Male Partner Engagement in Family Planning SMS Conversations at Kenyan Health Clinics

Trevor Perrier
Paul G. Allen School of Computer Science & Engineering
University of Washington
tperrier@cs.washington.edu

Elizabeth K. Harrington
Obstetrics & Gynecology
University of Washington
harri@uw.edu

Keshet Ronen
Global Health
University of Washington
keshet@uw.edu

Daniel Matemo
Kenyatta National Hospital
daniel.matemo@gmail.com

John Kinuthia
Obstetrics & Gynecology
Kenyatta National Hospital
kenuthia@uw.edu

Grace John-Stewart
Epidemiology, Global Health, Medicine, Pediatrics
University of Washington
gjohn@uw.edu

Richard Anderson
Paul G. Allen School of Computer Science & Engineering
University of Washington
anderson@cs.washington.edu

Jennifer A. Unger
Obstetrics & Gynecology, Global Health
University of Washington
junger@uw.edu

ABSTRACT

Maternal health outreach and engagement is a common goal of mobile health (mHealth) projects for development. Male partners of pregnant and postpartum women are known to be important influences on their health behavior. This paper presents a novel extension to previous HCI4D research by exploring how to engage male partners in SMS-based family planning conversations. First, we explore design considerations for inclusion of male partners in an existing semi-automated bidirectional SMS platform. A 12-month randomized controlled trial of a family planning counseling SMS program was conducted in western Kenya using our system. A total of 260 pregnant women and 101 of their male partners were enrolled in the system. We analyze enrollment and usage data from this trial to compare baseline technology use and demographics of mothers and their male partners. Our findings demonstrate significant technology gender divides in the study population. Finally, we explore how both the mothers and their male partners interacted with the SMS system through an analysis of over 11,500 messages. We conclude that it is feasible to include rural Kenyan men in an SMS-based family planning discussion program and that their inclusion does not dramatically affect the mothers' engagement.

CCS CONCEPTS

• **Human-centered computing** → Empirical studies in HCI;

KEYWORDS

mHealth; Maternal Health; SMS; Mobile; HCI4D; ICTD.

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1 INTRODUCTION

According to the 2014 Kenya Demographic and Health Survey (KDHS) [18], 40% of Kenyan women using modern contraceptive methods were not informed about the potential side effects. Moreover, 31% of women reported discontinuing contraceptive use within 12 months, and of this group, 29% cited health concerns or side effects as a primary reason for stopping. Studies have also highlighted multiple provider-level barriers to distributing information about and accessing family planning [24]. This results in 18% of married Kenyan women expressing an unmet need for family planning – an unmet need that is to some extent driven by a gap in knowledge and understanding.

The use of SMS for information access and dissemination has been well documented in HCI4D and Global Health fields [5]. However, most of the work on maternal health has focused on reaching pregnant women at clinics or at home through community health workers [7]. Systems that reach out directly to mothers are increasingly common [19, 21]. Studies suggest that reaching out to male partners during prenatal care and about family planning decision-making may improve outcomes [28], but few interventions have included them. In this paper we examine the feasibility of including male partners in a maternal health SMS intervention and how this

affects women's participation and engagement with the intervention. This work presents three main contributions to the HCI4D community:

(1) A description of the design considerations and system modifications necessary to incorporate male partners into sensitive maternal health conversations over a toll-free SMS gateway.
(2) A characterization of the extent of the gender-based technology divide within the study population.
(3) An evaluation of the participation and engagement of mothers and male partners in a family planning SMS intervention.

Not surprisingly, we show that on most measures of technology access and usage women have less access than men. Our contribution in this regard is to show that this gender divide exists within couple dyads. Despite this gender divide mothers engage significantly more than their male counterparts with the same family planning and maternal health SMS content. However, when men do engage, they do so in much the same way as their female counterparts. They respond quickly, talk about both family planning and maternal health, and show a willingness to ask personal questions.

2 RELATED WORK

In HCI4D projects for community outreach, the need to design universally available services constrains the design space to simple text and voice based applications. These are accessible on even the most basic mobile phone [20]. From IVR and live operator systems, to SMS and data-enabled systems, this design space has been well documented [14, 16]. In Sub-Saharan Africa, automated and bidirectional SMS has been used for projects as diverse as vaccine cold chain management [4], financial reimbursements [6], and medication reminders [13]. SMS systems, such as UNICEF's U-Report, have grown recently to large multi-country SMS platforms with millions of users [1]. Sub-Saharan Africa is ideal for these projects due to the low cost and universality of SMS, use of Latin-based scripts, and the prevalence of SMS gateways.

A primary focus of mHealth SMS interventions has been on maternal health [3, 19, 21]. One of the largest projects in this area is MomConnect, which runs nationally in South Africa and has connected over half a million mothers to health information via SMS [23]. Another maternal health project to have reached scale is m4RH, which is an opt-in reproductive health SMS service in Kenya and Tanzania [11]. Through a series of SMS-based menus, m4RH allows people to request information on different family planning methods. This differs from the semi-automated approach on which our study is based [19], where weekly SMS prompts are sent to all participants and a trained clinician answers individual questions [19].

One concern of mHealth interventions in HCI4D is that they can amplify existing gender inequalities [27]. Surveys of initial m4RH users showed that while a majority of users are women, a substantial number of men queried the database [12]. A systematic review of gender relations in mHealth projects revealed that many projects only reinforce existing gender inequalities. [10]. To date there has been very little analysis of how men participate in SMS messaging projects for maternal health and family planning. Therefore, it is important to understand how the inclusion of male partners in an SMS intervention affects the overall engagement with the system.

