic staff members were unaware of the participants' group assignments.

Procedures

At enrolment, baseline characteristics and participant mobile phone numbers were collected. After randomization, participants sent a registration text message containing the study site and participant identification number. For those in the SMS arm, the registration message also included the preferred time of day and language (English, Kiswahili or Dholuo) for receiving intervention messages. All participants received US \$0.25 worth of airtime as reimbursement to cover the cost of the registration SMS. Usual care consisted of a 'minimum package' that included HIV testing and counselling, screening and treatment for sexually transmitted infections, condom promotion and provision, risk reduction and safe sex counselling, the MC procedure, and post-operative review seven days after surgery.³⁰

To automate the SMS intervention, we used RapidSMS, an open source framework for SMS applications.³¹ Text messages were sent at the time and in the language preferred by the participant. For the first seven days, messages were sent once each day. Thereafter, messages were sent on days 8, 14, 21, 28, 35, 41, and 42 post-procedure. Table 1 summarizes the text message protocol. The message timing schedule was adapted from a pilot study conducted to assess the acceptability of the messages among circumcised men in Nyanza province, Kenya. After 42 days, study staff called participants in both randomization arms to conduct a brief structured interview. Participants were asked whether they had resumed sexual activity, which was defined to include sexual intercourse or masturbation per the Kenya MC guidelines.³² For those who reported sexual activity, additional questions were asked to determine the number of sexual partners, total number of sex acts, and number

of sex acts with a condom. If participants were unreachable by phone on our first attempt, we tried calling again once each day for one week. Those who could still not be reached were considered lost to follow-up.

Ethical review

All participants provided written informed consent. This trial was approved by the Human Subjects Division at the University of Washington, the Ethical Review Committee of the Kenya Medical Research Institute, and Institutional Review Board #3 at the University of Illinois at Chicago.

Statistical analysis

The primary outcome was the proportion of men reporting early resumption of sex (i.e. before 42 days post-MC). We assumed that 22.5% of men in the control group would report early resumption.¹ To have at least 80% power to detect a reduction to 15% or less reporting early resumption of sex in the SMS group, and allowing for 11% loss to follow-up at 42 days, we enrolled 600 men in each arm.

We assessed the effect of study arm on the primary outcome using relative risk regression (Poisson model, robust error variance).³³ We performed 1) a complete case analysis that included only men with follow-up at the end of the 42-day period and 2) a multiple imputation by chained equations analysis that imputed missing outcome data under missing-at-random assumptions, a method considered superior to complete case analysis in the presence of missing outcome data.³⁴ The multiple imputation analysis used baseline covariate information (age, ethnicity, employment status, education level, marital status, age at first sex, number of sex partners in the month prior to MC, source of referral to MC clinic, whether HIV testing was done before MC, whether condoms were issued after MC, and cadre of the health worker who performed the MC procedure) and allowed us to use data from all 1200 men. Lastly, we performed a sensitivity analysis that examined the composite outcome of early resumption or missing outcome.

We conducted secondary analyses using the complete case dataset. We used adjusted relative risk regression to estimate associations between other covariates and early self-reported resumption of sex. Variables included in this model were selected based on known or suspected risk factors for early resumption of sex and included: study arm, age, marital status, number of sex partners in the month prior to MC, level of education, and employment status. Secondary analyses were repeated using the imputed dataset.

We compared time to self-reported resumption of sex (in weeks from time of circumcision) by study arm using Kaplan-Meier analysis and a log-rank test. We also compared the number of sex partners, total sex acts, and unprotected sex acts by study arm, and compared using Wilcoxon rank sum tests. Among men who resumed early, the proportions of men reporting any unprotected acts versus using protection for all sex acts in each arm was compared using relative risk regression.

All tests were two-sided at the 5% significance level. Stata IC v10 was used for analysis. Multiple imputation used the Stata “ice” package with five imputed datasets.^{35,36}

Role of the funding source

The sponsors had no role in study design, data collection, analysis, interpretation, writing of the report, or decision to submit the manuscript for publication. The corresponding author had full access to all data and had final responsibility for the decision to submit for publication.

RESULTS

We assessed 3,572 men for eligibility at 12 sites in Nyanza province, Kenya, between September 2010 and April 2011. Of these, we randomly assigned 1,200 to receive either the intervention or usual care (figure 1). Data on self-reported resumption of sex before 42 days were available for 491 (81.8%) and 493 (82.2%) men in the SMS and usual care groups, respectively.

