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Patterns of usage and preferences of users for tuberculosis-related text messages and voice calls in Uganda

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SUMMARY

BACKGROUND: Little information exists about mobile phone usage or preferences for tuberculosis (TB) related health communications in Uganda.

METHODS: We surveyed household contacts of TB patients in urban Kampala, Uganda, and clinic patients in rural central Uganda. Questions addressed mobile phone access, usage, and preferences for TB-related communications. We collected qualitative data about messaging preferences.

RESULTS: We enrolled 145 contacts and 203 clinic attendees. Most contacts (58%) and clinic attendees (75%) owned a mobile phone, while 42% of contacts and 10% of clinic attendees shared one; 94% of contacts and clinic attendees knew how to receive a short messaging service (SMS) message, but only 59% of contacts aged ⩾45 years (vs. 96% of contacts aged <45 years, $P = 0.0001$) did so. All contacts and 99% of clinic attendees were willing and capable of receiving personal-health communications by SMS. Among contacts, 55% preferred detailed messages disclosing test results, while 45% preferred simple messages requesting a clinic visit to disclose results.

CONCLUSIONS: Most urban household TB contacts and rural clinic attendees reported having access to a mobile phone and willingness to receive TB-related personal-health communications by voice call or SMS. However, frequent phone sharing and variable messaging abilities and preferences suggest a need to tailor the design and monitoring of mHealth interventions to target recipients.

KEY WORDS: mobile technology; information and communication technology; SMS

MOBILE PHONES have transformed development in low-income countries in recent years,[1] especially in sub-Saharan Africa. Widely available, low-cost handsets have expanded access to and usage of mobile phones. In Uganda, mobile phone networks reach 78% of the population.[2] Pricing of voice calls and short-messaging services (SMS) has fallen since 2013,[2] and mobile internet should increase as innovative service plans further reduce costs and expand access.[3]

Clinicians and public health practitioners have been quick to experiment with mobile-health (mHealth) technologies such as SMS for many indications, including supply-chain management, social support to promote medication adherence, and appointment reminders.[4–6] Increasing evidence supports their use,[7–9] but routine implementation remains rare. More high-quality data are needed for scale-up,[10,11] including information about mobile phone ownership in key populations,[12] access to phone networks and charging facilities,[13,14] proficiency with mobile phones, expectations about confidentiality, messaging preferences,[15–17] and how these factors affect the uptake and usage of mHealth interventions.

Most published data relate to human immunodeficiency virus/acquired immune-deficiency syndrome (HIV/AIDS), community health, and maternal and child health,[18–20] with few studies on tuberculosis (TB).[21,22] We conducted two prospective observa-

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tional studies in Uganda to characterize mobile phone access, usage patterns, and messaging preferences for TB-related communications among rural clinic attendees and urban household contacts of TB patients. We sought to obtain results that could inform the design of future mHealth interventions to improve TB case finding.

METHODS

Study design

We carried out two cross-sectional studies among Ugandan adults. One involved surveys and brief interviews with the household contacts of index TB patients at seven urban primary care clinics in Kampala, Uganda. The other surveyed general out-patients at four rural primary care clinics offering TB diagnostic-evaluation services in central Uganda.

Study population and sampling

Household contacts

This was a sub-study of a randomized, controlled trial (Pan-African Clinical Trials Registry #201509000877140) of an intervention combining home-based TB evaluation and automated SMS reminders to improve TB case finding and linkage to care. We enrolled household contacts, defined as anyone sharing a roof with an index TB patient within the previous 3 months. We initially recruited consecutive participants during a pre-trial formative phase (October–November 2014). Later, during the pilot and initial enrollment phases of the trial (February–September 2016), we recruited contacts from two randomly selected households per week, excluding the households of index TB patients with no mobile phones. In each phase, we enrolled all available adult (age $\geqslant$15 years) household TB contacts.

General out-patients

We also enrolled a convenience sample of all general out-patients (age $\geqslant$18 years) present during 1-day site visits to four rural primary care facilities performed every month for 5 consecutive months during a prospective observational study of sample referral practices for molecular diagnostic testing for TB (December 2015–April 2016).[23]

Procedures

Research officers verbally administered separate structured surveys among household contacts and general out-patients. Both explored the ownership of and/or access to mobile phones, use of mobile phones for voice calls and SMS, and ability to send and/or receive SMS using a mobile phone. The household contact survey also inquired about mobile money transfers and language preferences for mHealth communications, and willingness to receive personal health information or reminders by SMS or voice call. We also carried out focus group discussions and key informant interviews with contacts. We have described our methods for qualitative data collection and provided study instruments in the Appendix.* We did not collect qualitative data from clinic patients.

Statistical analysis

We summarized continuous data using values for the mean with standard deviation (SD) or median with interquartile range (IQR), and categorical data using proportions. We explored the associations between mobile phone usage and the key demographic variables age, educational attainment, employment status, and sex, using logistic regression with χ^2 tests of significance. We report the representative responses of contacts to open-ended questions about SMS preferences.

Protection of human subjects

The Makerere University School of Medicine Research Ethics Committee, Kampala; the Uganda National Council for Science and Technology Kampala, Uganda; the University of California San Francisco Committee on Human Research, San Francisco, CA, USA; and the Yale University Human Investigation Committee, New Haven, CT, USA, approved separate protocols for the clinic and community studies. All participants provided verbal or written informed consent.