Partner Status	Control	Intervention	Total
	130	130 (n_i)	260 (n_a)
Not Invited	52	49	101
Invited	29	29	58
Invited + Enrolled	49	52	101
Enrolled + Phone Shared	12	9	21

Table 1: Male partner status of enrolled female participants. Total study enrollment was 260 n_a with 130 participants in the intervention arm n_i. Women's enrollment is further broken down by male partner status: not invited, invited (but not enrolled), both invited and enrolled, and finally enrolled but sharing a phone.

3 METHODOLOGY

While the focus of this work is not on clinical outcomes, the background of the larger randomized control trial (RCT) is necessary to fully understand the design constraints and context. This work represents the collaboration between the University of Washington (UW) Department of Computer Science and Engineering, the UW Department of Global Health, and the Kenyatta National Hospital/University of Nairobi in Nairobi, Kenya. The first author built the entire SMS platform in close collaboration with public health colleagues who designed and implemented the RCT. A study team of nine Kenyans with a diverse background in nursing, data management, and field work was hired for the duration of the study.

The project started in July 2016 and ended in September 2017, enrolling a total of 260 women from Ahero sub-County Hospital and Bondo County Hospital in the Nyanza region of western Kenya. The study was approved by the institutional review boards at the University of Washington and the University of Nairobi and Kenyatta National Hospital. Before recruitment began, small focus groups of mothers, partners, and providers were conducted. The second author, a family planning fellow at the University of Washington, developed 164 templates for maternal health and family planning messages.

3.1 Eligibility and Enrollment

Women were recruited to the study at two public maternal-child health clinics in the Nyanza region of western Kenya. Eligibility criteria for the study included: being at least 14 years old; being pregnant and within 12 weeks of estimated due date (EDD); having daily access to a mobile phone with a Safaricom SIM card; being able to read and respond to SMS in English, Swahili, or Luo; and having the intention of remaining in the study area for six months. The requirement for Safaricom SIM cards was due to the use of a shortcode – which in Kenya is a dedicated five digit phone number which can send and receive both SMS and voice calls. Setting up a shortcode is a time-consuming and bureaucratic process. For our study we used the third-party gateway, Africa's Talking[1], which simplified setup and provided simple backend API's for connecting to our shortocde. Through Africa's Talking, a shortcode costs about $150 USD per month and enables us to setup toll-free SMS so

[1] https://africastalking.com/

participants can send replies to the system at no cost while we pay about $0.007 USD per outgoing SMS. Limiting study participation to Safaricom subscribers was not a significant barrier since Safaricom dominates mobile services with 65% of the market [17]. In our study only 12% of ineligible participants did not have a Safaricom SIM.

There were many reasons for exclusion from the study, but the primary reason was gestational age. Of 648 women screened for enrollment 337 (56.4%) were ineligible. The non-mutually exclusive reasons for ineligibility were: being more than 12 weeks from EDD 155 (46%) - these women could be enrolled at a future ANC visit; not having daily access to a mobile phone 95 (28%); receiving antenatal care at a different hospital 68 (18%); not having a Safaricom SIM 40 (12%); not knowing their phone number 15 (4%); unwilling to receive SMS 4 (1%); and participating in another research study 31 (9%); Additionally, 51 eligible participants declined or desired to enroll on a different day.

During recruitment, women were randomized (1:1) into a control arm receiving standard care or an intervention arm receiving bi-directional SMS. All participants who reported having a partner were allowed to invite him to participate as well. Partner inclusion was not randomized, for two reasons: first, our study design needed to be generalizable to the larger population since any scale-up or deployment of the intervention would include both partnered and unpartnered women; second, we felt that it was important to understand how both partnered and unpartnered women used the system. For all partners invited into the study, a home visit by a male Kenyan staff member was attempted in order to enroll the parter and complete enrollment data collection.

3.2 Informed Consent

Female participants provided written informed consent at the time of enrollment. Male participants were consented at the time of the home visit. This was done via a home visit rather than a phone call because focus groups revealed that it was much more appropriate to talk with men about maternal health issues in person. Consent counseling was conducted, and forms provided in, either English, Swahili or Luo based on participant preference. The consent process made it clear that the study was about family planning, and that participants would be sent medical information via SMS and would have the option to respond to messages. If at any time they felt uncomfortable or did not wish to continue with the study they could SMS *STOP* to the study shortcode and would be removed from future SMS messaging.

3.3 Total Enrollment

Table 1 shows the breakdown of all mothers based on their partner's enrollment status. Of the 260 total participants, 198 (76.2%) were partnered, and of these, 159 (80.3%) invited their partner and 39 (19.7%) did not. This left left 101 (43.9%) participants who either did not have a partner or elected not to invite their partner. Of the 159 partners invited, 101 (43.9%) were enrolled in the study and were sent SMS. In nine cases (15%) this was because the male partner did not want to participate, however, more commonly it was because we were unable to contact the partner (20%) or the partner was living outside of the study area (37%) making a home visit for informed consent impossible. Five partners were recruited but were not successfully enrolled in the SMS system due to technical issues. and 58 mothers (25.2%) invited their partner but their partner was not enrolled. Since randomization occurred independently of partner enrollment status, the breakdown between each group and control or intervention arm was not completely equal. If a partner was enrolled, both members of the couple received the same automated SMS messages. Twenty-one enrolled dyads shared a mobile phone in which case there was only one number to send messages to (last column of Table 1).

3.4 Data Sources

In this paper, three primary sources of data were used for analysis: 1) self-reported demographic and technology use data taken from the enrollment questionnaires; 2) the content and meta-data associated with the SMS messages stored in the system; and 3) notes from field visits by the first and second authors as well as Skype calls and email logs between the research team and Kenyan study staff.

