# **Original research**

# **BMJ Open** Perceived acceptability, barriers and enablers in implementing mobile phone messaging-based message-framing intervention for improved maternal and Trest and enablers of mobile phone messaging interventions. The identified barriers and enablers. The qualitative nature of the study makes it difficult to quantitatively assess the magnitude of the identified barriers and enablers. The qualitative nature of the study makes it difficult to quantitatively assess the magnitude of the identified barriers and enablers. The qualitative nature of the study makes it difficult to quantitatively assess the magnitude of the identified barriers and enablers. The qualitative nature of the study makes it difficult to address these barriers while leveraging existing and contextual. To maximise the impact of mobile health messaging and ensure broad and effective reach, it is crucial to address these barriers while leveraging existing and the address these barriers while leveraging existing and and newborn health is a critical global public health concern, with a key priority being the reduction of maternal and newborn health is a critical global public health concern, with a key priority being the reduction of maternal and newborn health is a critical priority being the reduction of maternal and newborn health is a critical priority being the reduction of maternal and newborn health is a critical priority being the reduction of maternal and newborn by a maternal an newborn care in Jimma Zone, Ethiopia: a qualitative study

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# ABSTRACT

**Objective** To explore the perceived acceptability, barriers and enablers in implementing mobile phone messagingbased message-framing interventions to improve maternal and newborn care in Jimma Zone, Ethiopia.

Design A qualitative study employing thematic analysis of data collected through in-depth interviews (IDIs) and key informant interviews (KIIs).

Setting The study was conducted in Dedo, Shabe Sombo and Manna districts of Jimma Zone.

Participants We conducted 12 IDIs and 14 KIIs with pregnant women, male partners, health extension workers, healthcare providers and Ethio-Telecom experts across the three districts. Thematic analysis was used to identify patterns and themes in the data.

Intervention Mobile phone messaging-based interventions using gain-framed and loss-framed messages were explored for their potential to promote maternal and newborn health practices.

Key areas of exploration The study explored participants' awareness, perceived relevance. acceptability, and barriers and enablers, as well as participants' engagement with mobile health messaging interventions.

Results Participants were generally aware of the potential benefits of mobile phone messaging for maternal and newborn health. Mobile phone-based messaging was perceived as highly relevant and useful by most participants. However, many had limited prior experience using mobile messaging for health information. Despite this, participants expressed a strong willingness and readiness to receive and actively engage with the maternal and newborn mobile messaging intervention. The study also identified various barriers and enablers affecting the implementation of message-framing interventions through mobile phone messaging.

**Conclusions** Participants in this study generally recognised and accepted the benefits of mobile phone messaging for improving maternal and newborn health. Although rural women faced challenges in reading and understanding short messages, they demonstrated a strong willingness to engage with mobile health

mortality.<sup>1 2</sup> Despite some progress in recent **8** years in reducing maternal and neonatal mortality rates, significant challenges persist in many developing countries, including Ethiopia, which bears one of the highest burdens of maternal and neonatal mortality. In Ethiopia, maternal mortality is estimated at approximately 412 per 100000 live births, while neonatal mortality is around 29 per 1000 live births. Rural areas are disproportionately

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Dr Gebeyehu Bulcha; gebeyehubulcha@yahoo.com affected due to poor access to healthcare and suboptimal health-seeking behaviours.<sup>3–5</sup>

Technological innovations, particularly mobile health (mHealth) interventions, have shown promise in improving maternal and newborn health outcomes. These interventions primarily use mobile phone messaging to provide timely health information, promote healthy behaviours and enhance communication between healthcare providers and patients.<sup>3 6–10</sup>

In Ethiopia, mobile phone access is increasing-88% in urban areas and 47.2% in rural areas-making Short Message Service (SMS)-based interventions a potential tool for improving antenatal care attendance, birth preparedness, knowledge of pregnancy and childbirth danger signs, early breastfeeding initiation and postnatal care utilisation.<sup>9 11 12</sup> The country's main telecommunication service provider, Ethio-Telecom, serves as the backbone to this digital extension with its variety of services, including mobile voice, SMS, MMS, internet and mobile money through Telebirr. Additionally, it provides enterprise solutions, fixed-line services, customer care and innovations in fifth-generation (5G) and smart city infrastructure—all under one umbrella.<sup>13</sup>

The increasing penetration of mobile phones allows mHealth interventions to close the access gaps in healthcare, mainly in rural areas where health services may not be readily available.<sup>14</sup> However, several challenges may hinder the successful implementation of mHealth interventions, including low literacy rates, poor network coverage, technical difficulties,<sup>9 15 16</sup> poor access to mobile phones,<sup>17</sup> unreliable message delivery,<sup>17</sup> <sup>18</sup> message delays,<sup>19</sup> low smartphone penetration,<sup>20</sup> affordability constraints,<sup>18</sup><sup>21</sup> unreliable electricity access<sup>22</sup><sup>23</sup> and cultural barriers.<sup>24</sup>

Despite these barriers, several enablers can can enhance the effectiveness of mobile health interventions. These include interactive messaging, which enhance two-way communication,<sup>25</sup> engagement of community health workers, who provide personalised support and follow-up,<sup>26</sup> and tailored content, that aligns with local languages and cultural contexts.<sup>27</sup> These strategies can improve user engagement, understanding and compliance with the recommended maternal health practices, thereby make mobile health interventions more effective.