RESULTS

Participants

We enrolled all 145 available contacts from 83 households in urban Kampala and 203 eligible patients at four rural primary care clinics. Among eligible index patients, we excluded 5% without mobile phones. The median age of the contacts was 29 years (IQR 21–38); 100 (69%) were women. The median household income was approximately 16.67 USD per month (IQR 8.34–27.79, income missing for 22 households). The median age of the clinic patients was 29 years (IQR 24–40); 137 (67%) were women. Among clinic patients, 104 (51%) reported having primary education or less, 65 (32%) secondary, and 34 (17%) university education.

Mobile phone access

Among the 145 household contacts, 84 (58%) owned a mobile phone, while 61 (42%) shared a mobile phone owned by a family member (74%), spouse or partner (20%), or friend (7%; Table 1). Among the

* The appendix is available in the online version of this article, at http://www.ingentaconnect.com/content/iuatld/ijtld/2018/00000022/00000005/art00012

Table 1 Access to mobile phones and networks for participants in an urban, community-based study

Characteristic	Urban household contacts ($n = 145$) n (%)*
Own a mobile phone	84 (58)
Do not own but have access to a mobile phone, primarily through:	61 (42)
Spouse/partner	12 (20)
Family member	45 (74)
Friend	4 (7)†
Number of SIM cards used regularly	
Do not own a SIM card	5 (4)
One SIM card	102 (70)
Two or more SIM cards	38 (26)
Network access at home or work	134 (92)
Ever changed mobile phone number	38 (26)
Changed number within the last 6 months	14 (37)
Time with phone powered on, h/day, mean ± SD	18 ± 8

* Unless otherwise specified.
† Sum of percentages may exceed 100%, due to rounding.
SIM = Subscriber Identity Module; SD = standard deviation.

clinic patients, 153 (75%) owned a mobile phone, while 21 (10%) primarily shared with a spouse (29%), other family members (57%), or friend (14%); 29 (14%) neither owned nor had access to a mobile phone, although 17 of them (59%) had previously had access to one (Table 2).

About three quarters of the household contacts reported keeping their mobile phones powered on for ⩾12 h per day (average 18 h, SD 8 h). Among the general out-patients, 97% reported keeping their mobile phones switched on at all times, and only 4% reported problems keeping their phones charged; 92% of contacts and 88% of general out-patients reported having a mobile network connection either at home or work. Thirty-eight (26%) contacts had previously changed their mobile phone number,

Table 2 Access to mobile phones and networks for participants in a rural, clinic-based study

Characteristic	Rural general out-patients ($n = 203$) n (%)
Own a mobile phone	153 (75)
Do not own but do have access to a mobile phone, primarily through:	21 (10)
Spouse/partner	6 (29)
Family member	12 (57)
Friend	3 (14)
Number of SIM cards used regularly*	
Do not own a SIM card	3 (2)
One SIM card	76 (44)
Two or more SIM cards	95 (55)
Network access at home or work*	153 (88)
Phone always switched on*	168 (97)
Able to keep phone battery charged*	167 (96)

* Only for the 174 who owned or had access to a mobile phone
SIM = Subscriber Identity Module.

Table 3 Patterns of usage of mobile phones among those who owned or had access to a mobile phone for participants in an urban, community-based study

Characteristic	Urban household contacts ($n = 145$) n (%)*
Able to retrieve an SMS message from a phone	136 (94)
Ability to read an SMS message	140 (97)
Able to send an SMS message	131 (90)
Able to type using a mobile phone keyboard	140 (97)
Preferred language for SMS	
English only	30 (21)
Luganda only	64 (44)
Either English or Luganda	51 (35)
Number of days before checking SMS	
Check on the same day as message received	115 (79)
Check after 1–3 days	30 (21)
Number of days making a voice call in the last week, median [IQR]	3 [2–5]
Previously received a mobile money transfer	132 (91)

* Unless otherwise specified.
SMS = short messaging service; IQR = interquartile range.

including 14 (37%) within 6 months. Mobile phone ownership did not differ significantly by age in either study: 50% of contacts aged ⩾45 years owned phones vs. 59% of those aged <45 years (difference 9%, 95% confidence interval [CI] 0–32, $P = 0.41$). Phone ownership was similar among urban female (58%) and male (58%) contacts (difference 0%, 95%CI –17 to +17, $P = 0.98$). Significantly more rural men (86%) owned a mobile phone than rural women (70%, difference 16%, 95%CI 5–27, $P = 0.01$), and those with secondary education were more likely to own a mobile phone (89%) than those with primary education or less (62%, difference –28%, 95%CI –39 to –17, $P < 0.001$).

Usage of mobile phones

Most household contacts knew how to send (90%) and receive (94%) SMS. Fewer general out-patients knew how to send SMS (70%), but the proportion capable of receiving (94%) SMS was similar to that of

Table 4 Patterns of usage and acceptability of mobile phones among those who own or have access to a mobile phone for participants in a rural, clinic-based study

Characteristic	Rural general out-patients ($n = 174$) n (%)
Able to receive an SMS message	164 (94)
Able to send an SMS message	121 (70)
Willing to receive any test results via SMS text message	164 (94)
Willing to provide telephone number to health center	173 (99)
Willing to read messages from numbers unknown or not in contact list	142 (82)

* Response missing for 23 participants.
SMS = short messaging service.