During the study, a total of 11,469 SMS were sent or received (Table 2). The automated weekly messages from the system, which were sent from the week of enrollment to 6 months after delivery, accounted for 5176 of these messages (45.1%), participants sent 3575 (31.2%) messages into the system, and the study staff sent back 2718 (23.7%) replies. For all of these counts, duplicate outgoing messages sent to both the mother and father are counted as one SMS. All mothers in the intervention group (n_i=130) sent 3188 messages to the system. There were 43 participants in the intervention arm who had their partner enrolled and did not share a phone with him. These 43 women sent 1027 SMS messages to the system while their male partners sent a total of 387.

4 SYSTEM DESIGN

The SMS messaging platform was adapted from the open-source system described in Drake et al. [8]. Two major changes needed to be made to this existing system. First, the automated messaging had

	Not Invited	Invited	Enrolled	Phone Shared
n_i	49	29	43	9
Automated System Messages:				5176 (45.1%)
Mother	1893	1095	127	347
Partner	0	0	41	0
Both	0	0	1673	0
Participant Responses:				3575 (31.2%)
Mother	1345	643	1027	173
Partner	0	0	387	0
Study Staff Replies:				2718 (23.7%)
Mother	994	466	354	139
Partner	0	0	187	0
Both	0	0	578	0

Table 2: Distribution of 11469 SMSes sent or received in the study. All messages from a dyad sharing a SIM card or phone are counted as coming from the mother.

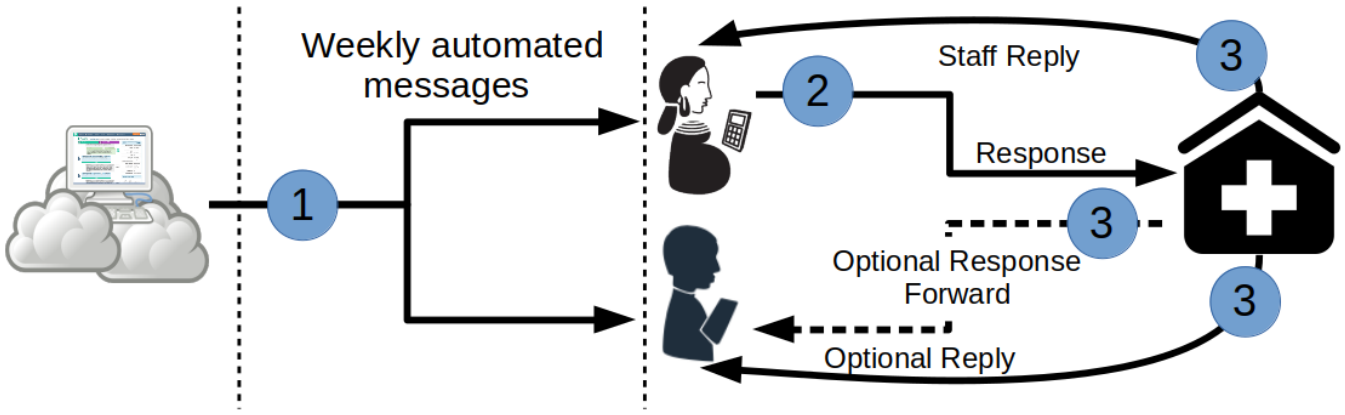

Figure 1: System design for three-way SMS conversation in enrolled partner dyads. (1) Automated messages from the system go to both partners. (2) Replies from either partner go only to the system. (3) Replies from study staff by default go only to the original sender, but message and response can optionally be forwarded to the other partner. This design allows study staff to have confidential conversations with either partner.

to be modified to include family planning messages and messaging needed to change based on any family planing methods initiated. Second, the system UI and back-end messaging system needed to handle sending and receiving messages from both the mother and the male partner.

4.1 Semi-Automated Bidirectional Messages

There were 164 messages in the SMS bank, each of which was translated into English, Swahili, and Luo (the dominant languages of the Nyanza region). Messages were adapted from previously created SMS banks to focus on family planning concerns, misconceptions, and needs. Six focus groups with women and men from the community surrounding the study clinics found that both women and men felt that SMS conversations with a trained nurse would help them talk as a couple about family planning.[2] Informed by feedback from these focus groups, previous SMS banks and the Theory of Planned Behavior [2, 9], specific family planning messages were developed. These automated messages fell into three categories:

ANC Messages tailored to the expected due date (EDD) of each mother. These messages started 14 weeks before EDD and included a mix of maternal health information – such as emphasizing facility delivery or information on important danger signs – and general family planning messages. For example, the message sent four weeks before EDD mentioned multiple family planning methods:

> {name}, this is {nurse} from {clinic}. There are many effective options for family planning after you deliver, including condoms, pills, injection, IUCD (coil), and implant. It is your choice – you can ask me or a nurse at the clinic about your options. Is your partner supportive of family planning?

All messages were modified for participants with enrolled partners to address the couple. For the above message ended with *"Have you talked about family planning as a couple?"* for the partner enrolled group.

[2] A manuscript describing findings from the focus groups is in preparation.

General Postpartum Messages based on the actual delivery date and addressing general maternal health issues. The first few weeks after delivery these messages asked about any challenges the parents may be having. By the fourth week, messages began emphasizing family planning methods. Each week a different family planning method would be featured with information about how it works and how often it would require clinic visits. Messages in this phase also addressed specific misconceptions about different methods such as this message sent nine weeks after delivery:

> {name}, this is {nurse} from {clinic}. There are some myths in the community about family planning. The injection does not cause infertility, so it is safe to get the injection if you are planning more children in the future. What have you heard about the injection?