While mHealth interventions have shown promise in Ethiopia, there remains a limited understanding of the perceptions of pregnant women regarding such interventions.<sup>28 29</sup> Moreover, there is a gap in the literature on the relative effectiveness of different message-framing techniques, such as gain-framed and loss-framed messaging, in influencing maternal health behaviours.<sup>30</sup> The digital divide between urban and rural areas, the influence of social and gender norms on mobile phone access and decision-making, and the sustainability of mHealth interventions beyond pilot programmes also need to be explored.<sup>31</sup> This qualitative study was conducted to explore the perceived acceptability, barriers and enablers of mobile phone messaging interventions that improve

maternal health service uptake and neonatal health practices in the Jimma Zone. The findings have informed the design and implementation of the cluster randomised controlled trial (cRCT).

# METHOD AND MATERIALS

The study has followed the SRQR checklist for reporting, which ensures transparency and consistency in the study (online supplemental file 1). A three-arm cRCT was conducted in 21 health posts in Jimma Zone, Ethiopia, to assess the effectiveness of a mobile phone messaging-based newborn health service utilisation. The study randomly assigned 588 pregnant women (16–20 weeks gestation) to 8 the gain-framed arm (emphasising benefits), loss-framed arm (emphasising risks) and control arm (no SMS). The intervention was implemented from May to December 2023. Primary outcomes included maternal service utilisation and newborn care practices, while secondary outcomes encompassed knowledge, self-efficacy and adherence to iron supplementation. A qualitative compoō nent involved 12 in-depth interviews (IDIs) with pregnant nent involved 12 in-depth interviews (IDIs) with pregnant women and male partners and 14 key informant interviews (KIIs) with health workers, health extension workers and Ethio-Telecom experts. The trial was published<sup>32</sup> and was registered on 4 January 2022, with Clinical Trials under the identifier PACTR202201753436676, available 5 text and da at https://pactr.samrc.ac.za.

# Study setting and period

The study was conducted in the Dedo, Shabe Sombo and Manna districts of the Jimma Zone. Together, the three a districts had a total population of 624534, including 21671 pregnant women. This study was conducted between 5 March and 20 March 2023. Study sites were selected purposively to ensure a representation of chartraining, and acteristics within the study area and to gain insights into both challenges and enablers related to mobile phone messaging interventions.

# Study design

We conducted a qualitative study to explore the perceived acceptability, barriers and enablers of mobile phone messaging-based message-framing interventions aimed at improving maternal and newborn health practices. This study was nested within a cRCT to gain deeper insights **o** into the perceived acceptability and contextual factors **g**. influencing the interventions. The matic analysis was used  $\overline{\mathbf{g}}$ to explore participants' perceptions within a qualitative paradigm. A constructivist stance recognised knowledge as being co-constructed between the researcher and participants, while a descriptive qualitative design provided insights into perceived acceptability, barriers and enablers of implementation. Key assumptions included honest participant responses, the suitability of thematic analysis, and minimal loss of meaning in translation, ensured through meticulous transcript validation.

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To reduce bias, researchers maintained reflexivity throughout. This approach allowed a systematic investigation of the reception of interventions, challenges and facilitators in mHealth.

# **Population and sampling**

The study population comprised a specific and targeted group drawn from a broader source population, including pregnant women, male partners, health extension workers, midwives, primary healthcare unit (PHCU) directors, district maternal and child health (MCH) coordinators, and local Ethio-Telecom experts. Participants in the three intervention arms of the cRCT were allocated by cluster randomisation to minimise selection bias.

The qualitative component involved purposive sampling of IDIs and KIIs within the intervention target areas. Participants were selected based on their relevance to the study's objectives. KIs with more than 1 year of work experience were included. The selection of Ethio-Telecom was based on their involvement in mobile health implementation, experience with networking and mobile messaging systems, and at least 1 year of work experience in the sector. IDI participants were selected based on their experience with MCH service utilisation and other background factors such as residence and educational level to ensure diversity of perspectives and views. The actual sample size was determined by data saturation, where further data collection no longer yielded new insights. Both IDIs and KIIs were continuously reviewed to assess whether additional sampling was needed to ensure a comprehensive range of perspectives within the study population.