Table 5 Acceptability of mobile phone personal health communications for participants in an urban, community-based study

Characteristic	Urban household contacts ($n = 145$) n (%)*
Willing to receive via SMS	
Laboratory test result	144 (99)
New request for clinic visit	145 (100)
Reminder for clinic visit	145 (100)
Reminder to take medicine	145 (100)
Willing to receive health information by voice call	
Laboratory test result	138 (96)†
New request for clinic visit	139 (96)
Reminder for clinic visit	138 (96)†
Reminder to take medicine	139 (96)
Number of SIM cards preferred for health-related SMS‡	
Prefer to receive SMS on one SIM card	30 (79)
Prefer to receive SMS on multiple SIM cards	8 (21)
Number of SIM cards preferred for health voice call‡	
Prefer not to receive voice calls	3 (8)
Prefer to receive calls on one SIM card	28 (74)
Prefer to receive calls on multiple SIM cards	7 (19)
Preferred type of health message	
Simple	65 (45)
Detailed	80 (55)

* Unless otherwise specified.
† Missing for 1 respondent.
‡ For those with >1 SIM ($n = 38$).
SMS = short messaging service; SIM = Subscriber Identity Module.

contacts (Tables 3 and 4). A large number of contacts (44%) preferred communicating in Luganda, 20% preferred English, and 35% either language. The median number of days on which household contacts had sent an SMS in the previous week was 1 (IQR 0–2). The median number of days on which they had made or received a voice call was 3 (IQR 2–5); 96% of rural clinic attendees sent less than one text message per day. One hundred and fifteen (79%) contacts reported checking SMS on the day of receipt, while 30 (21%) reported waiting 1–3 days to check SMS. One hundred and thirty-two (91%) contacts had previously received a mobile money transfer. While there were no significant differences by sex in self-reported ability to send SMS (90% for women vs. 91% for men, 95%CI −9 to +11, $P = 0.83$), younger individuals were significantly more likely to know how to send an SMS: 96% aged ⩽45 years vs. 59% aged ⩾45 years ($P = 0.0001$).

Preferences for mobile health communications

All enrolled contacts agreed to receive personal health information via SMS; a similarly high proportion found voice calls acceptable (96%; Table 5). Almost all general out-patients were willing to provide a mobile phone number to the health center ($n = 173$, 99%) and receive SMS containing test results ($n = 164$, 94%). However, 10 (6%) general out-patients subscribed to a list blocking bulk delivery of SMS ('spam'), 32 (18%) would not reply to an SMS from an unknown number, and 50 (29%) would not reply to an SMS from a health center. Furthermore, while all 21 (100%) general out-patients who reported sharing a mobile phone would agree to receive personal health messages on a shared phone, six (29%) were uncomfortable doing so. With regard to SMS content, 80 (55%) household contacts preferred a detailed health message vs. 65 (45%) who preferred a simple message (see Appendix Figure A). Participants who preferred detailed messages liked their directness and clarity, which most felt would encourage them to seek care as early as possible:

> I prefer the last [detailed] message because when it comes to health issues there is no need to hide anything. You have to tell someone directly so that he/she can come immediately for treatment… (Interview 8)

> The first two [simple] messages are weak. The way I know Ugandans, you need to be open just like the last [detailed] message and you can add on that 'if you do not come TB will kill you.' (Interview 7)

> If you just call me to come for treatment I might somehow be doubtful but the detailed message clearly shows that I have TB. (Interview 5)

However, those who preferred a simple message wanted to be informed about their illness at a health facility.

> I like the simple message. I want to be told that I have TB when I am at the clinic. (Interview 10)

Contacts did not mention TB stigma or privacy in interviews or focus group discussions about their messaging preferences.

DISCUSSION

Using mobile phones to facilitate delivery of health interventions holds considerable promise for improving health care quality in sub-Saharan Africa by increasing communication between patients and providers. Recent systematic reviews have highlighted the extensive use of mHealth technologies; however, only six publications related to TB have done so.[24,25] Importantly, few analyses have explored access, usage patterns, or preferences for mobile phone communications concerning TB evaluation.[24,25] Using cross-sectional surveys of urban household contacts and rural clinic patients in Uganda, we have shown that access to and the ability to use basic functions of mobile phones were high, with significant interest in receiving TB-related personal health information and clinic visit reminders via SMS or voice calls. However, we also found that phone-sharing was common and that proficiency, comfort, and message preferences may vary by age, sex, and geography, suggesting a need to tailor design

and monitoring of mHealth interventions to target recipients.

While previous studies have also demonstrated high levels of access to and acceptability of mobile communications in sub-Saharan Africa,[18,20,26,27] the variability we identified within populations deserves attention. Specifically, we identified lower mobile phone ownership among urban household contacts than among rural general out-patients. This finding could be explained by a selection bias if contacts present at home and enrolled were less likely to own phones than contacts not at home and not enrolled. However, we also identified less phone ownership among rural women, lower proficiency in sending SMS among rural general out-patients and among older individuals in urban areas, and important differences in messaging preferences. This observation suggests a need to offer voice calls for those unable to use SMS. Another new and notable finding was that a sizeable proportion of patients in rural clinics would not reply to messages from a health center or an unknown sender. This finding is consistent with popular support in Uganda for recent national regulations against SMS spam,[28] i.e., unsolicited messages from third parties. Furthermore, there may be value in registering senders' numbers as contacts in participants' phones during enrollment, as one study suggested that allowing recipients to verify the identity of the sender could increase the number who will read or reply to messages.[29] One third of the contacts had previously changed mobile phone numbers, further complicating delivery of longitudinal mHealth interventions. Studies among people living with HIV have highlighted the importance of confidentiality when communicating about stigmatized conditions, and there are significant challenges to ensuring that SMS containing personal health information remain private in settings such as Uganda, where mobile phone sharing is common.[30] Because TB is highly stigmatized,[31,32] similar concerns exist about communicating TB-related personal health information. However, almost all participants were willing to receive TB-related personal health information and reminders via voice calls or SMS, although nearly one third of general out-patients surveyed were uncomfortable receiving personal health information via SMS on a shared phone. Interestingly, contacts were almost evenly divided in their preferences between simple but vague SMS language and more detailed and direct language for communicating TB results. Participants cited preferences about when and where disclosure of a TB diagnosis should occur, but not, in our small sample, about loss of privacy from receiving communications on a shared phone. Research on SMS among persons living with HIV has highlighted concerns about confidentiality with mobile phone communications,[18,33,34] but efforts to password-protect SMS or strip SMS of disease-specific content has been associated with reduced efficacy of SMS interventions.[35] Continued exploration of mobile phone ownership, usage patterns, and messaging content in TB-specific populations is needed given the rapid evolution of technology, but our data suggest that greater personalization of mHealth interventions to user preferences is desirable.