Family Planing Specific Messages based on the date a couple started a family planning method. These messages were developed for this study and required major changes to the system so it could handle sending messages based on both the delivery date and family planning initiation date. Six different family planning tracks were created based clinic offerings – Pills, Injection, Implant, IUCD, Condoms, and Tubal Ligation. Once study staff were notified via SMS that a participant began a particular method they needed to update the system with her chosen method. At that point, tailored messages would start, beginning with a congratulatory message. The first four weeks of each family planning track focused on concerns and challenges associated with that method. For example the second week after a mother received a contraceptive injection (a common family planning method that lasts up to 12 weeks) both partners in the enrolled track received this message:

> {name}, this is {nurse} from {clinic}. Did you both know that irregular menstrual bleeding or no bleeding at all is normal and healthy with the injection?

After the first four weeks the frequency of family planning specific messaging was reduced and participants received general maternal health message every other week. The automated messages for all

participants continued until 24 weeks (six months) after delivery. This automated messaging schedule required the system to track delivery dates and family planning start dates for all participants. Study staff at each clinic kept system data updated by abstracting paper-based clinic records, talking with participants during study visits, and SMS inquiries for participants in the intervention arm.

4.2 Adding Partner Messaging

A significant component of system development was to enable male partners participation in the conversation. The process of modifying existing open-source SMS systems for three-person group messaging in a health context is one contribution of this work. Group messaging over SMS is common but it uses the Multimedia Messaging Service (MMS) extension which is not available on third party SMS gateways in Kenya. This meant that we had to simulate multi-party conversations by duplicating outgoing messages over a single shortcode on the SMS gateway.

The initial system designs intended the platform to replicate SMS or WhatsApp group messaging as closely as possible. We explored the possibility of all messages from either partner automatically forwarding to the other partner. This is very similar to Tangaza [15] and other systems for efficient and cheap group messaging over basic phones. However, the personal nature of health conversations and interpersonal relationship dynamics of a maternal health messaging system require different assumptions than social or friend based group messaging. Prior work has shown that when engaging pregnant women in open-ended SMS conversations, it is not a question of if but rather when sensitive information will be shared over SMS [19]. If women knew every message they sent would automatically be sent to their partner it could deter some questions and constrain the conversation. Also, instantaneously forwarding messages between partners could open the system up for abuse where a couple could start using the toll-free shortcode for free SMSes between them. Although observing this hypothetical emergent behavior would have been interesting, it is not within scope of the study or the intended use of the system.

Our final design is best described as semi-automated group messaging. Figure 1 illustrates the messaging flow for an enrolled couple when both partners have separate SIM cards. All automated system messages were sent to both partners at exactly the same time each week. From the participant's perspective, the only indication that both members received the SMS was the inclusive wording of messages. Replies from either partner went only to the system and were displayed on the web interface in a single conversation thread – much like group messaging on a smartphone. Study staff would then review, translate, and if necessary reply to the message – deciding if the reply should go to only the original sender or both partners. It was important to have the default be the lowest risk option and so by default the reply would only go to the partner who sent the message being responded to. However, if appropriate and if it would facilitate the conversation, the incoming message and outgoing reply could be forwarded to the other partner. The web interface for the messaging system was designed to seamlessly include the male partners. Incoming messages were color-coded by sender and icons next to the message clearly indicated if it had come from the mother or partner. When study staff replied, toggle buttons indicated if an outgoing message would be sent to the mother, partner, or both. The default action was to reply just to the sender of an original message but with minimal extra work messages could be forwarded to both partners. This feature was used quite often. Table 2 shows that study staff sent a total of 1119 messages to participants with an enrolled partner. Of these messages 578 (51.7%) were sent to both partners simultaneously while 354 (31.6%) were sent to the mother only and 187 (16.7%) were sent to the partner only.

5 PARTICIPANT CHARACTERISTICS

In this section we use responses from the extensive enrollment questionnaire to better understand the demographic characteristics of participants as well as their prior experiences with technology. The inclusion of 101 male partners offers an opportunity to compare baseline technology use between women and men from the same community as well as within the same household. This analysis helps to better understand the context of the intervention and to inform the selection of technology for future projects. Previous work has indicated that mobile phones and other technology amplify already existing gender differences [27]. It is, therefore, important to understand who the participants are and their existing technology use so that we can design mHealth solutions for greater equity and inclusion.

5.1 Basic Demographics

The basic demographic data in Table 3 reveals that within couple dyads and the population as a whole, women and men had significant differences in terms of sociodemographic and technology use characteristics.

First, the women were much younger than the men. The median age of women with a partner enrolled in the study was 23, and the median age of enrolled men is 30. The educational background of the women and men in the study also differed. While the percentage of women and men who reported having *no secondary* education (33.8% and 36.6%) and having *completed secondary* school (27.3% and 25.2%) were both similar, only 8.7% of the men reported having *some secondary* while 20.4% of the women did. This higher secondary school dropout rate among women is a trend seen throughout Sub-Saharan Africa [22]. Median household income was approximately 100 USD per month with no major differences reported between the men and women. The median individual monthly income was 0 USD for the women and 80 USD for the men. With a mean rural Kenyan household size of 4.4 [18], this places our study population in the 1.3 billion people globally living on less than $1.25(USD) per day.

