

Using SMS and Interactive Voice Response to strengthen continuity of care for planned cesarean delivery in Uganda

Henry Mark Lugobe

henrylugobe@must.ac.ug

Mbarara University of Science and Technology

Rohini Dutta

Yale University

Joseph Rwebazibwa

Mbarara Regional Referral Hospital

Emilie Baxter

Harvard Medical School

Paola Del Cueto

Massachusetts General Hospital

Nuwa Agaston

Mbarara University of Science and Technology

Rogers Mwavu

Mbarara University of Science and Technology

Edgar Mulogo

Mbarara University of Science and Technology

Angella Musiimenta

Mbarara University of Science and Technology

Bethany Hedt-Gauthier

University of North Carolina at Chapel Hill

Shehnaz Alidina

University of Saskatchewan

Leevan Tibaijuka

Mbarara Regional Referral Hospital

Adeline Adwoa Boatin

Massachusetts General Hospital

Keywords: cesarean delivery, mHealth, birth preparedness, interactive voice response, continuity of care, high-risk pregnancy

Posted Date: August 15th, 2026

DOI: <https://doi.org/10.21203/rs.3.rs-10046501/v1>

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Additional Declarations: No competing interests reported.

Abstract

Background

Planned pre-labor cesarean delivery for high-risk pregnancies is rare in sub-Saharan Africa, where up to 90% of cesareans are performed emergently with high risks of adverse outcomes. Improving the number of planned pre-labor cesareans requires attention to antenatal-intrapartum continuity of care. We developed an mHealth intervention using SMS and Interactive Voice Response (IVR) to support birth preparedness for planned cesarean delivery among high-risk pregnant women in Uganda.

Methods

We conducted a prospective pilot study at Mbarara Regional Referral Hospital, Uganda, among pregnant women (≥ 28 to < 39 weeks' gestation) with antenatal indications for pre-labor cesarean. Participants received educational SMS and IVR messages at 14, 7, and 2 days before their scheduled cesarean, covering delivery timing, danger signs, logistical planning, and perioperative preparation. Feasibility was assessed through platform-confirmed message delivery, self-reported receipt, and IVR call duration. Acceptability was assessed via a post-delivery survey capturing preferences, comprehension, and satisfaction. Descriptive statistics summarized outcomes; feasibility and acceptability were compared by digital access adequacy.

Results

Seventy-one women were enrolled between June 2024 and February 2025 (mean gestational age 33.1 weeks; 93% with ≥ 2 prior cesareans). Fifty-one percent delivered before their scheduled date, reducing exposure to later messages. Among those still pregnant at each time point, platform-confirmed message delivery exceeded 77% for SMS and 86% for IVR, with self-reported receipt closely mirroring these rates. Mean IVR call duration ranged from 70 to 108 seconds, with over 95% of calls exceeding 30 seconds. Among 59 respondents completing the acceptability survey, all rated message length and pacing as appropriate and content as easy to understand. Most preferred SMS over IVR (68% vs. 32%) and preferred weekly messaging. No participants reported concerns regarding privacy, network connectivity, or phone sharing. No differences in delivery or receipt were observed by digital access adequacy.

Conclusions

An SMS/IVR intervention for cesarean-specific birth preparedness was highly feasible and acceptable among high-risk pregnant women in Uganda. Further evaluation is warranted to assess clinical effectiveness and scalability.

Trial Registration:

clinicaltrials.gov; trial registration number: NCT07696325; Registered retrospectively July 6th, 2026.

Background

Access to timely, safe, and appropriate cesarean delivery is critical to reducing the approximately 300,000 maternal and 2.5 million perinatal deaths that occur globally every year.[1] However, such access remains severely limited in sub-Saharan Africa, which accounts for approximately two-thirds of annual maternal deaths and nearly half of perinatal deaths despite representing only a fraction of the global population.[1–3] Moreover, women in the region who do access cesarean delivery experience disproportionately poor outcomes, with reported mortality rates of 0.5–1% and complication rates approaching 20%, far exceeding those observed in high-income countries.^{5,6} Despite persistently low cesarean rates in the region (5% versus a global average of 21%), an estimated 25 million cesarean deliveries are projected annually in sub-Saharan Africa by 2030, making strategies to simultaneously improve access to and outcomes of this key surgical intervention a critical global health priority.⁷

While some cesarean indications are determinable only after the onset of labor, certain high-risk pregnancies have prenatal indications amenable to a planned surgery, accounting for up to 32% of all cesarean deliveries.[4–6] [7–9] For these conditions, a planned pre-labor cesarean is recommended given the high risk of morbidity and mortality accompanying labor. Yet such planned cesareans are rare in sub-Saharan Africa, where 80–90% of cesareans are performed emergently, compared to 13–15% in high-income countries.[9–12]

Achieving a planned cesarean delivery requires continuity across the antenatal–intrapartum continuum. Early identification of high-risk pregnancies, followed by birth preparedness interventions, such as education and counseling to help women and families recognize danger signs, make decisions before labor and plan where and how to seek care, offer a framework for this. Yet in sub-Saharan Africa and other low and middle-income country settings, such efforts have focused on vaginal delivery, with limited attention to cesarean-specific preparedness.