Our studies had four main limitations. First, we surveyed a convenience sample of general out-patients, and household contacts were not surveyed if absent during the home visit. We also did not visit contact households for a small proportion of index patients who did not own a mobile phone. We may therefore have overestimated phone ownership and access in contact households. A second limitation was that the household contact and clinic survey instruments were designed and implemented separately, which prevented detailed between-group comparisons. Nevertheless, our findings were complementary, and the differences between surveys facilitated some population-specific assessments. Furthermore, our surveys only collected information on voice and SMS, and did not explore other media such as chat clients and online social networks. Although such functionality requires access to Internet-enabled phones, we expect these communication platforms to gain wider use in the future. Finally, we did not collect qualitative data from rural general out-patients, which prevented exploration of other potentially interesting survey findings.

Our studies also had several strengths. This report is one of the first to provide primary data on the preparedness of key populations for use of mobile phones for TB care. Furthermore, we recruited a variety of participants from multiple clinics and communities representing both rural and urban populations. Together, these studies provided important and previously unavailable information about mobile phone ownership, usage patterns, and preferences among populations relevant for TB programs, and highlighted important heterogeneities within populations. We have shared this data with the Uganda National TB Programme to inform implementation strategies for household contact investigation and for communicating TB testing results by SMS if samples are referred off-site for Xpert™ (Cepheid, Sunnyvale, CA, USA) molecular testing. The mHealth aspects of these strategies will be evaluated in upcoming randomized, controlled trials.

In summary, the studies presented here demonstrated high levels of access to mobile phones and interest in receiving both general and personal health communications by mobile phone, while highlighting substantial stratification of mobile phone ownership, ability, comfort, and messaging preferences among target populations. Mobile communications offer tremendous potential to overcome several important

challenges in providing diagnostic services for TB, including drop-out from the evaluation process, limited health worker time to deliver test results, and difficulty arranging follow-up visits. However, to realize this promise, mHealth interventions should adapt to the heterogeneities that we have identified among users to maximize impact and equity. If such flexibility can be achieved in rigorous studies, mobile communications technologies should help the TB community realize its goal of making TB case finding and treatment more effective and patient-centered.

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APPENDIX

METHODS

Procedures

We did not collect identifying information or reasons for patient visits from the general out-patients at the rural clinics. Interviewers recorded all survey data in electronic databases (CommCare, hosted by Dimagi, Cambridge, MA, USA, and REDCap, hosted by University of California, San Francisco, CA, USA) using mobile electronic tablets; all analyses were performed using Stata 12 (StataCorp 2011, College Station, TX, USA). Survey instruments are provided in Tables A.1 and A.2 and in Figure A.

Study design and population sample

We carried out focus group discussions (FGDs) and key informant interviews at index patient homes between October and November 2014. We targeted the adult household contacts of index patients.

Research team

Research staff with basic training in qualitative methods carried out FGDs and interviews in settings familiar to participants. A graduate-trained social scientist (JG) led the FGDs and interviews with contacts, with the assistance of a note-taker. All FGDs and in-depth interviews were audio-recorded with participant permission, and the research team had the recordings professionally transcribed.

Recruitment

A consecutive sample of households of new adult index TB patients referred by *lay health workers* were visited after verbal consent was obtained from the index patient. To obtain a wide range of perspectives, households were randomly assigned to have data collected before or after the contact investigation had been conducted. Households were recruited until data saturation was achieved, defined as the point at which each subsequent interview no longer yielded new themes.

Data collection and study instruments

To establish an empirical evidence base and to facilitate data collection on implementation of household contact investigation, separate interview guides for each of the three stakeholder groups were developed. Each included 6–8 open-ended questions exploring the barriers and facilitators of contact investigation and associations between behavioral determinants and completion of three key tuberculosis (TB) contact investigation activities identified in conversations with the National TB Program Manager and Zonal TB Supervisor: 1) arranging household visits through index TB patients; 2) visiting households to screen contacts for TB symptoms and TB risk factors and referring them to health centers; and 3) performing clinical assessments and TB diagnostic testing of all at-risk contacts at health centers (Table A.3). The household contact discussion guide is provided in Table A.3.

Interview and discussion guides were drafted in English, and piloted and refined with a convenience sample of non-participating health workers. The guide for contacts was translated by a professional interpreter into Luganda, the local language; the guides were reviewed by the field research team, all of whom were bilingual, for accuracy; and they were then piloted and refined. The same guides were used for both the FGDs and interviews.

Before each session, the facilitator introduced the research team and explained the study objectives. The team took notes and summarized findings for participants at the end of each session. Following data collection, the project manager (IA) and a social scientist (JG) prepared summary reports of all notes. All FGDs and in-depth interviews were audio-recorded with participant permission; the research team had the recordings professionally transcribed.

Analysis

Study investigators (AC, LD) debriefed the research team between sessions, and supervised the categorization of the emergent themes. We applied an open coding approach to the responses to the question about preferences for mobile health communications. Two individuals (IA, JG) coded all transcripts using Dedoose v6 (SocioCultural Research Consultants, Manhattan Beach, CA, USA), an online application for collaborative qualitative data analysis. All coding differences were resolved by discussion.