# Data collection methods and procedures

Data were gathered through IDIs and KIIs with various stakeholders, including pregnant women, male partners, Health Extension Workers, midwives, PHCU directors, MCH focal persons and Ethio-Telecom experts, between 5 March and 20 March 2023. IDIs focused on capturing personal experiences and insights from individuals directly involved with the research topic, providing in-depth perspectives on personal perceptions and attitudes. KII, on the other hand, involved experts or influential individuals, such as professionals or community leaders, who offered broader, more strategic perspectives and contextualised the issue under study.

Before data collection began, the research team obtained permission from the selected districts and health facilities. All interviews were conducted in private settings to ensure confidentiality, with only the participant and the data collector present. An open-ended interview guide, pre-tested for accuracy and relevance, was employed to facilitate the interviews. Interviews lasted between 40 and 60 min and were recorded using a digital voice recorder, complemented by note-taking during the sessions.

# In-depth interviews with pregnant women and male partners

IDIs were conducted with 12 participants-six pregnant mothers and six male partners (not necessarily the partners of the six pregnant women interviewed). The interviews were randomly selected from three intervention arms, with four interviews per arm. To ensure diversity and representation, participants were purposefully sampled based on key variables including urban-rural distribution (eight from rural areas and four from urban areas), gestational age (nine participants beyond 20 weeks and three below 20 weeks) and proximity to network towers, meaning the closeness or distance of participants' locations to network towers, which could impact the availability and quality of mobile phone services. The other inclusion criteria were individuals' experiences 8 with maternal and newborn services and their utilisation of mobile phones, facilitating the exploration of a broad context of experiences related to mobile phone usage, as well as associated challenges and facilitators. The interviews were conducted by well-trained qualitative researchers and transcribed verbatim into English. To ensure privacy and participant comfort, all interviews ₫ were conducted in private settings. uses related

# Key informant interviews with health workers and Ethio-**Telecom experts**

To triangulate the findings of the IDIs, 14 key informants ť (KIs) were purposively selected and interviewed. The KIs included a diverse group of healthcare providers including health extension workers, midwives, PHCU ല ă directors, MCH focals and Ethio-Telecom experts. To ensure diversity of experience, healthcare providers were purposively selected based on the duration of their professional experience. The KIIs were conducted by well-trained qualitative researchers. Data collectors were responsible for conducting and transcribing the  $\triangleright$ interviews but did not participate in the development of the research questions, study hypotheses or the main trial team. Their role was limited to data collection to maintain objectivity and reduce the risk of bias in the , and similar study.

# Participant recruitment process

The recruitment process was designed to ensure that study participants were representative across urban and rural settings, study arms and key stakeholder groups. A total of 26 participants were recruited: 12 for IDIs and 14 for KIIs. Pregnant women and their male partners were selected from both urban (n=4) and rural (n=8) areas, evenly distributed across the gain-framed, loss-framed and control study arms. KIs included health extension workers (n=3), midwives (n=3), PHCU directors (n=2) and MCH coordinators (n=2) from health facilities with varying levels of responsibility in the maternal health services chain. Additionally, perspectives from four Ethio-Telecom experts were incorporated to enrich the understanding of the mobile messaging intervention (table 1).

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Table 1 Summary of participant recruitment by urban-rural distribution, study arms and participant groups								
			Study arms		Total participants			
Participant group	Urban	Rural	Gain-framed	Loss-framed	Control	(n=26)		
In-depth interviews (n=12)								
Pregnant women	2	4	2	2	2	6		
Male partners	2	4	2	2	2	6		
Key informant interviews (n=14)								
Health extension workers	1	2	1	1	1	3		
Midwives	1	2	1	1	1	3		
Primary healthcare unit directors	1	1	1	1		2		
Maternal and child health coordinators	1	1		1	1	2		
Ethio-Telecom experts	4	0				4		

# **Data analysis**

Interview recordings were carefully transcribed and translated into English. Transcripts and notes were carefully reviewed for accuracy. The collected data were analysed to identify common themes, patterns and valuable insights, providing an understanding of why mobile phone messaging-based message-framing interventions succeeded from participants' perspectives.

Thematic analysis was employed to identify the patterns and themes within the data. The research team familiarised themselves with the content by reviewing and analysing the transcripts, generating initial codes, and refining them as new codes emerged. ATLAS.ti V.7.1 software was used to manage and organise the data by grouping the codes into larger categories and subthemes. The subthemes were further reviewed to identify overarching themes that accurately captured the barriers and enablers of mobile phone messaging-based messageframing interventions for maternal and newborn health in the Jimma Zone, Ethiopia. A multistage coding and discussion process was followed among the research team to ensure consistency and reliability. Any discrepancies in coding were resolved by consensus; final themes were checked against existing literature for validation. To enhance accuracy and consistency, triangulation and member checks were conducted. Identified themes were validated through member-checking, where participants were invited to review and confirm whether their views were being accurately represented. Additionally, peer debriefing was used to strengthen the credibility of the findings.