Our prior work in Uganda underscores this gap. Among women with a prior cesarean, more than a quarter had no delivery planning during antenatal care, and those who did often lacked awareness of the safest delivery timing and location. As a result, most women in this cohort presented for delivery in advanced stages of labor, contrary to the normative and Uganda Ministry of Health guidelines for a planned pre-labor cesarean for women with this risk factor.[13, 14] Addressing this gap is further complicated by persistent and worsening health workforce shortages across the region.[15]

Mobile Health (mHealth) applications offer a potentially scalable solution to mitigate these health system gaps. mHealth has successfully been used in maternal health for education and reminders to women to engage in prenatal care and for facility-based delivery.[16–21] However, data on the use of

mHealth for high-risk pregnancies, and specifically for women with a prelabor indication for cesarean is scarce.

To mitigate against staffing shortages and enable cesarean-specific birth preparedness, we developed an mHealth tool using Short Message Service (SMS) and Interactive Voice Response (IVR) for pregnant women in Uganda with a prenatal cesarean indication. This tool complements a cesarean scheduling system implemented at Mbarara Regional Referral Hospital (MRRH) in Uganda as part of a quality improvement initiative to increase appropriate planned pre-labor cesarean deliveries. While mhealth interventions have shown promise for improving antenatal attendance and reproductive health outcomes in LMICs, [22] evidence on combined SMS/IVR use is limited, and to our knowledge, none has targeted high-risk pregnancies or surgical preparedness specifically.

This pilot study addresses this gap by focusing on cesarean-specific rather than general birth preparedness, combining SMS and IVR to accommodate varying literacy and phone access profiles, and embedding the intervention within an existing scheduling system at a tertiary referral hospital. The primary objective was to assess the feasibility and acceptability of using this tool among high-risk pregnant women with a medically indicated cesarean.

Methods

Study design

We conducted a prospective pilot study to assess the feasibility and acceptability of a mobile health (mHealth) educational intervention using SMS and IVR among pregnant women with antenatally identified indications for pre-labor cesarean delivery.

Study setting

The study was conducted in the Department of Obstetrics and Gynecology at Mbarara Regional Referral Hospital (MRRH), a tertiary referral hospital in southwestern Uganda that provides antenatal, intrapartum, and surgical obstetric care to a large catchment area. As part of a quality improvement initiative, MRRH introduced a cesarean delivery scheduling system in 2018 to reduce emergency cesareans among women with a known medically indicated pre-labor indication. Women attending the high-risk antenatal clinic and meeting criteria for a pre-labor cesarean are provided a scheduled date for surgery at term (37-39) weeks of gestation.

Participants and Eligibility

Pregnant women were eligible for this study if they were between ≥ 28 and < 39 weeks' gestation, receiving antenatal care at MRRH, intending to deliver at MRRH, had known gestational age (determined by last menstrual period and/or ultrasound dating if available), and were identified by clinicians as having a prenatal indication for pre-labor CS. Eligible indications included ≥ 2 prior cesarean deliveries, prior classical cesarean delivery, prior myomectomy, prior uterine rupture, or persistent breech presentation.

Participants were required to have access to a mobile phone within their household or neighborhood and be able to provide informed consent in English or the local language, Runyankole.

Women were excluded if they had signs or symptoms of labor or obstetric complications at the time of screening, did not have access to a mobile phone, or were unable to communicate in English or Runyankole. Pregnant adolescents were eligible to participate and were considered emancipated minors under Ugandan guidelines.

Recruitment and enrollment

Clinical decisions regarding cesarean indication and scheduling were made independently by routine clinical staff. A trained research assistant (RA) screened women attending the high-risk antenatal clinic who were flagged by clinicians as potentially eligible and interested. Clinicians introduced the study during routine visits, after which interested women were approached by the RA in a private area of the clinic. Written informed consent was obtained in the participant's preferred language (English or Runyankole). This pilot study used consecutive sampling with a target enrollment of 70 participants. The target of 70 was chosen to adequately describe implementation performance and acceptability outcomes, accounting for an anticipated 10% loss to follow-up rate.

Intervention

Participants were enrolled in an mHealth educational intervention delivered via SMS and IVR using the EngageSparkä platform designed to support birth preparedness for planned pre-labor cesarean delivery. Educational content focused on cesarean preparedness, including timing of delivery, signs requiring urgent care, logistical planning, and perioperative preparation. IVR message duration ranged from 20 to 115 seconds. Messages were delivered in English or Runyankole based on participant preference. Messages sent are provided in Supplemental Table 1.

Messages were scheduled to be delivered at 14, 7, and 2 days prior to the participant's scheduled cesarean date. One IVR message was sent at each time point. At the 14-day and 7-day time points, two SMS messages were sent to avoid long paragraphs of text. At the 2-day time point, one SMS message was sent. The number of time points participants were eligible for depended on the gestational age at enrollment, the scheduled delivery date, and their actual delivery date. Participants were scheduled to receive both SMS and IVR messages at all time points. Participants could request a follow-up phone call if they required clarification, which was initially handled by the RA and escalated to an obstetrician on the study team if clinical questions arose. The RA monitored message delivery and IVR engagement. If messages were not received or calls were unanswered, multiple automated and manual follow-up attempts were made. Technical issues encountered during SMS delivery or IVR use were documented automatically through the EngageSparkä platform.

