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Perceived Acceptability, Barriers, and Enablers in Implementing Mobile Phone Messaging-Based Message Framing Intervention for Improved Maternal and Newborn Care in Jimma Zone, Ethiopia

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Abstract

Background: Mobile phone messaging-based message-framing interventions have been identified as a promising strategy for improving maternal and newborn care practices on a global scale. Despite promising results, its implementation is a complex process that involves various barriers and enablers. This study aimed to explore the barriers and enablers of mobile phone messaging interventions for promoting maternal and newborn health practices in the Jimma Zone, Ethiopia.

Methods: The study was conducted in Dedo, Shabe Sombo, and Manna districts of Jimma Zone. We conducted 12 in-depth interviews and 14 key informant interviews with pregnant women, male partners, health extension workers, health workers, and ethio-telecom experts across the three districts of Jimma Zone. Thematic analysis was used to identify patterns and themes in the data.

Results: The findings indicated that Participants were generally aware of the potential benefits of mobile messaging for maternal and newborn health information and support. Mobile phone-based messaging was perceived as highly relevant and useful by the majority of participants. Many participants had limited experience with mobile messaging for health information. Participants expressed a strong willingness and readiness to receive and actively engage with the maternal/newborn mobile messaging program. We found various barriers and enablers to mobile phone messaging-based message framing interventions.

Conclusions: Participants in this study generally knew about and accepted the benefits of mobile phone messaging for improving maternal and newborn health. Although rural women face challenges in reading and understanding short messages, they still demonstrate a strong willingness to engage with mobile health messaging interventions. The identified barriers were categorized as technological, social & cultural, and behavioral & contextual. To

maximize the impact of mobile health messaging and ensure broad and effective reach, it's crucial to address barriers by fostering existing enablers.

Keywords: mHealth, Ethiopia, mobile phone messaging, perceived acceptability, barrier and facilitator

Background

Maternal and newborn health is a critical global public health concern (1,2). Reducing maternal mortality is a global health priority, and both global and local strategies are pivotal for achieving this goal. The key to this effort is enhancing access to services and promoting healthcare-seeking and service utilization (3–8). Despite progress in lowering maternal and neonatal mortality rates, challenges persist in many developing nations (9).

Ethiopia has one of the world's highest burdens of maternal and newborn mortality, with approximately 412 maternal deaths per 100,000 live births and 29 neonatal deaths per 1,000 live births, which are concentrated in rural areas, where inadequate access to healthcare and suboptimal health-seeking behaviors contribute to adverse health outcomes (10,11).

Technological innovation has created new ways of addressing public health challenges, including those related to maternal and newborn health (12). The intervention of digital health technologies including mHealth to improve maternal health is gaining power as a promising strategy to promote healthy practices during pregnancy, childbirth, and the postnatal period (13,14). These approaches aim to deliver timely, accurate health information, cultivate healthy behaviors, and foster communication between healthcare providers and patients through text messages on mobile devices (9,15). As mobile health interventions are cost-effective, simple, and scalable, they present more opportunities to combat pressing maternal and newborn challenges (16). Recent studies assessing the impact of mobile phone messaging-based interventions in low-income countries, including Ethiopia, have yielded encouraging results in improving antenatal care attendance, birth preparedness, knowledge of pregnancy and childbirth danger signs, early breastfeeding initiation, and postnatal care utilization (15,17).

In Ethiopia, 88% of urban households have access to mobile phones, whereas only 47.2% of rural households have access to mobile phones. Short Message Service (SMS) is one of the

most popular mobile phone communication systems (18), and Multimedia Messaging Service (MMS) was recently added as a communication feature to ethio-telecom services (19).