Participant characteristics were similar at baseline in SMS and usual care groups,²⁸ and remained similar when restricted to only participants with non-missing outcome data (table 2). However, several baseline characteristics of participants with endpoint data differed from the baseline characteristics of participants lost to follow-up (see Table, Supplemental Digital Content 1). Specifically, participants who were lost were significantly younger, less likely to be employed, and spent more time traveling to clinic. Greater loss to follow-up was also significantly associated with having fewer sex partners in the month prior to MC, fewer years of education, unmarried status, and more likely to be referred to MC by a friend.

In the complete case analysis, self-reported resumption of sex before 42 days post-circumcision was reported by 139/491 (28.3%) men in the SMS group and 124/493 (25.2%) men in the control group (relative risk for early resumption=1.13, 95% CI 0.91-1.38; $p=0.3$). Results were essentially unchanged when multiple imputation methods were used to account for losses to follow-up at day 42 (RR=1.13, 95% CI 0.92-1.38, $p=0.2$). Similarly, when we examined a composite outcome of resumed or missing outcome, the proportion of men who resumed sex in the SMS group remained slightly higher (248/600; 41.3%) than in the control group (231/600; 38.5%), but again the difference was not statistically significant (RR=1.07, 95% CI 0.93-1.23, $p=0.3$).

In the complete case analysis, men were more likely to report early resumption of sex (table 3) if they were married or had a live-in sexual partner (adjusted relative risk [aRR] 1.57, 95% CI 1.18-2.08, $p<0.01$); had one (aRR 1.50, 95% CI 1.07-2.12, $p=0.02$) or >1 (aRR 1.81, 95% CI 1.24-2.66, $p<0.01$) sexual partner(s) in the month prior to MC; had primary school or lower education level (aRR 1.62, 95% CI 1.33-1.97, $p<0.001$); or were employed (aRR 1.35, 95% CI 1.05-1.72, $p=0.02$). Compared to men less than 21 years old, there was higher likelihood of early resumption of sex in men 21-30 (aRR 1.58, 95% CI 1.01-2.47, $p=0.05$); 31-40 (aRR 1.91, 95% CI 1.18-3.09, $p<0.01$); and >40 years old (aRR 1.76, 95% CI 1.04-2.97, $p=0.03$).

A Kaplan-Meier plot showing the cumulative incidence of self-reported resumption of sex is shown in figure 2. There was no significant difference between the groups in time to resumption of sex (log-rank test, $p=0.3$). Of the 263 men who reported resuming sex early, 236 (90%) reported their first sexual activity after 28 days or later.

The median number of sexual partners within 42 days after MC did not differ between the SMS and control arms (median=1, IQR=1-1 versus median=1, IQR=1-1, $p=0.7$). Similarly, the median number of sex acts was the same in the intervention and control arms (median=0, IQR=0-1 versus median=0, IQR=0-0, $p=0.3$).

While the median number of unprotected sex acts was zero in both intervention and control groups, the distributions in the two groups differed significantly (Wilcoxon rank-sum test, $p=0.007$). We explored this finding further by comparing risk of any unprotected sex in analyses restricted to the subgroup of men who reported early resumption of sex. In this subgroup, 87/135 (64.4%) in the SMS arm and 58/122 (47.5%) in the control arm reported unprotected sex. Data on number of sex acts, number of unprotected sex acts, and number of sex partners for six men (four SMS arm, two control arm) who reported resuming sex were

missing and were excluded. After adjusting for age, employment, marital status, age at first sex, educational level, source of referral to the clinic, number of sex partners in the month prior to MC, and whether condoms were issued at the clinic after MC, men in the SMS arm remained significantly more likely to report unprotected sex within the first 42 days after MC (aRR 1.30, 95% CI 1.05-1.61, $p=0.02$). Men were also more likely to report unprotected sex during this period if they were married (aRR 1.61, 95% CI 1.05-2.48, $p=0.03$), or were referred to the clinic from a voluntary counselling and testing centre (aRR 1.96, 95% CI 1.25-3.10, $p<0.01$).