Protection of human subjects

Household contacts recruited during protocol development provided verbal rather than written consent for surveys, interviews, and FGDs because we did not collect personal health identifiers. Contacts recruited during the randomized trial provided written informed consent for surveys, interviews, and FGDs along with other activities for which we required collection of personal health identifiers. We did not record any personal health identifiers for either study population except participant signatures on consent forms.

RESULTS

The 83 households represented 58% of the 143 households with an enrolled index patient. During the enrollment period for the randomized trial, 104 of 1098 (9%) eligible index patients lacked access to a mobile phone. We enrolled 203/242 eligible patients at four rural primary care clinics. We excluded 39 clinic patients with incomplete data. Mobile phone ownership did not differ significantly by age in the clinic setting: 71% of contacts aged $\geqslant 45$ years were

mobile phone owners compared with 77% of those aged <45 years (difference 6%, 95% confidence interval –9 to –21, $P = 0.44$).

In October and November 2014, we recruited 14 consecutive index TB patients with one or more household contacts; all of whom gave consent for household visits. We recruited 36 contacts (range 1–8 per household): all consented. Sessions with contacts lasted 30–60 min. We held one FGD per household with four contacts present. In all other households, we interviewed contacts one at a time.

Preferences for content of SMS communicating tuberculosis-related personal health information

Two additional quotations explain patient preferences for the detailed message content.

> [The detailed message] tells you exactly why you need to go to the hospital. (Interview 13)

> The important thing is to tell me about the sickness so I can get medication instead of being unclear. (FGD 1)

Table A.1 Household contact survey

1. Date of interview	**1.** Date	Month	Year
2. What is your age (years)?			**2.**
3. What is your sex?	Male (0) Female (1)		**3.**
4. Would you allow us to scan your fingerprint on an electronic tablet to track your visits to the clinic?	No (0) Yes (1)		**4.**
5. Can you read in English?	No (0) Yes (1)		**5.**
6. Can you read in Luganda?	No (0) Yes (1)		**6.**
7. Can you type using a mobile phone keyboard in English?	No (0) Yes (1)		**7.**
8. Can you type using a mobile phone keyboard in Luganda?	No (0) Yes (1)		**8.**
9. Do you have your own SIM card? How many SIM cards do you use regularly?	List number of cards: 0, 1, 2, or >2		**9.**
10. Which networks do you use? (list all, you may list more than 1)			**10.**
a. MTN network?	No (0) Yes (1)		**a.**
b. UTL network?	No (0) Yes (1)Yes (1)		**b.**
c. Orange network?	No (0) Yes (1)		**c.**
d. Warid or Airtel network?	No (0) Yes (1)		**d.**
11. Have you ever stopped using a phone number, for any reason? (Skip to next numbered question if No)	No (0) Yes (1)		**11.**
a. When was the last time you stopped using a phone number?	List number of months ago		**a.**
12. Do you have your own mobile phone?	No (0) Yes (1)		**12.**
a. If not, do you have access to a mobile phone on a daily basis through any of your close contacts? (Skip to next numbered question if No)	No (0) Yes (1)		**a.**
b. If it is not your phone, whom does it belong to?	0 Spouse/partner	5 Friend	**b.**
	1 Sibling	6 Neighbor	
	2 Parent	7 Boss/co-worker	If 9, specify
	3 Child	8 Shop-owner	
	4 Other relative	9 Other	
c. Yesterday, for how many hours was the phone near you, and powered ON?	Specify number of hours: (0–24)		**c.**
If participant lacks phone and SIM, stop survey here			

Table A.1 *(continued)*

13. Do you know how to receive an SMS?	No (0) Yes (1)		**13.**
14. Do you know how to send an SMS?	No (0) Yes (1)		**14.**
15. In the past 7 days, on how many days did you send ≥1 SMS?	Specify number of days:(0–7)		**15.**
16. Is there any reason you wouldn't receive an SMS if we sent one to you?	0 No, I would receive it	5 Phone not with me	**16.** Mark any Y
	1 No phone/no SIM	6 Don't know how	
	2 Phone not on	7 Poor reception	If 9, please specify
	3 Phone not charged	8 Phone not working	
	4 SIM not in phone	9 Other	
17. Would it ever take ≥1 day for you to check for an SMS? How many days?	List 0 or number of days		**17.**
18. In the last 7 days, on how many days did you make or receive ≥1 phone call?	List number of days:(0–7)		**18.**
19. Have you ever received a mobile money payment (e.g., MTN Money, Airtel Money, Warid Pesa)?	No (0) Yes (1)		**19.**
20. Would you be willing to receive any of the following on the phone you use?	No (0) Yes (1)		**20.**
a. Laboratory test results by SMS?	No (0) Yes (1)		**a.**
b. A new request to come to clinic by SMS?	No (0) Yes (1)		**b.**
c. A reminder to come to clinic by SMS?	No (0) Yes (1)		**c.**
d. A reminder to take your medicine by SMS?	No (0) Yes (1)		**d.**
21. In which language would you prefer to receive SMS like these?	Neither (0) English (1) Luganda(2) Other (9)		**21.** If 9, please specify
22. To how many of your SIM cards should the SMS be sent?	List number of SIM cards		**22.**
23. At which time of day would you prefer to receive an SMS? Use 24-h clock, with 0 h for midnight and 23 h for 1 h before midnight	Enter hour of the day: (0–23) or any time (99)		**23.**
24. Would you be willing to receive any of the following on the phone you use?	No (0) Yes (1)		**24.**
a. Laboratory test results by a recorded voice call?	No (0) Yes (1)		**a.**
b. A new request to come to clinic by a recorded voice call?	No (0) Yes (1)		**b.**
c. A reminder to come to clinic by a recorded voice call?	No (0) Yes (1)		**c.**
d. A reminder to take your medicine by a recorded voice call?	No (0) Yes (1)		**d.**
25. In which language would you prefer to receive a recorded voice call like these?	Neither (0) English (1) Luganda (2) Other (9)		**25.** If 9, please specify
26. To how many of your SIM cards should the recorded voice calls be sent?	List number of SIM cards		**26.**
27. At which time of day would you prefer to receive a voice message? Use 24-h clock, with 0 h for midnight and 23 h for 1 h before midnight	Enter hours of the day: (0–23) or any time (99)		**27.**
28. We would like you to tell us which words you prefer for different types of SMS. Below are three examples. Which type of message do you prefer?	Simple (0) More information (1) Detailed (2) Cannot read (3)		**28.**