Data collection

At enrollment, the RA administered a structured background questionnaire (Appendix 1) using REDCap to collect demographic information, obstetric history, digital readiness (i.e., mobile phone use, network access, and digital literacy), and preferred language. The background survey and questions on digital

readiness and literacy were adapted from existing literature and developed for this study and have not previously been published elsewhere (Supplementary File 1).

Participants who delivered at MRRH were approached on postpartum day 2 or 3, before discharge, to complete an acceptability questionnaire (Appendix 1), which captured participants' perceptions of usefulness, comprehensibility, and satisfaction with the mHealth tools. Women who delivered outside MRRH were contacted by phone approximately 1–2 weeks after their scheduled delivery date to complete a modified acceptability questionnaire that included questions on reasons for delivering elsewhere and outcomes of their delivery. (Appendix 1).

Outcomes and Variables of Interest

The primary outcomes of interest were the feasibility and acceptability of the SMS/IVR intervention. We defined feasibility as a multi-dimensional implementation outcome that encompasses 1) reach i.e., the proportion of enrolled women eligible to receive messages at each scheduled time point based on their actual delivery date; 2) delivery fidelity, i.e. platform-confirmed message delivery; and 3) engagement with messages, i.e., self-report of receipt of SMS and/or IVR messages and duration of IVR calls. Acceptability outcomes were assessed among participants who completed the post-delivery acceptability survey and included preferences for message modality (SMS vs. IVR), timing and frequency of message delivery, perceived appropriateness of message length and pacing, ease of understanding, perceived usefulness and relevance of the messages, and concerns related to privacy or technical barriers (e.g., phone charging or network access). Acceptability measures were summarized separately for SMS and IVR modalities.

Participants were categorized into two groups based on self-reported indicators of digital access and literacy. Women were classified as having limited digital access if they reported any of the following: exclusive reliance on a shared phone, difficulties with mobile network access, challenges with phone charging, or inability to send or receive SMS messages. All remaining participants were classified as having adequate digital access.

Analysis

Descriptive statistics were used to summarize participant characteristics, feasibility metrics, and acceptability outcomes. Feasibility outcomes were calculated using denominators restricted to participants who remained pregnant at each scheduled message time point. Message delivery success was defined as confirmation of SMS message delivery or IVR call delivery by the EngageSpark platform, and self-report of message receipt was based on participant self-report during the acceptability interview. IVR engagement was summarized using the mean, median, and interquartile range of call duration. Acceptability outcomes were summarized using frequencies and proportions for categorical variables, with preferences and satisfaction ratings described across message modalities. Feasibility and acceptability outcomes were compared across dichotomized digital access groups using Chi-square tests.

Ethical approval

The study protocol was reviewed and approved by the institutional review boards of Mbarara University of Science and Technology (MUST Protocol No. MUST-2023-127), Massachusetts General Brigham (MGB Protocol No. 2024P000837), and the Uganda National Council for Science and Technology (UNCST Protocol No. HS4081ES). All participants provided written informed consent before enrollment.

Results

A total of 71 high-risk pregnant women with antenatally identified indications for pre-labor cesarean section were enrolled in the study between June 2024 and February 2025 (Figure 1). The mean age was 31.6 years ($\pm$ 4.3); most participants were aged 18–35 years, and all were married (Table 1). Most participants had completed at least secondary education (82%), including nearly one-third with tertiary or postgraduate education. Occupations varied, with 42% reporting unpaid domestic work, 37% engaged in informal employment, and 21% in formal employment. Mean monthly household income was approximately 280,000 Ugandan Shillings (approximately USD 80).

Table 1: Participant Characteristics

Demographics characteristics	N=71 (% , SD)
Age	
mean (SD)	31.6 (4.3)
18-35	52 (73)
≥35	19 (27)
Education	
Primary	13 (18)
Secondary	36 (51)
Tertiary, University or Postgraduate	22 (31)
District of origin	
Mbarara	64 (90)
Isingiro	6 (8.5)
Ntungamo	1 (1.4)
Married	71 (100)
Occupation	
Formal employment	15 (21)
Informal employment	26 (37)
Homemaker/unpaid domestic work	30 (42)
Monthly Household Income (in),	
Uganda Shillings, mean (SD)	280,281 (311,503)
USD, mean (SD)	80 (89)
Antenatal care	
Number of antenatal visits prior to enrollment	
One	1 (1.4)
Two	2 (2.8)
Three	12 (17)
Four	23 (32)
Five or more	33 (46)
Facilities for Antenatal care	

MRRH only	39 (55)
Health Center II or III	15 (21)
Health Center IV	10 (14)
Other hospital or referral center	7 (9.8)
Obstetric and Medical Characteristics	
Gestational age at enrollment, mean (SD)	33.1 (2.8)
Gravidity, mean (SD)	4.1 (1.3)
Parity, mean (SD)	2.6 (1.0)
Prior cesarean, mean (SD)	2.5 (0.8)
Prior vaginal births, mean (SD)	0.3 (0.6)
Prior stillbirth or neonatal demise	16 (23)
Indications for cesarean delivery	
≥2 prior cesarean sections	66 (93)
Breech presentation	1 (1)
* Other	4 (6)

*Other CS indications include multiple pregnancy, prior fistula, placenta previa, prior cesarean, and short interpregnancy interval

The mean gestational age at enrollment was 33.1 weeks ($\pm$ 2.8). Participant obstetric histories reflected a high-risk pregnancy population with a mean gravidity of 4.1 ($\pm$ 1.3), parity of 2.6 ($\pm$ 1.0), and a mean of 2.5 prior cesarean deliveries; nearly a quarter of the cohort reported a prior stillbirth or neonatal/infant demise, and 10% reported a medical comorbidity, primarily hypertension and HIV. The predominant indication for a planned cesarean delivery was having two or more prior cesarean sections (93%).