The enrollment questionnaire assessed baseline technology use. We wanted to gain a sense of what type of phone the study participants had, and how they used it. The bottom half of Table 3 summarizes the technology access and use data. We see that the men were much more likely to report having used the Internet as well as having used WhatsApp or Facebook. As a proxy for determining if participants had a smartphone, we asked if their phone had a touch screen or not and 27.3% of women said their phone had a touch screen compared to 35.9% of men. These numbers are

	Enrolled women						Enrolled men		Enrolled vs partners	All women vs partners
	Partner not invited		Partner invited		Partner enrolled					
	n		n		n		n		(paired)*	(unpaired) **
Age	101	21 (19-25)	58	24 (21-29)	101	23 (20-27)	101	30 (26-35)	<0.0001	<0.0001
Education	101		58		101		101		0.01	0.03
No secondary		29 (28.7)		19 (32.8)		40 (39.6)		37 (36.6)		
Some secondary		18 (17.8)		15 (25.9)		20 (19.8)		9 (8.9)		
Secondary complete		33 (32.7)		14 (24.1)		24 (23.8)		26 (25.7)		
Above secondary		21 (20.8)		10 (17.2)		17 (16.8)		29 (28.7)		
Income										
Household	43	70 (25-150)	36	100 (52-175)	56	100 (50-150)	98	80 (50 – 200)	0.85	0.91
Individual	81	0 (0-40)	53	1 (0-50)	87	10 (0-50)	97	80 (40-150)	<0.0001	<0.0001
ICT Access and Use										
Airtime per week (USD)	100	100 (50-250)	100	100 (50-150)	58	100 (50-200)	99	200 (100-350)	<0.0001	<0.0001
SMS sent per week	95	21 (7-50)	94	5 (3-20)	57	5 (2-10)	90	10 (3-30)	0.20	0.30
Used internet	101	40 (39.6)	101	34 (33.7)	58	23 (39.7)	101	68 (67.3)	<0.0001	<0.0001
Used WhatsApp/Facebook	101	31 (30.7)	101	21 (20.8)	58	17 (29.3)	101	46 (45.5)	<0.0001	0.001
Touchscreen	101	33 (32.7)	101	23 (22.8)	58	15 (25.9)	101	36 (35.6)	0.02	0.12

Table 3: Demographic characteristics and technology access by gender. For continuous variables the median and interquartile range (IQR) are shown, for categorical the count and percentage are shown. * paired t-test for continuous, McNemar test for binomial, McNemar-Bowker test for multinomial. ** t-test for continuous, χ^2 for categorical

slightly higher than other work exploring women's technology use in Kenya [26], which may indicate how quickly cheap touchscreen phones are being adopted. The last two columns of Table 3 display the outcome of paired statistical tests comparing the mother and partner in each dyad as well as unpaired tests on the larger population of all women to all enrolled men. Interestingly, while men reported spending about twice as much per week on airtime, both men and women said they sent about the same number of SMS messages per week. The only two variables that are not significantly different between women and men are self-reported household income and number of SMS messages sent per week. Taken together these demographic data indicate that data-based services still haven't reached the pockets of enough rural Kenyan women to be universally available and SMS remains the most ubiquitous messaging platform for our study population.

	Enrolled women			Partner
	Not invited	Invited	Enrolled	
n_a	n = 101	n = 58	n = 101	n=101
Torch	92.1	98.3	90.1*	79.2
Radio	80.2	89.7	83.2**	95.1
Play Music	70.3	74.1	72.3*	84.2
Take Pictures	59.4	46.6	60.4*	73.3
Show Videos	42.6	20.7	37.6**	62.4
Multiple SIMs	36.6	39.7	34.7**	51.5

Table 4: Percentage of participants self-reporting phone feature use at enrollment based on partner enrollment status. For enrolled participants significant p-values for paired t-test comparing enrolled mothers and partners are indicated at **p<0 .01, *p<0.05.

5.2 Phone Features and Use

We asked participants what features their phones had and which, if any, they used. In Table 4 we show the percent of mothers whose phones had each feature. It is important to note that numbers reported for features are a lower bound since participants might not be aware of the feature. For all features a paired t-test shows significant difference between the mothers and their partners. The only feature fewer men report having is a torch (flashlight) on their phone – a surprising finding since this is a feature built into even the most basic phones. This may be partially explained by the fact that more men reported having touchscreen phones and the use of the camera flash as a torch is not as intuitive or discoverable as the torch on more basic phones.

Having a phone with certain capabilities does not mean they are actually used. In our data, the significant gender differences in features that participant phones had was amplified when taking in to account the features that are actually used. In Figure 2 the percent of participants who used (green/bottom), had but did not use (yellow/middle), and did not have (blue/top) is shown. The only truly universal feature is SMS, with 100% of both women and men saying their phone has SMS and around 90% of all groups saying they use SMS. Large gender divides in both access and use existed for the other features. For example around 90% of participant phones support FM radio; however, only about 60% of women reported using radio on their phones while almost 90% of the men did. The large fraction of phones capable of playing FM radio demonstrates an important non-data enabled multimedia function mobile phones served for our study population. Large gender differences in actual use also existed for playing music, taking pictures, and watching videos. With videos the difference was particularly large, with less than 10% of women using their phone to watch videos and 50% men reporting they did. Lastly, the number of participants who reported using multiple SIM cards, for both women and men, was greater than the number of participants who said they had a dual SIM

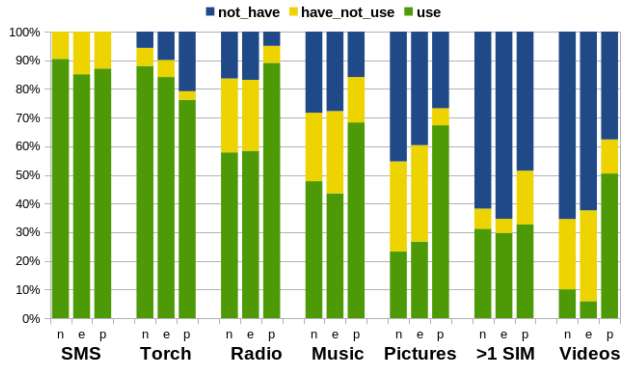

Figure 2: Phone feature use among participants. Percent of participants who used (bottom/green), had but did not use (middle/yellow), and did not have (top/blue) each phone feature. Participant categories: (n) mothers with partner not enrolled, (e) mothers with enrolled partners, and (p) partners.

phone. This suggests that many people were switching SIM cards to get the best deals on phone calls. This is an important observation about designing mHealth interventions meant to reach individuals. It should be expected that at least a quarter of the participants will have multiple phone numbers and the system should account for this.