# **Researcher characteristics and reflexivity**

The team of researchers was highly experienced in maternal and newborn health, mobile health interventions and behavioural sciences. This may influence not only the framing of the study objectives but also the interpretation of the findings of this study. Their familiarity with both mobile phone messaging interventions and message-framing techniques may have framed their assumptions about the possible findings of the study. Although the researchers were not previously involved . in maternal and child health programmes within the study setting, their broader academic and professional background offered valuable insights into the contextual factors that would influence mobile health interventions. The researchers had linguistic and cultural knowledge of the Jimma Zone, which helped in communicating and understanding the context but might also induce some implicit biases in the interpretation of the data. These were, in turn, counterbalanced by reflexive practices from the research team: triangulation, peer debriefing and an attempt to be neutral during the interviews. That way, the findings indeed were a representation of the participants and not some projection of the researchers' presuppositions, increasing credibility and transferability of the study results.

# **Quality control**

A rigorous quality control protocol was followed to ensure the integrity and consistency of the results. Data were collected by trained qualitative researchers to enhance accuracy and reliability. The training was conducted by two experienced researchers (one male and one female) over a period of 2 days to make sure all members of the team were well equipped. The collected data underwent rigorous expert review to verify their suitability and relevance.

During fieldwork, daily debriefing sessions were conducted to facilitate the selection of supplementary samples, enhancing the comprehensiveness of the collected data. Observations and insights from both facilitators and note-takers were meticulously documented to provide a holistic overview of each data source.

Triangulation techniques were employed to strengthen the credibility of the data by integrating insights from both IDIs and KIIs. Additionally, the generalisability of the findings was improved by incorporating diverse perspectives from both rural and urban settings.

# Patient and public involvement

The study participants included pregnant women, male partners, health extension workers, midwives, PHCU directors, MCH focal persons and experts from Ethio-Telecom. While patients and members of the public were not directly involved in the design, conduct or reporting of the study, their perspectives were actively sought through IDIs and KIIs. These stakeholders provided crucial insights into the acceptability, barriers and enablers of using mobile phone messaging-based message-framing interventions to improve maternal and newborn health practices. The findings will be shared with relevant stakeholders, including district health offices and healthcare providers, to inform future digital health interventions.

### RESULTS

#### **Background characteristics**

A total of 26 participants (12 for IDI and 14 for KII) were interviewed for this study. The mean age of the study participants was 28 years. The majority (65.4%) had attained tertiary education. More than three-fourths (84.6%) of the participants were Oromo, the largest ethnic group in Ethiopia, with a distinct language and cultural identity. Among the pregnant women, 41.7% had access to electricity, 16.7% were primigravida, 66.7% were at or beyond 20 weeks gestation and 66.7% had attended up to their fourth antenatal care visit. On average, each woman had 1.6 children, with a maximum of 7. The majority (71.4%) of the KIs had over 5 years of experience (see table 2).

#### **Emergent themes and categories**

The results are organised into five key thematic groups: awareness, perceived relevance, usefulness and benefits of mobile messaging; prior experience or exposure to mobile phone messaging; willingness and readiness to receive and engage with mobile phone messaging; perceived barriers and challenges to mobile phone messaging; and enablers and facilitators of mobile phone messaging (figure 1).

# Awareness, perceived relevance, usefulness and benefits of mobile messaging

# **Awareness**

The majority of the study participants are aware of how mobile phone-based interventions can promote the health of mothers and newborns. According to them, mobile health is a powerful strategy for improving the health of mothers and their newborns. They explained that by using mobile technology, personalised health messages and advice can be directly sent to mothers or family members' mobile devices, making it easy and accessible for them to receive the care they need at their convenience. Responses differed between male and female participants, as well as between KII and IDI participants. While both genders acknowledged the utility of mobile messaging, female participants, especially pregnant women, emphasised its direct applicability to their