DISCUSSION

In this large randomized trial in Kenya, SMS messages with educational and reminder content sent to men after MC did not reduce self-reported resumption of sexual activity before the end of the 42-day prescribed period of abstinence. To our knowledge, this is the first trial to assess the effect of text messages on resumption of sex after MC for HIV prevention. Although the intervention was not successful, additional analyses of data from this trial provide new insights about factors associated with early resumption of sexual activity after MC.

There is a growing body of evidence that text message reminders can increase attendance at clinic appointments.³⁷⁻³⁹ Similarly, we have shown improvement in clinic attendance after male circumcision.²⁸ Our SMS intervention did not lead to delayed self-reported resumption of sexual intercourse as intended, and might have been more successful if it had been supported by formative qualitative research grounded in a behavioural change framework.⁴⁰⁻⁴² Other SMS interventions have also provided conflicting results. For example, the Cameroon Mobile Phone SMS (CAMPS) trial found no effect of text messaging on antiretroviral adherence.²⁹ This finding is somewhat surprising, as two randomized trials in Kenya had demonstrated a significant benefit.^{21,22} The success of SMS interventions may be related to specifics of the intervention and to contextual factors. Designing future interventions with a firm basis in behavioral theory may make it easier to predict where, when, and how SMS interventions are likely to be successful.

Our study did not formally assess acceptability of the intervention, or whether participants would have preferred more interactive two-way text messaging. In other studies such as the WelTel Kenya1 trial,⁴³ two-way messaging was associated with significant improvements in antiretroviral adherence and virologic suppression. Further support for the acceptability of two-way messaging comes from the CAMPS trial where half of participant responses were messages of gratitude.⁴⁴

The high overall proportion who reported resuming sex within 42 days (26.7%) was similar to the proportion in a randomized trial population in South Africa,¹ and in observational studies in Kenya (31%¹⁴; 37.7%⁴⁵) and Zambia (24%).¹⁰ In contrast, fewer men reported resumption of sex earlier than 42 days in the randomized trials of MC for HIV prevention in Kisumu, Kenya (3.9%) and Rakai, Uganda (5.4%).⁸ This striking difference may be explained by the intense, individually tailored risk-reduction counselling given to participants in Kisumu and Rakai at each study visit. In contrast, the South African Trial did not include any counselling during the 42-day abstinence period, and MC programs on-going today typically include counselling only at the time of circumcision.

In our study, the great majority (90%) of participants who resumed sex early did so more than 28 days after MC. This may be related to men's own perception of completion of wound healing. In a separate study by our group, more than 70% of men had completely healed wounds by the end of the fourth week post-circumcision.⁴⁶ Of note, the SMS

message we sent on day 28 advised men not to have sex until they were fully healed. If men in the intervention arm perceived their wounds to be fully healed by day 28, then this message may have inadvertently supported a decision to resume sex before 42 days for this group. Also, none of the messages explicitly told men to delay sex until six weeks, except the day 8 message. The 41 day message may have tacitly alluded to sex or may have seemed to encourage resumption by use of the word “if” instead of “when”. Future interventions aimed at delaying resumption of sex should focus on risk reduction throughout the risk period after MC, and specifically encourage abstinence until after day 42 regardless of the appearance of the wound. In this regard, messages between days 28 and 42 should address the issue of not assuming that the wound is healed based on self-assessment. While many men have achieved complete wound healing by 4 weeks, nearly one-third are not completely healed at this point.^{13,47} Moreover, men’s own assessment of wound healing agrees with that of a clinician only 65% of the time.⁴⁵ As such, what men perceive as healed may not be “fully healed”. In the absence of follow-up visits for certification of wound healing by a clinician, the conservative period of a minimum of six weeks allows for the majority of wounds to heal.

This study included a number of limitations. First, men less than 18 years old and those who did not possess phones were excluded, limiting generalizability of our results. However, access to mobile phones is increasing substantially in Kenya. Between December 2011 and March 2012, mobile phone subscribers increased from 28.08 million to 29.2 million.⁴⁸ Second, we recognize that resumption of sex before 42 days was a self-reported outcome. In this context, our results may be affected by social desirability bias, with under-reporting of early resumption of sex. If men were worried about sexual performance after MC, they may also have over-reported resumption of sex. Third, we did not ask men in the intervention arm if they received the text messages, or how many messages were received. It is possible that some may not have received the SMS due to changing phone numbers, network failures, or other reasons. Fourth, we did not collect data on phone sharing by study participants. Some men may share phones, and could have missed the SMS messages as a result. Fifth, we did not specifically test for literacy in participants. However, only 30 (2.5%) study participants reported having no education. Nonetheless, we recognize that failure to receive messages, sharing of phones, and challenges with literacy may have contributed to the lack of efficacy observed in this trial. Finally, the 18% loss to follow-up at day 42 was higher than anticipated. Being unreachable by phone may have been associated with failure to receive intervention messages for men in the SMS arm.