Despite its promising effectiveness, the successful implementation of mobile phone messaging interventions depends on a range of obstacles and enablers (20). Researchers have identified multiple challenges that influence the acceptance and implementation of mobile health interventions including low literacy rates, inadequate awareness of mobile health, poor network coverage, and technical challenges, (15,21,22). A study conducted by Donson et.al identified a range of obstacles, including network connectivity issues, privacy concerns, and the need for culturally sensitive messaging (23). Studies have further explored the challenges associated with mobile phone access (24), affordability (25,26), and concerns about message reliability (24,26). Low smartphone penetration and limited digital literacy among women in rural areas are also major challenges to the implementation of mHealth (27). Sunday O. Oyeyemi and Rolf Wynn addressed challenges such as message delivery delays and participant concerns regarding message accuracy (28). Restricted mobile phone ownership is a major barrier to the effectiveness of mobile phone messaging interventions in maternal and newborn health in rural areas. Rural women's ownership of mobile phones is often significantly lower than that of their urban counterparts, and unreliable access to electricity for charging mobile devices and receiving text messages further compounded this issue (29,30).

Despite these challenges, various enablers have been identified to increase the uptake and effectiveness of mobile phone messaging to improve maternal and newborn health including interactive messaging & personalized content (31)engagement of community health workers in supporting mobile phone interventions significantly improved its acceptability and effectiveness in enhancing healthcare delivery (32), feedback, and privacy (33).

The use of mHealth interventions in Ethiopia has yielded promising results in improving maternal and child health. However, there is a lack of comprehensive knowledge regarding the extensive utilization of mHealth interventions in Ethiopia, specifically regarding pregnant women's opinions, challenges, cultural aspects, perceived benefits, and enablers (34,35). This study was conducted before the eight-month (May –December 2023) cluster randomized controlled trial (cRCT) project to inform the design and implementation of mobile phone messaging-based message framing intervention. This study aimed to deploy a qualitative assessment approach to better understand the barriers and enablers of mobile phone messaging interventions to improve maternal health service uptake and neonatal health practice in the Jimma Zone.

Method and materials

The trial protocol has been accepted for publication (36) and the trial was registered on 04 January 2022 with Clinical Trials (trial identifier PACTR202201753436676) and can be accessed 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 districts had a total population of 624,534, of which 21,671 were pregnant women. This study was conducted between March 5 and March 20, 2023. The study sites were selected purposively to ensure a representation of characteristics 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 perceived acceptability, barriers and enablers of mobile phone messaging-based message-framing interventions to improve maternal and newborn health practices.

Population and sampling

The study population included a more specific and targeted group of individuals 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 were chosen based on their relevance to the study`s objectives. Purposive sampling was used to select both In-depth Interviews (IDIs) and key informant interviews (KIIs) participants within the intervention target areas. Key informants with more than one year of work experience were included in the study. In-depth Interview (IDI) participants were selected based on their experience in terms of usage of MCH services, and other background variables such as residence and educational level, which helped to ensure diversity of perspectives and views. The actual sample size depends on the saturation of ideas, where further data collection does not yield new insights. Both IDIs and KIIs were continuously reviewed to determine whether additional sampling was necessary to ensure a comprehensive range of perspectives within the study population.

Data collection methods and procedures

Data were gathered through in-depth and key informant interviews involving various stakeholders, including pregnant women, male partners, Health Extension Workers, midwives, PHCU directors, Maternal and Child Health (MCH) focal persons, and thio-telecom experts. Before commencing data collection, the research team obtained permission from the selected districts and health facilities to conduct the study. All interviews were conducted in private settings to ensure confidentiality, with only the participant and the data collector present during each session. An open-ended interview guide, pre-tested for accuracy and relevance, was employed to facilitate the interviews. All interviews, which ranged in

duration from 40 to 60 minutes, were recorded using a digital voice recorder, complemented by note-taking during the interview process.

In-depth interviews with pregnant women and male partners

In-depth interviews were conducted with 12 participants (six pregnant mothers and six male partners). The interviews were randomly selected from three distinct arms (four interviews per arm). To ensure diversity and representation, participants were purposefully sampled considering variables such as 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. The inclusion criteria were based on individuals' experiences with maternal and newborn services and their utilization 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 patient privacy and ensure their comfort, all interviews were conducted in private settings.

Key informant interviews with health workers and ethio-telecom experts

To triangulate the findings of the IDI, 14 key informants were interviewed with purposively selected healthcare providers and ethio-telecom experts. Diverse groups of health care providers including health extension workers, midwives, PHCU directors, MCH focals, and ethio-telecom experts were included in the key informant interviews. To ensure diversity of experience, healthcare providers were also purposively selected considering the duration of their experiences. The KIIs were conducted by well-trained qualitative researchers. The data collectors were recruited only to conduct and transcribe the interviews and they did not have any interest in this study.