Table 2 Characteristics of study participants, Jimma Zone, Ethiopia

Variables	Category	# (%)		
Mean age (n=26)		28		
Sex (n=26)	Female	14 (53.8)		
	Male	12 (46.2)		
Education (n=26)	No formal education	6 (23.1)		
	Primary/secondary	3 (11.5)		
	Tertiary	17 (65.4)		
Occupation (n=26)	Farmers	3 (11.5)		
	Merchant	3 (11.5)		
	State workers	18 (69.2)		
	Others	2 (7.7)		
Work experience (n=14)	<5 years	4 (28.6)		
	>5 years	10 (71.4)		
Monthly income	<5000 ETB	12 (46.2)		
(n=26)	>5000 ETB	14 (53.8)		
Religion (n=26)	Muslim	17 (65.4)		
	Christian	8 (30.8)		
	Others	1 (3.8)		
Ethnicity (n=26)	Oromo	22 (84.6)		
	Amhara	2 (7.7)		
	Others	2 (7.7)		
Access to electricity (n=14)	Yes	5 (41.7)		
	No	7 (58.3)		
Gravidity (n=6)	Primigravida	1 (16.7)		
	Multigravida	5 (83.3)		
Gestational stage	<20 weeks	2 (33.3)		
(n=6)	≥20 weeks	4 (66.7)		
ANC status (n=6)	Attended	4 (66.7)		
	Not attended	2 (33.3)		
ANC Antenatel Care: ETD Ethionian Dirr				

ANC. Antenatal Care: ETB. Ethiopian Birr

Protected by copyright, including for uses related to text and data mining, AI training, and health needs, such as reminders for antenatal visits and l simi tailored advice. Male participants often described mobile health interventions in terms of supporting household decision-making. Similarly, KIs provided more technical technologies. insights about the feasibility and implementation of mobile messaging, while IDI respondents shared more personal experiences and perceptions of its usefulness in their everyday lives.

...mobile phone interventions are accessible at all times and can provide convenient and personalized messages to pregnant women.

# Perceived usefulness and relevance

According to the majority of the study participants, mobile phone-based messaging can ensure that pregnant women receive care at the right time by encouraging them to visit health facilities when needed. It also empowers them to



Figure 1 Thematic groups of results. The diagram shows the five most important thematic groups that were derived from the study: (A) awareness, perceived relevance, usability, and utility, and benefit of mobile phone messaging; (B) pre-exposure or prior experience of mobile phone messaging; (C) willingness and preparedness for receiving and reading mobile phone messaging; (D) perceived limitation and constraints to mobile phone messaging; and (E) enablers and facilitators for mobile phone messaging. These were arrived at through thematic analysis and represent the study's main findings. ANC - Antenatal Care; LMP - Last Menstrual Period

maintain a healthy life for themselves and their babies throughout the pregnancy and beyond by promoting self-care, adherence to advice, shared responsibility and improved health-seeking behaviour. This, in turn, can result in favourable health outcomes for both mother and baby, while also enhancing their satisfaction with the care they receive. Pregnant women often have multiple household responsibilities, which can make it challenging for them to access health information through conventional media such as health workers, printed materials, radio

interventions may be the best option to educate mothers at their convenience.

...women with busy schedules prefer mobile phones over conventional media outlets to seek health information due to time constraints.

ated to text and

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# Prior experience or exposure to mobile phone messaging Access to and source of information on maternal and newborn care

The majority of KII and IDI participants reported that health extension workers, community meetings, women development groups, health workers and media outlets such as radio and television serve as common sources of health-related information. Rural communities rely heavily on health extension workers and radio broadcasts, while urban communities access health information through televised programmes, radio and health workers.

...we get pregnancy and child care information from different places like health workers, peers, health extension workers, the 'Hello Doctor' television (TV) program, radio, and more.

# Mobile phone availability and usage

Participants reported significant differences in mobile phone availability and usage between urban and rural areas. Urban households typically have up to four phones, but usage is mainly limited to voice calls, with incoming SMS often overlooked due to low literacy and promotional texts. In rural settings, most households have at least one mobile phone, and its usage is similar to that of urban counterparts. However, in rural areas, in some households, only male partners have autonomy over mobile phone usage.

... the use of mobile phones is hindered by low literacy levels, a high volume of promotional messages, and the digital divide among family members.

# **Experiences**

The majority of the study participants revealed that there are no mHealth interventions for pregnant women in their area. Health messages can only be accessed through subscription, and this generally applies only to general health information.

...there are no specific health messages sent to our mobiles to promote maternal and newborn health.

A few participants reported that a mobile-based intervention called ComCare was piloted 5 years ago. According to their observations, such interventions could ensure optimal pregnancy and newborn care by enhancing access to health information, supporting health workers in delivering high-quality care, and empowering women and their families to make informed decisions about their health.

# Willingness and readiness to receive and engage in mobile phone messaging

# Willingness

Participants at all research sites consistently expressed positive willingness and readiness to engage in mobile phone messaging interventions aimed at improving maternal and newborn health. However, it is crucial to

involve indigenous communities and relevant stakeholders to gain a deeper understanding of their perspectives, customs and principles regarding maternal and newborn health.

... I am pleased to see that more and more people are willing to participate in mobile-based interventions...

# Perceived supportive environment

Based on the opinions of participants in the study, women in areas generally lack confidence in reading and comprehending SMS messages. However, urban women tend to exhibit good levels of digital literacy and confidence. Involving the entire family enhances the impact and shared responsibility. Families are willing to discuss the copyright, including messages among family members and support pregnant women according to suggestions from the intervention. Success relies on willingness, comprehension, engaging families and providing awareness before interventions.