SIM = Subscriber Identity Module; SMS = short messaging service.

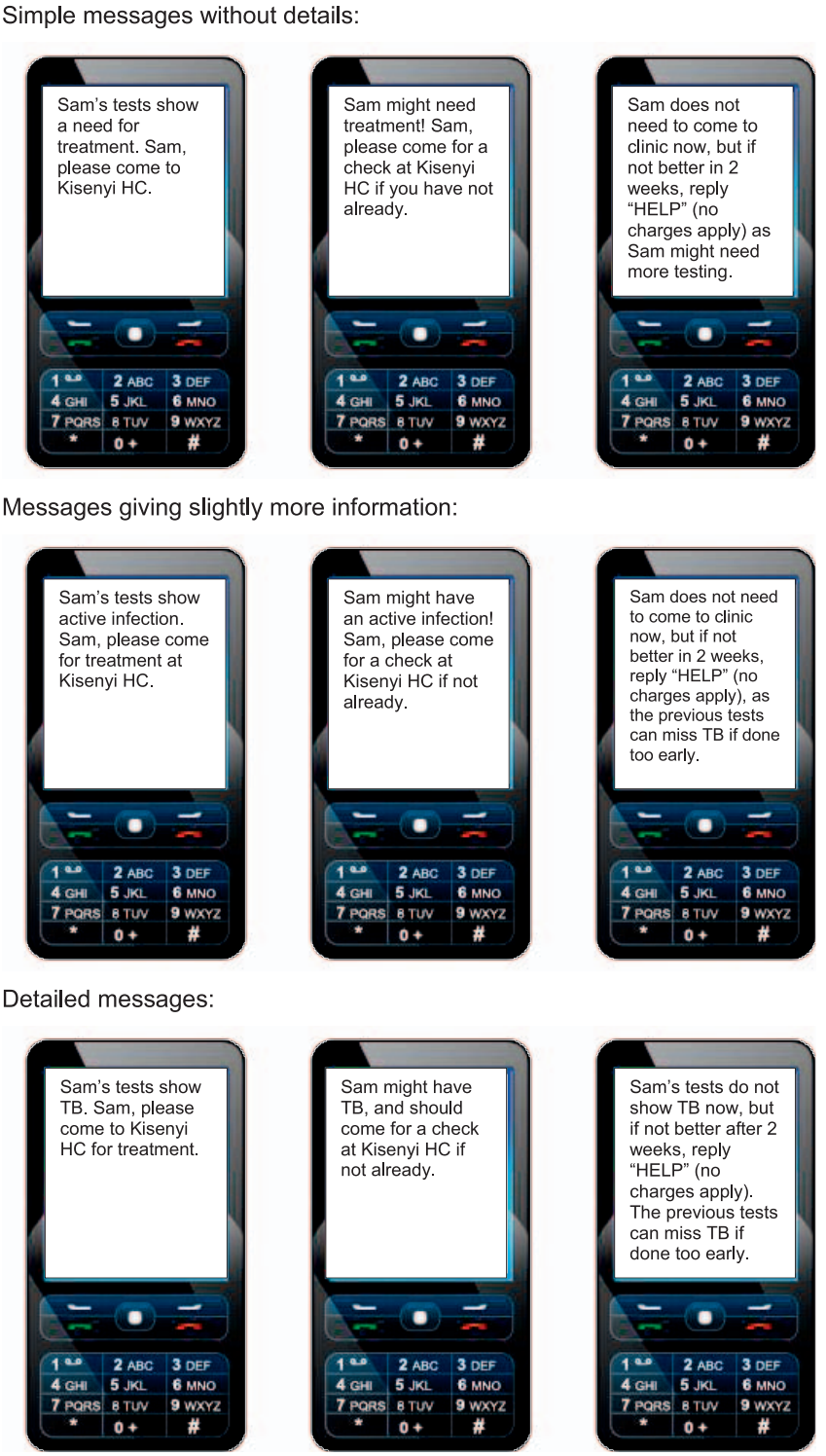

Figure A Samples of SMS messages.

Table A.2 Uganda TB Surveillance Project: clinic-based patient survey

Introduction: Thank you for accepting to take part in this short survey. This survey is part of an ongoing SIMPLE-TB study at this facility which is aimed at determining the feasibility and cost-effectiveness of the single-sample streamlined TB diagnosis and treatment. To streamline diagnosis and testing, the study is aimed at improving the speed of microscopy testing and daily referral of sputum samples for GeneXpert testing. Ultimately, we hope to link patients to treatment by utilizing the text messaging service. The purpose of this survey is to try and establish whether patients would be willing to share their mobile phone numbers with health workers to facilitate communication between the patients and health care providers concerning their health care.