Access to mobile phones and digital infrastructure was high among participants (Table 2). Most women owned a personal mobile phone, including 37% with a basic phone and 58% with a smartphone, while a small proportion (5.6%) reported no personal phone but reliable shared access. Nearly all participants reported consistent access to mobile network coverage, with network interruptions reported rarely. All participants reported reliable access to phone charging, most commonly within the home or through solar chargers.

Table 2: Digital/mHealth Readiness

Phone ownership	
Any personal phone ownership	68 (96)
Basic phone	26 (37)
Smart phone	41 (58)
No personal phone	4 (5.6)
Shared use of phone	9 (13)
Other household members with phone	
Husband	69 (97)
Child	1 (1.4)
In-Law	1 (1.4)
Do you have access to mobile network?	
No	1 (1)
Yes	70 (99)
How often do you have network access trouble	
Rarely	64 (90)
Sometimes	6 (8)
Access to phone charging	71 (100)
Phone charge location	
Inside home	50 (70)
Neighbor	4 (6)
Workplace	1 (1)
Solar charger	16 (23)
Digital literacy	
Comfortable retrieving SMS messages	71 (100)
Comfort sending SMS messages	71 (100)
Other uses of phone	
SMS	71 (100)
Email	11 (15.4)
Mobile applications, browsing, health tracking	0

Mobile phone literacy was uniformly high. All participants reported being comfortable retrieving and sending SMS messages, and all reported routine use of SMS. However, use of more advanced phone functions, such as email, was less common, and no participants reported routine use of mobile applications for health tracking, browsing, or education. Most participants (n=57/71, 80%) had adequate digital access. Of the 14 (19.7%) with limited digital access, 9 (12.7%) reported sharing a household phone, and 5 (7%) reported some network connection difficulties.

Twenty participants (28%) were delivered on the scheduled delivery date. A total of 36 (51%) participants delivered earlier than the scheduled cesarean. The mean number of days before the scheduled date was 6 days (± 8.2) and ranged from 1 to 36 days before the scheduled date. Fewer participants delivered after the scheduled cesarean date (n=15/71, 21%), with a mean number of days after the scheduled date of 6 days (± 4.1), ranging from 1 to 15 days. Timing of the actual delivery influenced exposure to scheduled messages: 63 (89%), 53 (75%), and 40 (56%) participants remained pregnant at the time of the planned 14-day, 7-day, and 2-day message windows, respectively.

Message delivery rates and self-reports of message receipt rates of these participants are presented in Table 3.

Table 3: Delivery of Message and Self-Report of Receipt

	Pregnant at time of message schedule	14-day message n=63	7-day message n=53	2-day message n=40
Message delivered by EngageSpark n (% of participants pregnant at time of message schedule)	SMS message 1	51 (80)	40 (77)	35 (88)
	SMS message 2	54 (86)	44 (83)	N/A
	IVR message	51 (81)	49 (92)	35 (88)
	IVR call duration (s) mean ±SD	108±54	93.6±47	70±28
	IVR call duration (s) median (IQR)	143(44-148)	82 (52-196)	76 (60-89)
	Calls with duration > 30 seconds n (% of calls delivered)	49 (96)	48 (98)	32 (91)
Self-report of message received	SMS	53 (84)	49 (92)	37 (92)
n (% of participants still pregnant at time of message schedule)	IVR	49 (78)	47 (89)	36 (90)

Among participants still pregnant at each time point, the successful delivery of messages via the EngageSpark platform was high across modalities. At the 14-day window, 80% of SMS messages and 86% of IVR calls were successfully delivered, with 81% and 84% of participants, respectively, self-reporting receipt. At the 7-day window, 77% of SMS messages and 92% of IVR calls were successfully delivered, and corresponding self-reported receipt was reported for 92% for SMS and 89% for IVR. At the 2-day window, delivery success remained high, with 88% of IVR calls and 92% of SMS messages delivered, and self-reported receipt of 90% or higher for both modalities. There were no differences in SMS or IVR message delivery or self-report by digital access adequacy (Table 4).

Table 4. Feasibility outcomes by Digital Access Adequacy

Outcome	Adequate digital access n=49	Limited digital access n=14	p-value
Any SMS message delivered (any time point), n (%)	48 (98)	14 (100)	0.3
Any IVR message delivered (any time point), n (%)	46 (94)	14 (100)	0.2
Self-reported receipt of any SMS message, n (%)	46 (81)	13 (93)	0.3
Self-reported receipt of any IVR message, n (%)	46 (81)	13 (93)	0.3

Denominators reflect participants eligible for message receipt at one or more time points. “Any” delivery or receipt indicates at least one successful message or call across scheduled time points (14-, 7-, or 2-day messages) for participants eligible to receive messages at that time point.