... involving all family members in the intervention can help promote shared responsibility for the family's health.

# Best time for mothers to receive and read messages

for uses rel The best times to receive messages are around noon and early in the morning (between 12:00 and 1:00). During these hours, women are more likely to be free from work commitments and other engagements, making them more receptive to receiving messages.

# Preferences for language and mode of message delivery

data mining, AI training, and The majority of the participants expressed a preference for Afan Oromo, which is the mother tongue of the Oromo people and one of the official languages of Ethiopia.

... The use of multiple languages would help overcome language barriers and improve the effectiveness of interventions; however, we prefer Afan Oromo in our context.

# Perceived barriers and challenges to mobile phone messaging

The barriers to implementing mobile phone messaging interventions in maternal and newborn health can be categorised into six key dimensions based on their conceptual closeness.
Low mobile health literacy
According to our results, challenges related to mobile

health literacy encompass issues such as a lack of reading culture for messages, low literacy levels among pregnant women and their partners, and difficulties in comprehending the messages received due to literacy barriers. This poses a particularly significant problem for short messages, as they usually require limited wording and may lack context or detail, making them difficult to understand for low-literacy individuals. Face-to-face communication and audio-only messages can provide much more

clarity in tone and explanation, whereas text messages demand a certain level of reading proficiency and familiarity with written health information. Moreover, limited exposure to digital health communication further exacerbates these comprehension difficulties.

...we (pregnant women) are less educated and unable to read and comprehend mobile phone-based messages.

#### Gender and cultural barrier

In this study, one of the obstacles to implementing mobile phone-based messaging is gender and cultural barriers. This includes challenges related to male dominance in decision-making, limited empowerment of women to engage with mobile health interventions, and cultural reluctance or taboos that hinder effective communication and message reception. According to the majority of study participants, male dominance over the economic affairs of families can hinder pregnant mothers' ability to act on the key messages sent via mobile-based interventions.

... male partners have more access to mobile phones and have decision making power over other household resources.

#### Technology-related challenge

According to this study, challenges such as network disruptions, power-related issues (eg, frequent power outages affecting phone usage) and inadequate technological infrastructure in certain areas can impede the smooth delivery and reception of mobile health messages.

... network dropouts are common, lasting up to 1-2 days at times. Power is another obstacle; women often have to travel to urban areas to charge their mobile devices.

Mobile network coverage varies between urban and rural areas, with the best coverage generally found in urban areas. Residents in urban areas enjoy relatively uninterrupted connectivity, allowing them to access a variety of mobile services. However, in rural areas, there is limited network service, which challenges residents' ability to access a range of mobile services.

... the mobile network is relatively good in urban areas compared to rural ones. There are more complaints from rural communities than urban regarding network connectivity.

#### Family dynamics and communication

The results of this study show issues such as limited family dialogue and challenges in ensuring that health information reaches all relevant family members. Some of the study participants reported that there may be a lack of discussion within families, where messages sent to one mobile device are not shared among family members, limiting the intervention's reach and impact.

# Traditional healing practice and beliefs

This includes challenges related to community reliance on traditional healing rituals and preferences for traditional medicine over modern health interventions, particularly during complications or pregnancy-related issues. Often, pregnant women opt for traditional medicine, and in many instances, families employ local rituals and traditional remedies for the treatment of newborns.

... women visit health facilities when the condition

... women visit health facilities when the condition worsens; otherwise, they prefer traditional medicine. Timing and disclosure issue In this study, challenges such as late pregnancy disclosure, where pregnancies are not revealed until they are visibly evident, lead to delayed antenatal care and potential care-seeking. There are also difficulties in accurately recalling the last menstrual period. The majority of study participants indicated that it is not customary to disclose a pregnancy due to concerns about potential adverse outcomes such as abortion, fetal death and other related issues. Pregnancy becomes publicly known within the community when the woman's abdomen visibly enlarges to the uses related to text point where it becomes difficult to conceal. Women tend to seek antenatal care and related services once the pregnancy naturally becomes evident due to the increase in abdominal size.

...we keep our pregnancy a secret until our belly visibly grows larger. Even if we face any health issues during this period, we choose to consult traditional healers instead.

According to the majority of study participants, women often struggle to recall the exact date of their last menstruation. Healthcare providers opt for rough estimations or rely on associations with various events to determine a woman's last menstrual period, follow fundal height measurement or rely on ultrasound readings where available.

... they (women) were unable to recall their last menstrual period, which hinders interventions that rely on this information.