6 MEASURING MALE ENGAGEMENT

Two primary research questions were (1) how men's use and involvement in family planning conversations would be similar to or different from mothers'; and (2) if inclusion of male partners affected the participation of mothers in any way. In this section we attempt to answer these two questions. First, we analyze statistics of system use to see how responsive partners were and if their inclusion changed the overall participation of the mothers. Second, we examine the content of the messages and highlight interesting and novel interactions with the system. The major takeaway from this analysis is that, as expected, male partners engage less with the system than women. However, when men do engage, it is in almost exactly the same manner as the women.

6.1 Quantifying Engagement

Of the 52 men enrolled in the intervention group, nine shared a phone with their partner, and so did not receive individual messages. The remaining 43 male partners sent a total of 387 messages with a median of 7 , IQR(3 - 13). This is drastically less than 130 women in the two-way group who sent a median of 20 IQR(10 - 38) messages.

The cumulative frequency plot in Figure 3 shows the number of messages each percentile of male partners and mothers sent. A larger proportion of male partners sent fewer messages, with 55% sending less than five messages. The maximum number of messages sent by a male partner was 43 and the graph shows that 10% of men sent more than 20 messages while 60% of women sent more than 20 messages. The number of messages sent by mothers with a partner in the study and mothers without a partner in the study did not differ.

While it is clear that the men engaged less than the women, an important follow-up question is: which men engage? Are the men who engage the most the partners of mothers who send the most SMS messages? In only eight instances does the male partner send more messages than his female partner. We found that there was no correlation between the number of messages sent by the female and male partner in each couple (r=0.14, p=0.38).

It was also possible that including male partner would decrease the mother's engagement. To understand this we compared the total number of messages sent per mother based on the partner's enrollment status (not invited, invited, and enrolled) Table 5 shows the proportion of each group that responded at least once, as well as the median number of SMS sent for the whole study period. A majority of both men and women engaged at least once with the system. Of all mothers, 123 (94.6%) sent at least one message into the system and 38 (88.4%) men sent at least one SMS (second column of Table 5). More importantly, if we look at each couple as a whole, then 100% of dyads sent at least one message to the system. Thus, including the male partner engaged more households than would otherwise be included in the conversation. The unequal variance t-test between the number of messages sent by mothers in the enrolled group and others was calculated. There was no significant difference between mothers with an enrolled partner and the other groups of mothers. Including the male partner in the conversation, therefor, does not change the frequency with which any mothers engage. However, comparing mothers with an enrolled partner and their partners, there is a highly significant difference in engagement, with men sending 37.7% as many messages as the women.

Another way to analyze engagement is from the time interval between when the system or study staff sent an outgoing message and the system receiving an incoming message. Of the 5176 outgoing system messages, 2040 (39.4%) were replied to within seven days by either the mother or partner. Figure 4 plots, on a log scale for time, the cumulative distribution function (CDF) of response times

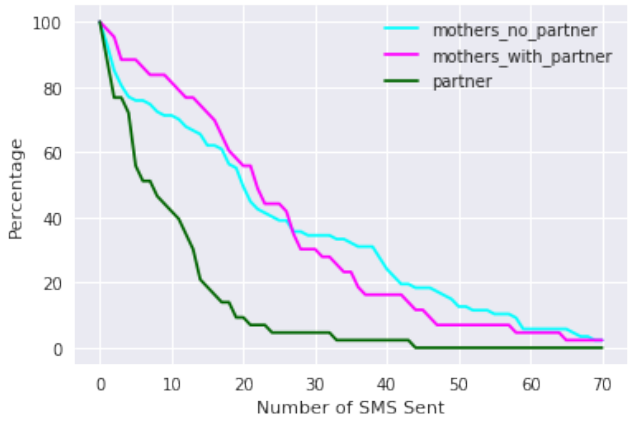

Figure 3: Cumulative frequency of SMS messages sent by mothers (grouped by partner status) and the enrolled men. Only 10% of men send more than 20 messages while 50% of women do.

	n_i	Active (n / %)	Total SMS median (IQR)	p
All Mothers	130	123 (94.6)	20 (9.25 - 38)	0.84
Not Invited	49	47 (95.9)	23 (14 - 40)	0.38
Invited	38	34 (89.5)	15.5 (1.3 - 37.3)	0.58
Enrolled	43	42 (97.7)	21 (13.5 - 32.5)	ref
Partners	43	38 (88.4)	7 (3 - 13)	<0.0001
Couples	43	43 (100)	33 (18 - 41)	ignore

Table 5: SMS engagement by individuals and couple dyads. Active (column 2) is a count of participants who sent at least one message at anytime during the study. In the Total SMS column the median and inter-quartile range are given.