Despite these limitations, our study identified important risk factors for early resumption of sexual activity after MC, providing guidance to inform the development of interventions to improve outcomes after adult MC for HIV prevention. Specifically, and consistent with previous studies by Herman-Rolof et al.¹⁴ and Oduyo-June et al.,⁴⁵ we found that early resumption of sex was associated with being married or living with a sexual partner, reporting one or more sexual partners in the month prior to MC, older age, employment, and education level. Men living with sexual partners likely have greater opportunity to resume sex, may simply feel more comfortable resuming sex earlier than advised, or find it harder to abstain. Involvement of female partners in scale-up of MC might address this problem.^{49,50}

Men with primary or lower level of education were significantly more likely to report early resumption of sex. It is possible that such men were less likely to understand the post-operative care instructions. Additional education and counselling for this group should be considered as MC programs continue to expand. Lower health literacy is associated with poor HIV treatment adherence.^{51,52} In-depth qualitative studies would be helpful for understanding the reasons for early resumption of sex, and could inform the development of interventions aimed at promoting sexual abstinence until 42 days after MC.

While we did not find a reduction in early self-reported resumption of sex following MC with this SMS intervention, these data highlight the need for further research using low-cost technologies to reduce early resumption of sexual activity and maximize the benefits of MC for HIV prevention. Where SMS interventions have been successful in promoting antiretroviral adherence and smoking cessation, the lingering question has been *why* they worked.^{53,54} Future interventions with mobile phone technologies could be strengthened by developing a foundation based in behavioural theory to explain the mechanism by which they might reduce early resumption of sex following MC.

As MC programs continue to expand across sub-Saharan Africa, resumption of sex before 42 days after the procedure will continue to be an issue to address, and a possible threat to significant reduction in HIV incidence. Our findings point to several key risk factors for early self-reported resumption of sex that MC programs should take into account as they develop interventions to address this issue.

Supplementary Material

Refer to Web version on PubMed Central for supplementary material.

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Figure 1. Trial Profile

*The five men circumcised before the interview date were determined to be ineligible at the point of screening and were not included in the study.

Figure 2.
Kaplan-Meier plot of the cumulative probability of self-reported resumption of sex

Table 1
Intervention text messages

Post-op Day	Messages (English)
1	If u r not the intended recipient of this Male Circumcision (MC) message, please text STOP to 0722819835 and you will not receive future messages. Thank you.
1	This is your MC provider. It is normal to feel a bit of pain and swelling, but if there is severe swelling, bleeding or pain please come back to the clinic.
2	This is your MC provider. Remember do not allow water to soak the dressing before removal on the 3 rd day.
3	Remove the dressing today. Make sure you review the post-op instructions and use the blade provided. Throw away the blade after use.
4	This is your MC provider. Always keep the genital area dry n clean to avoid infection. Do not apply any ointment or creams that are not prescribed by the clinic
5	This is your MC provider. If you feel heavy pain, swelling, bleeding, or any signs of infection please consult the clinic.
6	This is your MC provider. Don't forget to come back to the clinic for your day 7 follow-up visit. You will be checked to be certain the healing is going well.
7	This is your MC provider. See you at the clinic today for your follow-up visit.
8	Good things come to those who wait. Remember no sex or masturbation until the end of 6 weeks.
14	This is your MC provider. Be sure to call or come back to the clinic anytime if you have a question or concern.
21	This is your MC provider. Abstaining from sex and masturbation ensures that you will heal properly.
28	This is your MC provider. Remember don't have sex until you are fully healed.
35	Remember that MC does not provide 100% protection from HIV and STIs.
41	If you start sex after MC, it is important to protect yourself and your partner by using condoms.
42	Remember that MC does not provide 100% protection from HIV and STIs. Be faithful to one partner and use a condom correctly every time you have sex.