Engagement with IVR messages was sustained across all time points, with mean call durations of 108 ± 54 seconds at 14 days, 94 ± 47 seconds at 7 days, and 70 ± 28 seconds at 2 days before the scheduled cesarean date; the majority (>95%) of IVR calls exceeded 30 seconds, indicating active message engagement.

The post-delivery acceptability survey was completed by 59 (86%) of the 69 participants with follow-up data. The remaining 10 did not complete the survey due to early discharge (n=8) and delivery outside the hospital (n=2). Acceptability of the SMS and IVR intervention was high among participants completing the post-delivery acceptability survey (N=59), as summarized in Table 4 and Figure 2. All respondents reported that the length and pacing of both SMS and IVR messages were “just right,” with no participants indicating that messages were too short or too long. Messages were consistently described as easy to understand, and no participants reported difficulties related to phone charging, network connectivity, or privacy concerns. More participants preferred SMS messages over automated voice calls (68% vs. 32%), though both modalities were viewed favorably. Preferences for timing of message delivery were similar across SMS and IVR, with most participants favoring afternoon (69%) or evening (27%) delivery (**Table 5**).

Table 5: Message preferences for IVR and SMS (N=59)

Preference Domain	SMS n (%)	IVR n (%)
	40 (68)	19 (32)
Preference on time of day to receive messages		
Morning	0	0
Afternoon	41 (69)	41 (69)
Evening	16 (27)	16 (27)
Night	2 (3)	2 (3)
No preference	0	0
Message length appropriateness		
Too short	0	0
Too long	0	0
Just right	59 (100)	59 (100)
Unsure	0	0
Preferred frequency for messages		
Daily	0	0
Twice a week	1 (2)	0
Three times a week	0	0
Weekly	58 (98)	58 (98)
Twice a month	0	0
Monthly	0	1 (2)

Nearly all participants preferred to receive messages weekly, regardless of modality. Perceived usefulness and satisfaction with IVR were uniformly positive, with all respondents strongly agreeing that the messages were helpful, relevant, and improved CS preparedness (Figure 2).

Of 69 participants with follow-up data, 67 (97%) delivered at MRRH and 2 (2.9%) delivered elsewhere. The latter two participants delivered at a private facility. All 69 participants delivered via cesarean delivery. Of those with cervical dilation recorded, 87% (n=53/61) were in early or no labor, i.e., <4 cm dilated at the time of cesarean, and 13% (n=8/61) were in active labor. There were no stillbirths or early neonatal deaths. Seven neonates were admitted to the pediatric ward. Two participants suffered complications. One participant with a history of hypertension developed pre-eclampsia and was delivered early (before any study intervention) and suffered paralysis. The second participant was delivered one day after the scheduled cesarean date and received a blood transfusion. There were no maternal deaths.

Discussion

In this pilot study, an SMS- and IVR-based intervention supporting cesarean preparedness among high-risk pregnant women with antenatal indications for planned pre-labor cesarean delivery in Uganda was highly feasible and acceptable. Message delivery was high across reminder windows and both modalities, with self-reported receipt closely mirroring platform-confirmed delivery. Participants consistently rated messages as understandable, appropriate, and helpful. These findings support a combined SMS-reminder and IVR-based education strategy as a promising approach to strengthen continuity of care for high-risk pregnancies across the antepartum-intrapartum continuum in low-resource settings.

These results were observed in a population with high digital readiness, including high rates of personal phone ownership, frequent SMS use, high smartphone ownership, and relatively high education and household income compared with regional cohorts.[23] Only a minority had limited digital access, with no meaningful differences in message delivery or receipt in this subgroup. This profile may reflect the urban referral-hospital context and underscores the need to assess feasibility in more rural or resource-constrained settings where phone access, network reliability and digital readiness and literacy may be lower.

Acceptability was uniformly high across evaluated domains. Participants generally preferred SMS over IVR, though both modalities were viewed favorably. Most favored weekly messaging, suggesting that relatively low-intensity communication may be suffice for preparedness without message fatigue. Participants also expressed clear preferences for message timing, with most favoring delivery in the afternoon or evening, aligning with daily routines related to household responsibilities and work. Notably, no participants reported concerns related to privacy, phone charging, network connectivity, or phone sharing, which are commonly cited barriers in mHealth interventions in similar settings.[22,23]

Our findings are consistent with mHealth interventions that used SMS to improve antenatal attendance and facility-based delivery in LMICs, including an SMS/IVR intervention targeting low-risk pregnancies in southwestern Uganda, which have also demonstrated favorable feasibility and acceptability.[22,24] However, few studies have focused on high-risk pregnancies or cesarean-specific preparedness, and few have used IVR for maternal health. [22] By targeting women with high-risk pregnancies and antenatally identified indications for pre-labor cesarean and combining SMS with IVR, this study contributes novel evidence for a vulnerable and understudied population. The dual-modality design also extends a smaller literature on IVR, which may be especially valuable in settings with variable literacy and supports the premise that multiple communication channels can enhance inclusivity.[24,25]