Demographic information

Age: ☐ in completed years

Sex: ☐ Male ☐ Female

Marital status: ☐ Single ☐ Married/Cohabiting ☐ Divorced/Separated ☐ Widow/Widower ☐ Unknown

Level of education: ☐ None ☐ Primary ☐ Secondary ☐ Tertiary ☐ University ☐ Unknown

Date of interview	*dd*	*mm*	*yy*
	No (0)	Yes (1)	Unknown (9)
1) Do you own a mobile phone? (*If yes, skip to question 2*)			
1b) If No above, do you have access to a mobile phone? (*if No skip to question 23)*			
1c) If yes above, what is your relationship with the person whose phone you have access too? ☐ Spouse ☐ Family member ☐ Friend ☐ Other, specify			
2) Can you retrieve a text message from a phone?			
3) Can you read SMS text messages sent to your phone?			
4) Can you send SMS text messages to others?			
5) Are you on any list that blocks SMS messages sent to your phone?			
6) If asked to give a telephone number when you visit the health center, would you be comfortable providing one?			
6a) If No in (6) above, give reasons why			
7) Would you be willing to receive your test results via SMS text message on your phone?			
7a) If No in (7) above, give reasons			

Table A.2 *(continued)*

7b) If No in (7) above, would you be willing to receive an SMS text message asking you to come back to the health center (i.e., without any specific test results included)?			
8) Would you reply to an SMS message sent from the Health Center?			
9) If No in (8) above give reasons why			
10) Do you always have network connection at home or work?			
11) Are you able to always keep your phone battery charged?			
12) Do you always keep your phone switched on?			
13) In the past month, how many days have you not been able to receive SMS messages on that phone due to (lack of battery, no access to contact person)			
14)Do you share your mobile phone with anyone?			
14a) If yes, whom do you share it with?			
15) How many text messages do you receive on an average day?			
16) How many of those are from people who are not your personal contacts?			
17) How many text messages do you send on an average day? (*Skip if answered No to question 4)*			
18) Do you read messages from numbers unknown to you or not in your contact list?			
19) How many SIM cards do you use regularly (*list number of SIM cards 0, 1, 2, >2*)			
20) Which network company provides your service (i.e., Airtel, Africell, MTN, etc. *(List all that apply if patient has more than one SIM card*)			
21) What is your language of preference for receiving SMS text messages? Specify. *(Skip if answered No to question 3)*			
22)Are you able to receive SMS text messages sent to someone else's phone?			
22a) If Yes, whose phone? (specify relationship):			
22b) If Yes, do you know their mobile number?			
22c) If Yes, would you be comfortable receiving an SMS message with your medical test results on their phone?			
22d) If No to 22c, would you be comfortable receiving an SMS text message to come back to the health center (i.e., without any test results included) on their phone?			
Applies only to those who do not have/cannot access a phone			
23) Have you ever lost a phone or had it damaged?			
24) If you had a phone, would you be comfortable providing your telephone number when you visit the health center? If No, give reasons why			

Thank you for your participation.

SMS = short messaging service; SIM = Subscriber Identity Module; CHW = community health worker.

Table A.3 Systematic screening for TB in households of TB patients (TB contact investigation): household contact focus group discussion/in-depth interview guide

The topic for today's discussion is 'Systematic screening for TB in households of TB patients'. This is when community health workers visit the homes of community members who have a TB patient in their household to interview them to determine whether others in the household have TB symptoms and might also have TB disease. We are working with the Uganda National TB and Leprosy Programme (NTLP) and with Ministry of Health (MoH) personnel from the Kampala Capital City Authority (KCCA) clinics to evaluate how well this activity is going and to learn how we can improve it using new approaches. The information that you share in this focus group will help us do this.

1. Have any health workers from the Track TB Program recently visited your home to provide information and support for TB care for your household? What happened when they came to your house? [PROCESS 1]

2. What do you think is the risk of TB among people living in the same household as a patient diagnosed with active TB? What are the chances that someone who has symptoms of TB also has HIV? [KNOWLEDGE]

3. How easy or difficult was it (or would it have been) for you to go to the clinic to be tested and evaluated for TB, if you had been (or ever were in the future) asked to do so by the community health worker? [OPPORTUNITY, MOTIVATION]

4. What did you think of the care and services that you received (or do you think of the services there in general)? [PROCESS 2]

5. If you needed it, how would you feel about our collecting a sputum specimen from you at home rather than having you come to clinic to give that specimen? [PROCESS 1a] How would you feel about our offering you voluntary HIV counseling and testing in your home? [PROCESS 1b]

6. How would you feel about our recording information from you using an electronic tablet? How would you feel about our scanning your fingerprint to help us track your visits to the clinic? [PROCESS 0]

Now we are going to take a break from the discussion. We are going to ask you a few questions individually about your use of mobile phones. We will then finish the discussion by talking about your answers together.

7. How would you feel if we sent you an SMS with the results of your sputum examination and advice about the need to come to clinic for additional evaluation or treatment, instead of having you go back to clinic to get this information or having a health worker come to deliver it? Which words do you prefer for the sample SMS included in the survey? [PROCESS 1c]

That is all the questions we have for you today. Is there anything else that YOU think is important about this topic that we haven't asked about?

Overall, what were your thoughts about the interview?

Table A.3 *(continued)*

Prompts and follow-up questions

This side provide specific prompts and/or follow-up questions to help focus and/or redirect respondents *as needed* to make sure that they are addressing the issues we are interested in exploring.

1. [PROCESS 1] 'Have CHW come to ask about TB at home'
   Prompts/follow-up:
   How did you feel/would you feel about having a CHW come into your home to interview you about TB symptoms?