#### Frequent promotional messages

According to most study participants, essential messages may go unnoticed or disregarded due to the constant entry of promotional messages from Ethio-Telecom. They mentioned that the community may link the intervention  $\boldsymbol{\underline{G}}$ with the overwhelming volume of messages they receive  $\boldsymbol{\$}$ on their mobile phones.

...we almost ignore reading incoming messages due to the high volume of promotional messages.

# Enablers and facilitators of mobile phone messaging **Reinforcing strategies**

According to the majority of study participants, the availability of women's forums and home-to-home visit

and

data

mining,

AI training, and similar

strategies can support the implementation of mobile phone messaging-based interventions, enabling mothers to put into practice what they have learnt through the messaging intervention. Health extension workers can conduct home visits to locate and encourage mothers to act on the messages.

... pregnant women forum and home-to-home visits by HEWs can support the mobile phone-based messaging intervention.

#### Traditional community networking

Acknowledged by study participants, community-oriented networking like idirs, ikubs and social groups enhances maternal and newborn health through timely pregnancy detection, adherence to treatment plans, and support for pregnant mothers.

...community-based organizations can support Mobile phone messaging intervention through early pregnancy identification and notification.

#### Mobile phone penetration and positive attitude

Participants across the study sites mentioned that the community has a positive perception of mobile phonebased messaging interventions. According to the study participants, mobile phone-based interventions can be effective in improving antenatal care uptake, promoting birth preparedness and complication readiness, and increasing rates of timely postnatal care and exclusive breastfeeding.

## Convenience and accessibility

The majority of study participants reported that mobile phone messaging is convenient and provides instant communication, regardless of distance or time limitations. According to them, users have the flexibility to send and receive messages whenever they want, allowing for asynchronous communication.

# **Cost-effectiveness**

The majority of study participants reported that there are no costs associated with participating in mobile phonebased messaging interventions, except for indirect costs such as travelling to urban areas to recharge batteries.

# DISCUSSION

Mobile phone messaging for the promotion of healthy practices for maternal and newborn health is increasingly accepted as one of the effective emerging strategies.<sup>9 33</sup> The current study indicated that mobile phone-based messaging was perceived as highly relevant and useful among the majority of participants, which aligns with studies conducted in Ethiopia by Mekonnen *et al*<sup> $\beta$ 4</sup> and Gebremariam *et al*,<sup>35</sup> who highlighted the acceptability, barriers and facilitators of mobile text message reminders for child vaccination and infant feeding education.<sup>34,35</sup>

The current study also revealed that most participants expressed a high willingness and readiness to receive and actively engage with mobile messaging interventions. This finding is in line with studies conducted in Ethiopia by Mekonnen *et al*,<sup>34</sup> underlining the acceptability, barriers and facilitators of mobile text message reminder systems for child vaccination,<sup>34</sup> and a study by Walle et $al_{s}^{37}$  which presents healthcare professionals' intention to  $\Xi$ adopt mobile phone-based SMS for adherence support 8 and TB (Tuberculosis) care.<sup>37</sup> These findings reflect a positive attitude towards using mobile messaging as a tool to promote maternal and newborn health.

The feasibility and scalability of mHealth interventions depend on mobile phone ownership among rural women. At the national level, feature phone ownership among rural Ethiopian women is low.<sup>38</sup> In our study area, one of the studies carried out as part of a large cRCT

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Kenva, Bangladesh and Nigeria, urban areas consistently have higher mobile phone availability and usage compared with rural areas. Rural populations, particularly women, face barriers such as poor infrastructure, low income, limited education and cultural restrictions.<sup>42</sup>

The current study indicated a prevailing male dominance over resource control at the household level, which affects women's access to mobile devices, potentially reducing the effectiveness and reach of messaging through mobile phones. This result echoes findings from a study conducted by Mars<sup>43</sup> in Sub-Saharan Africa.<sup>43</sup> Technical challenges like poor signal strength and electricity interruptions were reported by the majority of participants. This finding aligns with a study by Andresen et al,<sup>44</sup> which emphasises the universal importance of reliable network connectivity and alternative power sources for sustaining effective mobile health interventions.<sup>44</sup>

The study revealed a notable lack of family discussions regarding maternal and newborn health across the study areas, which could result in a lack of sharing and discussion of messages received through the mobile messaging intervention. This finding is supported by the realist synthesis by Kabongo *et al*,  $^{45}$  which pointed out similar challenges in message engagement and dissemination within families.<sup>45</sup>

The delay in revealing pregnancies until they are visibly apparent, along with challenges in accurately estimating gestational age due to difficulties in recalling the last menstrual period, was another barrier identified by this study. This finding aligns with existing studies, including UNFPA,<sup>46</sup> Kingdon et al,<sup>47</sup> Goldberg and El-Sayed, and Majola et al,<sup>49</sup> which highlight similar challenges in delaying pregnancy disclosure and estimating gestational age. These challenges may impede the timely and effective delivery of interventions aimed at improving maternal and newborn health.