Data analysis

Interview recordings were carefully transcribed and translated back into English. Transcripts and notes were carefully reviewed for accuracy. The collected data were thoroughly analyzed to identify common themes, patterns, and valuable insights. This analysis provided a window into why mobile phone messaging-based message-framing interventions succeeded from participants' perspectives. Thematic analysis was employed to identify the patterns and themes in the data. The research team familiarized themselves with the content by reviewing and analyzing the transcripts, generating initial codes, and refining them as new codes emerged. We used ATLAS.ti 7.1 software to manage and organize the data by grouping the codes into larger categories and sub-themes. The sub-themes were further reviewed to identify overarching themes that accurately captured the barriers, and enablers of mobile phone messaging-based message framing interventions for maternal and newborn health in the Jimma Zone, Ethiopia. To ensure the accuracy and consistency of the data, triangulation, and member checks were conducted to validate the study's findings.

Quality control

We followed a thorough quality control protocol to maintain the integrity and consistency of our results. The data were gathered by trained qualitative researchers to determine the accuracy and reliability of the results. The data collected by our highly trained qualitative researchers underwent rigorous expert review to guarantee their suitability and relevance. During fieldwork, the field team conducted daily debriefing sessions to facilitate the selection of supplementary samples, thereby augmenting the overall comprehensiveness of the collected data. We carefully recorded the thoughts and observations shared by both the facilitators and note-takers, ensuring a comprehensive overview of each data source. By employing triangulation techniques, we strengthened the credibility of our data through a combination of In-Depth Interviews (IDIs) and Key Informant Interviews (KIIs).

Additionally, we increased the generalizability of the findings by incorporating diverse representations from rural and urban settings.

Results

Background characteristics

A total of 26 participants (12 for IDI and 14 for KII) were interviewed for this study. The mean age of study participants was 28 with SD ± 6. The predominant (65.4%) level of education was tertiary education. More than three-fourths (84.6%) of the study participants were Oromo. Among pregnant women participants, 41.7% had access to electricity, 16.7% were primigravida, 66.7% were at or beyond 20 weeks gestation, and 66.7% attended up to the fourth antenatal care visit. On average, each woman had 1.6 children, with a maximum of 7. The majority (71.4%) of the key informants had over five years of experience (see Table 1).

Emergent themes and categories

The results are presented in five key thematic groups including awareness, perceived relevance, usefulness, and benefits of mobile messaging; prior experience or exposure to mobile phone messaging; willingness and readiness to receive and engage in mobile phone messaging; perceived barriers and challenges to mobile phone messaging, and enablers & facilitators to mobile phone messaging (Fig. 1).

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

Awareness: The majority of the study participants are aware of how mobile phone-based intervention can promote the health of mothers and newborns. According to them, mobile health is a powerful strategy for promoting the health of mothers and their newborns. They explained that by using mobile technology, personalized health messages, and advice can be directly sent to mothers or family members' mobile devices, making it easy and accessible to receive the care they need at their convenience.

"...mobile phone interventions are accessible at all times and can provide convenient and personalized messages to pregnant women." ***Male Partner, 38 years old***

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 persuading them to visit health facilities at appropriate times. It also empowers them to maintain a healthy life of their own and their babies throughout the pregnancy spectrum and beyond by promoting self-care, adhering to advice, sharing responsibility, and improving health-seeking behaviour, which can result in favourable health outcomes for both mother and baby while also enhancing their satisfaction, with the care they receive.

Pregnant women have multiple household responsibilities, hence could be challenging for them to access health information through conventional media like health workers, printing materials, radio, and television. In such situations, mobile phone-based interventions can be the best option to educate mothers at their convenient time.

"…women with busy schedules prefer mobile phones over conventional media outlets to seek health information due to time constraints." ***HEWs, 32 years old***

Prior experience or exposure to mobile phone messaging

Access to and source 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 like 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 programs, radio, and health workers.