Table 2
Baseline Characteristics

Characteristic	SMS group (n=491) n (%)	Control group (n=493) n (%)
Age group (years)		
18-20	85 (17.3%)	88 (17.8%)
21-30	277 (56.4%)	280 (56.8%)
31-40	92 (18.7%)	79 (16%)
>40	37 (7.5%)	46 (9.3%)
Age (years) - median (IQR)	25.4 (22.0-31.2)	25.14 (22.0-31.1)
Luo ethnic group (versus other)	469 (95.7 %)	477 (96.8 %)
Employed (versus unemployed)	291 (59.4 %)	285 (57.8 %)
Number of sex partners in month prior to MC		
0	115 (23.4 %)	136 (27.6 %)
1	307 (62.5 %)	286 (58 %)
2+	69 (14.1 %)	71 (14.4 %)
Ever tested for HIV (versus never tested)	445 (90.6 %)	450 (91.3 %)
Condoms offered on day of MC (versus not)	11 (2.2%)	6 (1.2%)
Age at first sex – median (IQR)	17.0 (15.0 - 18.0)	16.0 (14.0 - 18.0)
Travel time to/from clinic (hours) – median (IQR)	1.0 (0.5-1.0)	1.0 (0.5-1.0)
Transport cost to/from clinic (US\$) – median (IQR)	0.75 (0.5-1.25)	0.63 (0.25-1.25)
Time away from work (hours) – median (IQR)	3.0 (0.0-6.0)	2.0 (0.0-6.0)
Primary or less education	134 (27.3%)	131 (26.6%)
Married or living w/sexual partner (versus no sexual partner)	292 (59.5%)	282 (57.2%)
Referral source		
Self	338 (68.8%)	334 (67.7%)
Parent	2 (0.4%)	4 (0.8%)
Friend	64 (13%)	83 (16.8%)
Voluntary Counselling and Testing	2 (0.4%)	2 (0.4%)
Community Health Worker	8 (1.6%)	6 (1.2%)
Other	77 (15.7%)	64 (13.0%)

IQR, interquartile range; MC, male circumcision

Table 3
Relative risk regression analysis of predictors of early self-reported resumption of sex

	Resumed sex early	Unadjusted		Adjusted	
	n (%)	RR [95% CI]	p value	RR [95% CI]	p value
Study arm					
Control	124/493 (25.2%)	1 (ref)	---	1 (ref)	---
SMS	139/491 (28.3%)	1.13 [0.91-1.38]	0.3	1.09 [0.89-1.32]	0.4
Age group (years)					
18-20yr	20/173 (11.6%)	1 (ref)	---	1 (ref)	---
21-30yr	144/557 (25.9%)	2.34 [1.45-3.46]	<0.001	1.58 [1.01-2.47]	0.05
31-40yr	69/171 (40.4%)	3.49 [2.22-5.48]	<0.001	1.91 [1.18-3.09]	<0.01
>40yr	30/83 (36.1%)	3.13 [1.89-5.16]	<0.001	1.76 [1.04-2.97]	0.03
Marital status					
No sexual partner	59/410 (14.4%)	1 (ref)	---	1 (ref)	---
Married or living w/sexual partner	204/574 (35.5%)	2.47 [1.90-3.21]	<0.001	1.57 [1.18-2.08]	<0.01
No. of sex partners in month prior to MC					
0	34/251 (13.6%)	1 (ref)	---	1 (ref)	---
1	179/593 (30.2%)	2.23 [1.59-3.12]	<0.001	1.50 [1.07-2.12]	0.02
2+	50/140 (35.7%)	2.64 [1.80-3.87]	<0.001	1.81 [1.24-2.66]	<0.01
Education level					
Secondary or higher	156/719 (21.7%)	1 (ref)	---	1 (ref)	---
Primary or less	107/265 (40.4%)	1.86 [1.52-2.28]	<0.001	1.62 [1.33-1.97]	<0.001
Employment status					
Unemployed	69/407 (17.0%)	1 (ref)	---	1 (ref)	---
Employed	194/576 (33.7%)	1.99 [1.56-2.54]	<0.001	1.35 [1.05-1.72]	0.02

RR, relative risk; SMS, short message service; MC, male circumcision