The frequent inflow of promotional messages was another challenge reported by the majority of participants. Similarly, a study by Mao *et al*<sup>50</sup> found that continuous exposure to promotional content raises consumer scepticism, making individuals question the authenticity and motives of health messages, leading to decision fatigue and hindering individuals from prioritising and acting on health recommendations.<sup>50</sup> This indicates that it is essential to develop strategies to ensure that health messages stand out and become unique among a sea of information entering mobile phones.

The current study also identified critical enablers to the implementation of mobile phone messaging interventions. One of the main enablers reported was the use of intermediaries like community health workers. Similarly, a study by Mahmood *et al*<sup>b1</sup> found success in using community health workers as intermediaries for mobile health messages due to their embedded trust and community presence, enabling effective health communication.<sup>51</sup>

Positive attitudes were other enablers for mobile phone messaging-based interventions. Positive attitudes set the stage for a receptive environment, nurturing engagement with the potential benefits they offer. This is supported by a study by Yang and Van Stee,<sup>52</sup> which found that high mobile phone penetration and positive attitudes increase the effectiveness of interventions.<sup>52</sup> Traditional community networking, such as idirs, ikubs (Ethiopian social institutions for mutual support and savings) and other social groups, was another facilitator of mobile phonebased messaging interventions. These community-rooted networks can contribute to the effectiveness of mobile phone-based messaging by assisting with pregnancy **\_** detection, treatment adherence and providing support of to mothers. Similarly, a study by Mengesha *et al*<sup>23</sup> in rural Ethiopia showed the positive influence of traditional ŝ community networks in a mobile health intervention.<sup>53</sup>

This study had some limitations. First, it is context- 8 bound, so the generalisation of the findings to settings with different socio-cultural and technological backgrounds may be limited. Second, the qualitative design does not allow for quantification of identified barriers and enablers, making it difficult to assess the magnitude of each. Finally, the limited mobile phone ownership and digital literacy among rural women might have influenced the depth of the insights obtained on mobile uses related to text health interventions. Despite these limitations, this study provides valuable evidence concerning the feasibility and challenges of using mobile messaging for maternal and newborn health in rural Ethiopia.

# CONCLUSION

The study identified that participants generally understand the benefits of mobile phone messaging in ð improving maternal and newborn health, perceiving it as  $\mathbf{\bar{a}}$ a relevant and useful tool for enhancing health knowledge, care-seeking behaviours and confidence in caring for mothers and babies. However, rural women often lack confidence in reading and comprehending SMS messages. Despite limited prior experience with mobile health messaging and a lack of confidence in reading and understanding SMS messages, there was strong willingness and readiness among participants to receive and engage with mobile phone messaging interventions, indicating a positive outlook for the implementation of mobile messaging interventions.

This study identified challenges, including low mobile health literacy, gender and cultural barriers, technologyrelated issues, preference for traditional healing practices, urban-rural disparities in mobile phone access, and & male dominance in resource control, all of which could **3** limit the effectiveness of these interventions. Despite these challenges, enablers such as community-based support networks, traditional community structures like idirs and ikubs, home-to-home visits, the high penetration of mobile phones in urban areas, and positive community attitudes towards mobile-based interventions can support the success of mobile messaging interventions. To maximise the impact of mobile phone messaging, stakeholders must ensure cultural sensitivity, address

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infrastructural challenges and foster a supportive environment. Engaging community leaders, health workers and families, along with reinforcing strategies such as women's forums and community health workers, will be key to the effectiveness and reach of mobile phone messaging-based message-framing interventions.

Understanding potential barriers and enablers can provide evidence-based support for initiatives that consider mobile health solutions to promote healthy practices in maternal and newborn care. Considering the preferred language, timing and modes of message delivery, providing orientation to study participants and their families before rolling out the intervention, and actively involving families in the intervention process are all essential for its effectiveness. Additionally, tailoring messages to accommodate multiple mobile phones within a family is crucial for ensuring optimal reach and impact.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, conduct, reporting or dissemination plans of this research. Refer to the Methods section for further details.

Patient consent for publication Consent obtained directly from patient(s).

Ethics approval This study involves human participants. Ethical approval was obtained from the Ethical Review Board of Jimma University (Ref No. JUIH/ IRB/316/23). Consent details, including study objectives and participant roles, were explained in the local language. All participants provided verbal consent before participation and willingly took part in the study. The consent procedure was approved by the Ethical Review Committee. Collected information was kept confidential and used solely for the agreed-upon purpose. Only the core research team had access to the data, which was stored on password-protected computers and laptops. During data transcription and organisation, participant identifies were delinked from their identification codes. This qualitative exploration was the initial step in a mobile phone messaging intervention study and had no negative impact on the participants.

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