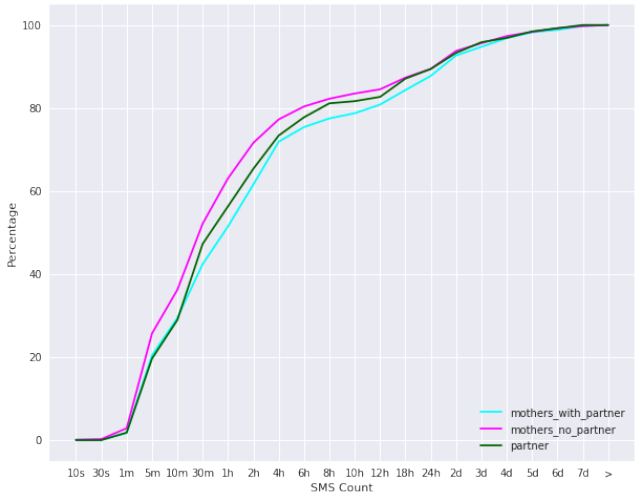

Figure 4: Response times between an outgoing message and an incoming message on a logarithmic time scale. Results are broken down by partners, mothers with enrolled partner, and mothers without an enrolled partner.

for all messages from the mothers and partners. Unexpectedly, the curves for both women and men are exactly the same. Within one hour of sending messages out about 60% of replies were received. The fact that all of these curves are identical means that 1) even though the women have less ICT access they can be thought of as being *online* with regards to SMS and 2) even though the men do not engage with the system as much as women, when they do, it is within the same timeframe as the women.

6.2 Participant Conversations

As we have shown, even though the male partners participated less in family planning SMS conversations, when they did participate it was in much the same way as the women. The next question asks with what content did the men engage? Throughout the study, every incoming message was processed by study staff and categorized by topic. The topic of a message cannot be determined from the SMS content alone, but requires knowing the context of the messages that preceded it. For example in the following message exchange:

System Both 06-01 8:01 – *Spacing pregnancies by 2 years promotes health for mothers and babies. Have you talked about when to have another child as a couple?*

Partner 06-01 8:24 – *yes*

Mother 06-01 12:14 – *Yes, not less than 5 years*

The single answer reply from the partner would be classified as family planning since it engages with a family planning related system message. Figure 5 shows the topics of messages sent by partners and mothers. It is apparent that the men and women engage in very similar topics and at basically the same frequency. About 70% of messages from both mothers and partners are evenly split between family planning and maternal health. While not surprising (more than half of the messages we set out were about family planning), this was by no means guaranteed. This shows that the primary use of the system was centered around the two intended topics. The fact that all participants engaged in the primary topic the system was intended for is encouraging. Messages in the 'other' category tended to be about the study or unrelated health concerns.

What exactly did the participants talk about? Were the only responses to the automated questions short Yes/No answers, or did the men engage in substantive family planning discussions and address real concerns? One, admittedly rough, estimation of engagement is message length. We found that over 77.3% of messages were ten characters or longer, which indicates more engagement with the system than Yes/No replies. For the mothers 76.7% of their messages were longer than ten characters, whereas for the male partners, 81.6% of messages are longer than ten characters. We now present a few examples of longer messages and interesting SMS conversations involving male participation in the study. This first example demonstrates how the system enabled a multi-party conversation between the system, study nurse, and both partners. This conversation took place in Luo and was translated by study staff into English. It starts with a generic infant care question three weeks after delivery:

System Both 11-07 14:01 – *Please ask us if you need any information. We are here for you and your baby. Are you having any challenges?*

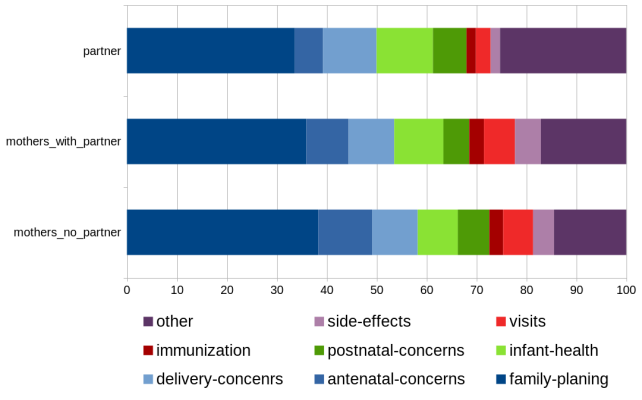

Figure 5: The topic of incoming messages by group. All mothers and partners engage with the SMS system around the same topics and at the same frequency.

Later that evening the partner replies:

> **Partner 11-07 18:23** – *Mama {name} and I are doing fine, although for the baby he has difficulty when passing stool, he can pass stool once in a week, so I don't know where the problem is!*

And then the next morning the mother asks two family planning related questions.

> **Mother 11-08 10:45** – *if i use the coil are there any problems?*

> **Mother 11-08 10:55** – *if you want to insert the coil is it a must you come with your husband*

It is interesting that the mother brings up contraceptive use on her own even though the most recent system message did not talk about family planning. Participants often did not reply directly to the content from the automated system and clearly saw the SMS exchange as a general maternal health resource.

The next day the study staff arrive at the hospital and begin to respond to messages. The important question from the partner is forwarded to the mother so she is also aware of the conversation. Next the study staff answer both questions.

> **Nurse 11-08 11:34 Mother** – *Hi {name},if you want to be inserted for the coil it is not a must you come with your husband, but if he has time he can accompany you. you will experience cramps during menses and during the first few days.*

> **Nurse 11-08 11:37 Both** – *Hi {name}, have you started giving the baby other food and fluids apart from breast milk?*

The first answer about not needing to come with your husband to get an IUCD is sent just to the mother. The second question asking about other foods is a response to the partner's question and sent to both mother and partner. Within 20 minutes the mother replies to the nurses question about having other foods.