The high feasibility and acceptability observed here suggest that similar interventions could be applied in other facilities where planned cesarean delivery is indicated but inconsistently achieved. This approach may also be adaptable to other high-risk pregnancy conditions that require complex delivery planning, such as pregnancies complicated by chronic hypertension or diabetes necessitating induction of labor, where prior research has demonstrated elevated risk of adverse outcomes.[26] Similarly, it may extend

continuity of care and education into the postpartum period, increasingly recognized as a high-risk period for adverse maternal and newborn outcomes.[27] In settings such as Uganda, where human resource constraints limit the time available for repeated in-person counseling, mHealth tools like this intervention may offer a practical means of standardizing education and reinforcing critical information with repeated counselling while reducing demands on clinical staff.

This study has several strengths, including its focus on a high-risk obstetric population and real-world implementation within a routine referral hospital setting. Objective platform-derived metrics allowed for a detailed assessment of message delivery and IVR engagement, complementing participant-reported receipt. However, the findings should be interpreted in light of several limitations. As a small pilot study conducted at a single site, analyses were descriptive and not powered to assess effectiveness or subgroup differences. The study population demonstrated high levels of digital readiness, which may limit generalizability to more rural settings or settings with lower phone ownership, literacy, or network access. Additionally, early delivery among a substantial proportion of participants reduced exposure to later scheduled messages, underscoring the need to consider flexible or adaptive messaging strategies in future implementations, or earlier enrollment in the intervention. Finally, reliance on self-reported message receipt and acceptability metrics may be subject to social desirability bias and impede our inability to objectively confirm message comprehension or full IVR listening beyond call duration metrics.

Future studies should evaluate whether this intervention improves timely presentation for scheduled cesarean delivery, reduces emergency cesarean sections among women with antenatal indications, and favorably impacts maternal and neonatal outcomes. There are also opportunities to refine the intervention by tailoring message content, timing, and intensity based on individual risk profiles, gestational age at enrollment, or prior obstetric history. Integration with electronic scheduling systems or clinical decision support tools could further enhance effectiveness by enabling automated updates to delivery dates and message schedules. Additionally, evaluating performance in more rural settings and among populations with lower digital readiness will be essential to understand the generalizability of these findings and to identify adaptations needed for broader implementation

Beyond clinical impact, enabling scale-up will require deliberate attention to implementation pathways alongside effectiveness. Applying the digital fit–viability framework [28], our preliminary findings suggest strong contextual fit of the intervention, including alignment with patient digital access and literacy, appropriateness of SMS/IVR for the intended educational task, and potential for compatibility with existing antenatal care workflows. However, long-term viability will require addressing organizational and system-level factors, including processes for identifying eligible patients, delineation of responsibility for message deployment and clinical oversight, mechanisms for responding to patient questions and evolving obstetric care plans, and integration with scheduling and record systems. These challenges are particularly salient in many sub-Saharan African settings, where fragmentation between antenatal clinics and maternity wards and limited continuity of clinical records can undermine the execution of the planned delivery pathway.

Conclusion

An SMS- and IVR-based educational intervention is feasible and highly acceptable for supporting preparedness for planned pre-labor cesarean delivery among high-risk pregnant women in Uganda. These findings suggest that mHealth tools can play an important role in strengthening continuity of care for high-risk pregnancies in low-resource settings, particularly where staffing constraints limit repeated in-person counseling. Further evaluation in larger studies is warranted to assess clinical and system-level impacts and to inform strategies for integration and scale-up.

Declarations

CONSORT

This manuscript was prepared in accordance with the CONSORT 2010 reporting guideline where applicable to prospective interventional studies. Because this was a single-arm pilot feasibility study without randomization, CONSORT items relating to randomization, allocation concealment, and blinding were not applicable. Please supplemental files for a consort checklist.

Ethical approval

The study protocol was reviewed and approved by the institutional review boards of Mbarara University of Science and Technology (MUST Protocol No. MUST-2023-127), Massachusetts General Brigham (MGB Protocol No. 2024P000837), and the Uganda National Council for Science and Technology (UNCST Protocol No. HS4081ES). All participants provided written informed consent before enrollment. All study procedures were performed in accordance with the ethical principles of the Declaration of Helsinki and all applicable institutional and national regulations governing research involving human participants.

Consent for publication

All participants provided written informed consent before enrollment.

Availability of data and materials

The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request

Competing Interests

The authors declare that they have no competing interests

Author contributions

HML and AAB conceived and designed the study. HML, JR, RD, LT, and AAB supported participant recruitment and clinical implementation. EB and NW conducted data collection. RD, EB, and AAB

performed data analysis. AAB, RD and EB drafted the manuscript. RD, PDC, HML, LT, EB, and AAB contributed to intervention development and implementation. BHG, SA, RM, and AM provided methodological guidance. HML and LT supported clinical oversight at the study site. All authors reviewed, edited, and approved the final manuscript.

Funding

This research was supported by an institutional award from the Connors Center for Women's Health and Gender Biology, Division of Women's Health, Brigham and Women's Hospital, and by institutional funds from Massachusetts General Hospital.