"...we get pregnancy and child care information from different places like health workers, peers, health extension workers, the 'Hello Doctor' TV program, radio, and more." - ***Pregnant woman, 30 Years old***

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 in the household, but usage is mainly limited to voice calls, overlooking incoming (short message service) SMS due to low literacy and promotional texts. In rural settings, in most households at least one mobile phone is available and its usage is also similar to their urban counterparts. In rural areas, for some only male partners have autonomy over mobile phone usage.

> *"... mobile phones is by low literacy levels, high dose of promotional messages and digital divide among family members."* ***HEWs, 28 years old, urban***

Experiences: The majority of the study participants revealed that there are no mobile health (mHealth) interventions for pregnant women in our area. Health messages can only be accessed based on subscription, this also only works for general health information.

> *"...there are no specific health messages sent our mobiles to promote maternal and newborn health" –* ***pregnant woman, 26 Years old***

Few of the participants reported a mobile-based intervention called ComCare was piloted five years ago, according to our observation these interventions can *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 showed positive willingness, and readiness to engage in Mobile Phone Messaging Interventions for 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..." ***HEW, 29 years old***

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 messages among family members and support pregnant women according to suggestions from 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." ***Male Partner, 41 years old***

Best time for mothers to receive and read messages: The best times to receive messages are around noon, and early in the morning (between 12-1 o'clock). 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: Majority of the participants expressed a preference for Afan Oromo.

''... the use of multiple languages would help overcome language barriers and improve the effectiveness of interventions, however we prefer Afan Oromo in our context.'' ***Male Partner, 38 years old***

Perceived barriers and challenges to mobile phone messaging

The barriers to implementing Mobile Phone Messaging Interventions in maternal and newborn health can be categorized into six key dimensions based on their conceptual closeness.

Low mobile health literacy: According to our result, 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.

''...we (pregnant women) are less educated and unable to read and comprehend mobile phone-based messages. ***"Pregnant Women, 22 years old***

Gender and cultural barrier: In this study, one of the obstacles to implementing mobile phone-based messaging is gender and cultural barriers. This encompasses 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, there is male dominance over economic affairs of families, which can hinder pregnant mothers' ability to act on the key messages and reminders sent via mobile-based interventions.

''.. male partners have more access to mobile phones and have decision power over other household resources .'' ***Pregnant Women, 35 years old***

Technology-related challenge: According to this study challenges like network disruptions, power-related issues (e.g., 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." ***HEWs, 31 years old, rural***

Mobile network coverage varies between urban and rural areas, with the averagely best coverage 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 to access a variety of mobile services.

"...mobile network is relatively good in urban areas compared to rural one, there are more complaints from rural communities than urban regarding network connectivity." ***Ethio-telecom Expert, 26 years old***

Family Dynamics and Communication: the result of this study shows 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 discussed 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 gets worse, otherwise they prefer traditional medicine.'' ***Pregnant women, 29 years old***

Timing and disclosure issue: in this study, challenges like late pregnancy disclosure, where pregnancies are not disclosed until they are visibly evident, lead to delayed antenatal and potential care seeking. There are also difficulties in accurately recalling the last menstrual period. The majority of study participants have indicated that it is not customary to reveal 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 point where it becomes difficult to conceal. Women tend to seek antenatal care and related services when 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 faced any health issues during this period, we chose to consult traditional healers instead.'' ***Pregnant Women, 28 years old***

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.'' ***Midwives, 30 years old***

Frequent promotional messages: According to most study participants, essential messages may go unnoticed or disregarded among the constant entry of promotional messages to their mobile phones from ethio-telecom. According to them, the community may link the intervention with the overwhelming volume of messages they receive on their mobile phones.

"...we almost ignored reading incoming messages due to the high volume of promotional messages." ***Male Partner, 37 years old***

Enablers and facilitators of mobile phone messaging

Reinforcing strategies: According to the majority of the study participants, the availability of women's forums and home-to-home visit strategies can support the implementation of mobile phone messaging-based intervention, enabling mothers to put into practice what they have learned through the messaging intervention. Health extension workers can conduct home visits to locate and encourage mothers to act upon the messages.