2. [KNOWLEDGE] 'Risk of TB in the home', 'Risk of HIV in someone who has symptoms of TB'
   Prompts/follow-up:
   Please draw on information you received from the community health worker, and on your general understanding of TB.

3. [OPPORTUNITY, MOTIVATION] 'Traveling to the clinic'
   Prompts/follow-up:
   a. What would have made this easier?
   b. Difficulties finding time or funds to take transport?

4. [PROCESS 2] 'Visiting the clinic'
   Prompts/follow-up:
   Is there anything the health workers could have done to make this easier?

5. [PROCESS 1a, PROCESS 1b] 'Providing sputum at home', 'HIV testing at home'
   Prompts/follow-up:
   a. What concerns, if any, would you have about the safety of this?
   b. What concerns, if any, would you have about standing outside your home to do this?

6. [PROCESS 0] 'Providing personal health information and fingerprint scan to tablet'
   Prompts/follow-up:
   Would you have any privacy concerns?

7. [PROCESS 1c] 'Receiving text messages"
   Prompts/follow-up:
   a. Show sample SMS content and ask for feedback on wording. Which messages do you prefer?
   b. Is there anything we could do to address these concerns (e.g., requiring a password to access an SMS?)

If you are unable to read, how acceptable would it be for someone else to help you read SMS notifications on your phone? Would you have any privacy concerns, for example, if the SMS include personal health details?

TB = tuberculosis; HIV = human immunodeficiency virus; SMS = short messaging service.

RÉSUMÉ

CONTEXTE : Il existe peu d'informations relatives à l'utilisation ou aux préférences en matière de téléphones mobiles pour la communication liée à la tuberculose (TB) en Ouganda.

MÉTHODE : Nous avons fait une enquête auprès des contacts domiciliaires de patients tuberculeux en zone urbaine à Kampala, Ouganda, et de patients dans le centre rural de l'Ouganda. Les questions ont concerné l'accès, l'utilisation et les préférences en matière de communications relatives à la TB. Nous avons recueilli des données qualitatives à propos des préférences de messagerie.

RÉSULTATS : Nous avons enrôlé 145 contacts et 203 patients consultant au dispensaire. La majorité des contacts (58%) et des patients en consultation (75%) possédaient un téléphone mobile, tandis que 42% des contacts et 10% des consultants en partageaient un. Des contacts et des consultants, 94% savaient comment recevoir un SMS, mais seulement 59% des contacts âgés de ⩾45 ans pouvaient le faire, contre 96% parmi les contacts âgés de <45 ans ($P=0{,}0001$). Tous les contacts et 99% des consultants ont été disposés à et capables de recevoir des communications personnelles en matière de santé par SMS. Des contacts, 55% ont dit préférer des messages détaillés révélant les résultats des tests, tandis que 45% des contacts ont préféré des messages simples leur demandant de se rendre au dispensaire pour obtenir leurs résultats.

CONCLUSION : La majorité des contacts de TB dans des foyers urbains et des consultants en zone rurale ont déclaré avoir accès au téléphone mobile et être disposés à recevoir des communications personnelles relatives à la TB par appel vocal ou SMS. Cependant, la fréquence du partage de téléphones mobiles et la capacité variable en matière de messagerie et de préférences suggèrent qu'il est nécessaire de personnaliser et de suivre les interventions en matière de santé en fonction des publics cibles.

RESUMEN

MARCO DE REFERENCIA: Existe poca información sobre la utilización de los teléfonos móviles o las preferencias en materia de comunicaciones de salud relacionadas con la tuberculosis (TB) en Uganda.

MÉTODOS: Se llevó a cabo una encuesta domiciliaria a los contactos de los pacientes con TB en la zona urbana de Kampala, en Uganda, y a los pacientes de los consultorios en una zona rural en el centro del país. Las preguntas concernían el acceso y la utilización del teléfono y las preferencias con respecto a las comunicaciones relacionadas con la TB. Se recogieron datos cualitativos de las preferencias sobre el envío de mensajes.

RESULTADOS: Participaron en la encuesta 145 contactos y 203 pacientes que acudían a los consultorios. La mayoría de los contactos (58%) y de los pacientes de consulta externa (75%) poseía un teléfono móvil, pero el 42% de los contactos y el 10% de los pacientes de consultorios compartían el dispositivo. El 94% de los contactos y los pacientes de consultorios sabía cómo recibir un SMS, pero la proporción fue solo del 59% en los contactos de ⩾45 años de edad (contra el 96% de los contactos de edad <45 años; $P = 0{,}0001$). Todos los contactos y el 99% de los pacientes de los consultorios sabían cómo recibir comunicaciones personales de salud por SMS y estaban dispuestos a utilizarlas. El 55% de los contactos prefería recibir mensajes detallados con la comunicación de los resultados de las pruebas, pero el 45% de los contactos prefería mensajes cortos con la propuesta de una cita al consultorio, a fin de conocer los resultados.

CONCLUSIONES: La mayoría de los contactos domiciliarios de casos urbanos de TB y de pacientes que acudían a la consulta externa en zonas rurales refirieron contar con acceso a teléfonos móviles y estaban dispuestos a recibir comunicaciones personales de salud relacionadas con la TB, mediante llamadas telefónicas o SMS. Sin embargo, la frecuencia con la cual se comparten los teléfonos y las diferencias en la capacidad de utilizar los mensajes y en las preferencias de utilización ponen de manifiesto la necesidad de diseñar métodos adaptados y supervisar las intervenciones de cibersalud que utilizan la telefonía móvil, con el fin de escoger a los destinatarios.