Acknowledgments: N/A

References

1. World Health Organization (2019) Trends in maternal mortality 2000 to 2017: estimates by WHO, UNICEF, UNFPA, World Bank Group and the United Nations Population Division: executive summary. World Health Organization
2. Hug L, You D, Blencowe H et al (2021) Global, regional, and national estimates and trends in stillbirths from 2000 to 2019: a systematic assessment. *Lancet* 398:772–785. 10.1016/S0140-6736(21)01112-0
3. Hug L, Alexander M, You D et al (2019) National, regional, and global levels and trends in neonatal mortality between 1990 and 2017, with scenario-based projections to 2030: a systematic analysis. *Lancet Glob Health* 7:e710–e720. 10.1016/S2214-109X(19)30163-9
4. ACOG Committee Opinion No (2019) 764: Medically Indicated Late-Preterm and Early-Term Deliveries. *Obstet Gynecol* 133:e151–e155. 10.1097/AOG.0000000000003083
5. Dy J, DeMeester S, Lipworth H et al (2019) 382-Trial of Labour After Caesarean (SOGC). *J Obstet Gynaecol Can* 41:992–1011. 10.1016/j.jogc.2018.11.008
6. Obstetric care consensus no (2014) 1: safe prevention of the primary cesarean delivery. *Obstet Gynecol* 123:693–711. 10.1097/01.AOG.0000444441.04111.1d
7. Chu K, Cortier H, Maldonado F et al (2012) Cesarean section rates and indications in sub-Saharan Africa: a multi-country study from Medecins sans Frontieres. *PLoS ONE* 7:e44484. 10.1371/journal.pone.0044484
8. Dumont A, de Bernis L, Bouvier-Colle MH et al (2001) Cesarean section rate for maternal indication in sub-Saharan Africa: a systematic review. *Lancet* 358:1328–1333. 10.1016/s0140-6736(01)06414-5
9. Shah A, Fawole B, M'Imunya JM et al (2009) Cesarean delivery outcomes from the WHO global survey on maternal and perinatal health in Africa. *Int J Gynaecol Obstet* 107:191–197. 10.1016/j.ijgo.2009.08.013

10. Simonelli MC, Gennaro S, O'Connor C et al (2021) Women Construct Their Birth Narratives and Process Unplanned Cesarean Births Through Storytelling. *J Obstet Gynecol Neonatal Nurs* 50:30–39
11. von Katterfeld B, Li JH, McNamara B et al (2012) Perinatal complications and cesarean delivery among foreign-born and Australian-born women in Western Australia, 1998–2006. *Int J Gynecol Obstet* 116:153–157. 10.1016/j.ijgo.2011.09.012
12. Bishop D, Dyer RA, Maswime S et al (2019) Maternal and neonatal outcomes after caesarean delivery in the African Surgical Outcomes Study: a 7-day prospective observational cohort study. *Lancet Glob Health* 7:e513–e522. 10.1016/s2214-109x(19)30036-1
13. ACOG (2019) ACOG Practice Bulletin No. 205 Vaginal Birth After Cesarean Delivery. American College of Obstetricians and Gynecologists
14. Reproductive and Child Health Department, Ministry of Health (2022) Essential Maternal and Newborn Clinical Care Guidelines for Uganda. Ministry of Health, Kampala
15. Ahmat A, Okoroafor SC, Kazanga I et al (2022) The health workforce status in the WHO African Region: findings of a cross-sectional study. *BMJ Glob Health* 7:e008317
16. Lee SH, Nurmatov UB, Nwaru BI et al (2015) Effectiveness of mHealth interventions for maternal, newborn and child health in low-and middle-income countries: systematic review and meta-analysis
17. Colaci D, Chaudhri S, Vasan A (2016) mHealth interventions in low-income countries to address maternal health: a systematic review. *Ann Glob Health* 82:922–935
18. Haddad SM, Souza RT, Cecatti JG (2019) Mobile technology in health (mHealth) and antenatal care—searching for apps and available solutions: a systematic review. *Int J Med Inf* 127:1–8
19. Sondaal SFV, Browne JL, Amoakoh-Coleman M et al (2016) Assessing the effect of mHealth interventions in improving maternal and neonatal care in low-and middle-income countries: a systematic review. *PLoS ONE* 11:e0154664
20. Amoakoh-Coleman M, Borgstein AB-J, Sondaal SF et al (2016) Effectiveness of mHealth interventions targeting health care workers to improve pregnancy outcomes in low-and middle-income countries: a systematic review. *J Med Internet Res* 18:e5533
21. Maliwichi P, Chigona W, Sowon K (2021) Appropriation of mHealth Interventions for Maternal Health Care in Sub-Saharan Africa: Hermeneutic Review. *JMIR MHealth UHealth* 9:e22653
22. Kante M, Målqvist M (2025) Effectiveness of SMS-based interventions in enhancing antenatal care in developing countries: a systematic review. *BMJ Open* 15:e089671
23. Joseph N, Boatun AA, Randall T et al (2018) Primary High Risk HPV Self-Sampling for Cervical Cancer Screening in a Community Health Fair Setting in Rural Uganda. New York, USA
24. Atukunda EC, Matthews LT, Musiimenta A et al (2021) mHealth-Based Health Promotion Intervention to Improve Use of Maternity Care Services Among Women in Rural Southwestern Uganda: Iterative Development Study. *JMIR Form Res* 5:e29214. 10.2196/29214
25. Tripathi V, Arnoff E, Bellows B et al (2020) Use of interactive voice response technology to address barriers to fistula care in Nigeria and Uganda. *mHealth* 6:12. 10.21037/mhealth.2019.12.04