> **Mother 11-08 11:52** – *until 6 months is when he will start taking other fluids*

This example illustrates how complex the multi-conversation messaging can get. Including the forwarded message, the mother received three messages from the system in less than five minutes and they were out of order for a natural conversation. However, this did not stop her from understanding and replying.

This next example demonstrates why it is important for the system to not automatically forward messages between the partners. In replying to an automated message about family planning, one mother asked if it was possible to do family planning without your husband knowing.

> **Mother** – *can you do family planning without your husband knowing?*

> **Nurse** – *yes you can, if he does not approve of family planning and you really want to use it.*

> **Mother** – *i will soon come alone*

The study nurse also used the ability to have a conversation with just one partner to talk with the men about sensitive issues. For example in the following exchange a partner asked about family planning methods that are applicable to men only. This exchange took place in English and with the exception of names is represented exactly.

> **Partner** – *Hi can you tell me a method of family planning that is applicable to men only*

> **Nurse** – *hello {name},for now men can use condoms and vasectomy, although this is an irreversible method.it can be used when you feel you have had enough children and you need a permanent family planning method.*

They then go on to exchange three more messages about the details and side effects of a vasectomy.

When analyzing the messages sent with the male partners' phones, we observed 12 messages that were clearly sent by the mother such as this one:

> **Partner** – *i feel like my tummy is heavy and the baby is not moving,blood builder medicines that i was prescribed for i have not yet bought,that is where i need help.*

For many of the messages it is impossible to know who is actually sending the message, but the use of first person to describe the pregnancy clearly indicates that this message from the partner's phone was written by the mother. This sharing of the phone may also have happened in the other direction as well (i.e., the partner was responding on the mother's phone number) but coding all 3188 messages individually was beyond the scope of this analysis so it is unclear how commonly this occurred.

7 DISCUSSION

A central paradox of all ICT4D behavior change work is that the people that most need outreach are also those with the least access to ICTs. It is important to choose the correct technology and medium based on the target population and demographics. Like most of Sub-Saharan Africa, the women in our study had limited access to data-enabled services and smartphones. It might be tempting to create a WhatsApp or Facebook messaging application since both channels offer the developer more features. However, only 27% of women in our study said they had used either service. Slightly more men (45%) reported using these data-enabled services – but that still means we would be reaching less than 50% of the population. Our data show that every single phone is capable of sending and receiving SMS messages and, more importantly, the weekly use of SMS between genders was basically the same prior to the study. By choosing to use toll-free SMS as the communication channel for this intervention we were able to reach and engage the mothers. Any M4D project that plans on reaching end users needs to have an SMS or IVR fall back even if it uses data enabled channels for some users. This makes the intervention scalable across the technology requirements and needs of the whole population.

The use of toll-free SMS messaging means that the cost of messaging must be paid by the provider – in this case the research team, but if a similar service were to be scaled up an NGO or the Ministry of Health would need cover the messaging cost. Previous work with IVR has shown that as soon as an intervention stops using a toll-free number usage significantly drops off [25]. No one has replicated this study in SMS, but requiring participants in our study to pay for SMS messages would likely reduce engagement. However, with SMS, the toll-free costs are nowhere near as large as in an IVR system. The monthly $150 USD cost for the short code

was fixed regardless of how many messages we sent and at $0.007 USD per message $100 USD would send over fourteen thousand messages. With SMS the communication cost is not a prohibitive factor to scale.

One aspect of the system that is difficult to scale is the need to the synchronize internal variables that drive messaging with each participant's current status. This is a major challenge in the design and implementation of automated messaging platforms in M4D. For a small RCT such as ours, this was manageable with a dedicated staff – but if a maternal health platform scales to an entire district or nation, then simple and easy data collection methods need to be deployed. For example, MomConnect in South Africa has community health workers register pregnant women over basic USSD menu systems [23]; however, there has been little work analyzing the accuracy of this approach and how well it captures future events such as deliveries.

Since male engagement was not randomized it will be impossible to know for certain if there are any causal effects of male partner inclusion in the family planning conversation. However, our findings indicate that at the very least involving male partners does not negatively impact the conversation held by women and actually engages more households. The inclusion of men in family planning messaging raises several interesting questions. First, how do we know if the limited engagement we did see from the men is typical, or should we expect more engagement? Male partners in Kenya typically do not attend prenatal clinic sessions. With few points of contact with the health system it becomes more difficult to enroll male partners in the SMS platform. In our study we conducted home visits to reach the partners but if this were to scale up to the district or national level home visits quickly become impractical. A similar question for the women is how does a health system engage with them before they come in pregnant? Family planning knowledge and agency might be more useful *before* a pregnancy than after. One solution to both of these problems is to have an opt-in SMS platform such as m4RH. This raises questions of equity and access, since those who learn about and contact the system are often less likely to need the information.

8 CONCLUSION

Involving male partners in the family planning conversation is difficult since they do not engage with the health system as frequently as women during antenatal and postpartum care. This project has shown that, given the opportunity, men engaged via SMS in useful and important ways. However, even though they had more access to technology, they engaged less their female counterparts with the same maternal health intervention. When male partners did engage, it was in a very similar way to the mothers. When they responded to automated messages they did so quickly and they responded equally to family planning and maternal health related content. In addition, the men asked important and personal questions. Including male partners in an SMS system engages more households than not including them and work needs to be done exploring how to sustainably involve men in future interventions. The semi-automated SMS system plays an important role in enabling this engagement without overwhelming medical professionals. The weekly automated messages serve as open-ended invitations to ask questions and the topic of these messages largely drives the topic of responses. From this stepping stone, the individualized responses from study staff help build a level of trust in the SMS system opening the door to more engagement. Male partner participation in SMS based maternal health conversations does not decrease the mothers' engagement and allows the intervention to engage with more households.

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