26. Tibaijuka L, Boatin AA, Tornes YF et al (2025) Impact of non-communicable diseases on maternal and perinatal outcomes in a low resource setting. *Matern Health Neonatol Perinatol* 11:41
27. Trends in maternal mortality 2000 to 2023: estimates by WHO, UNICEF, UNFPA, World Bank Group and UNDESA/Population Division
28. Jiwa A, Ngatia A, Benali K et al (2026) Africa's Digital Health Revolution: The Digital Fit-Viability Model to Move From Innovation to Scaled Implementation. *J Med Internet Res* 28:e63495

Figures

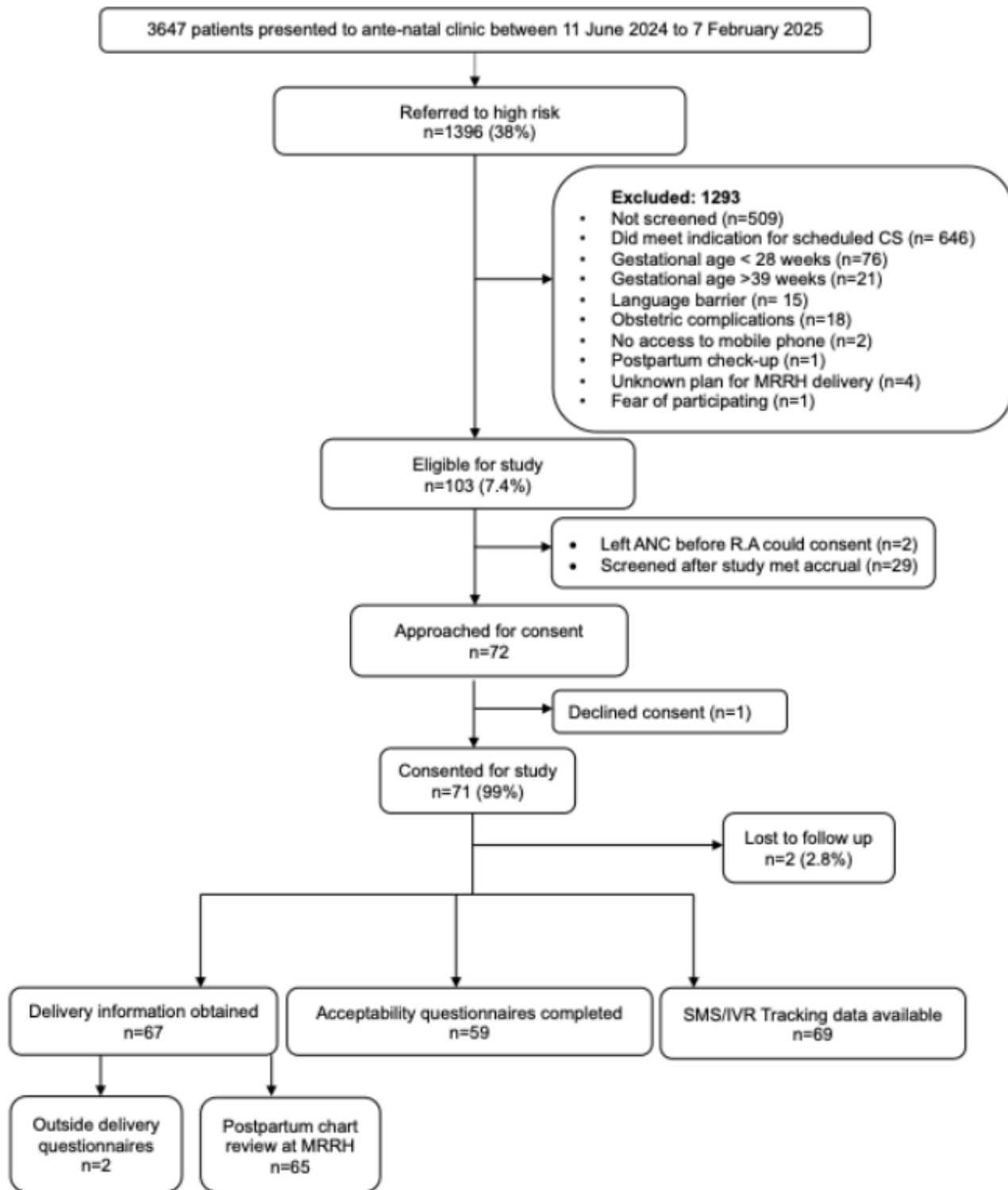


Figure 1

Participant screening, recruitment, enrollment, and follow-up



Figure 2

Perceived usefulness and satisfaction ratings for SMS and IVR messages (n=59).

Domains assessed include relevance, comprehensibility, and preparedness benefit, rated on a 5-point Likert scale.

Supplementary Files

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- [CONSORT2010ChecklistSMSIVRPilotJuly6th.docx](#)