"... pregnant women and home-to-home visits by HEWs can support the mobile phone-based messaging intervention." ***Midwives, 24 years old***

Traditional community networking: Acknowledged by study participants, community-oriented networking like idirs, ikubs, and social groups enhance 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."* ***-MCH focal, 27 years old***

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

Convenience and accessibility: The majority of the study participants reported that mobile phone messaging is convenient and can provide 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 the study participants reported that no costs are associated with being involved in mobile phone-based messaging intervention except indirect costs like moving to urban to recharge batteries.

Discussion

Mobile phone messaging for the promotion of healthy practices for maternal and newborns is increasingly accepted as one of the effective emerging strategies (15,37). This study indicated that mobile phone-based messaging was perceived as highly relevant and useful among the majority of participants, this aligns with studies conducted in rural India (38), Nigeria (39), and Ethiopia (40,41), which demonstrates the perceived benefits of mobile messaging for maternal and newborn health information and support. Many participants had limited prior experiences with mobile messaging for health information. Similar studies have shown that the adoption of mobile messaging for health purposes is often a new concept for many individuals, particularly in resource-constrained settings (42). This study also showed that the majority of participants expressed a strong willingness and readiness to receive and actively engage with mobile messaging intervention. This finding is consistent with the study conducted in Ethiopia (40,43). This finding indicates a positive attitude toward using mobile messaging as a tool for the promotion of maternal and newborn baby health.

In this study, the following conventional sources of information such as community health workers, community meetings, and local media outlets remain crucial, but text messaging through mobile phones is rarely reported as source messages. These findings align with existing studies from low- and middle-income countries (44,45). This could be due to the absence of such intervention in the area or the high digital divide and low digital literacy.

This study identified various barriers to mobile phone messaging-based message framing intervention. One of the major barriers is low mobile health literacy, which is notably pronounced among rural women. This finding is supported by a study conducted in China (46) and USA (47). There were disparities in mobile phone availability and usage between urban and rural areas within the study areas. This is consistent with existing studies (48,49). These disparities stress the importance of promoting the culture of sharing mobile between family

members to bridge the digital divide and ensure equitable access to vital health information for all pregnant women, regardless of their geographical location and residence. The current study's findings indicated a prevailing male dominance over resource control at a household level, this affects women's access to the use of mobile devices thereby potentially affecting the effectiveness and reach of messaging through mobile phones. This result echoes with findings from Sub-Saharan Africa research (50). In this study, technical challenges like poor signal strength and electricity interruptions may pose significant obstacles to access and reach of mobile phone messages. These challenges could lead to unreliable mobile network coverage and frequent power disruptions, hampering the delivery of health messages and the functionality of mobile devices. This finding aligns with existing literature, emphasizing the universal importance of reliable network connectivity and alternative power sources for sustaining effective mobile health interventions (51). The study reveals a notable deficiency in family discussions regarding maternal and newborn health across the study areas, which could result in a lack of sharing/discussion of the message received through mobile messaging intervention. This significantly reduces the effectiveness of text messages via mobile phones. This finding is consistent with one realistic synthesis in low and middle-income countries(52). The delay in revealing pregnancies until they are visibly apparent, and the challenge of inaccurately estimating gestational age due to difficulties in recalling the last menstrual period was another barrier identified by this study. This finding aligns with findings from existing studies that highlight similar challenges faced by women in delaying pregnancy disclosure and accurately estimating gestational age (53–56). These challenges may impede the timely and effective delivery of interventions aimed at improving maternal and newborn health. According to the literature, the frequent inflow of promotional messages is another challenge reported by the majority of participants. Continuous exposure to promotional content breeds consumer skepticism, making individuals question the

authenticity and motives of health messages, leading to decision fatigue and hindering individuals from prioritizing and acting on health recommendations (57). It is essential to develop strategies to ensure that health messages stand out and become unique among a sea of information entering mobile phones.

This study also identified various factors that enable the implementation of mobile phone messaging-based message framing intervention. One of the major enablers identified was community engagement towards mobile phone messaging. This suggests the need to engage community leaders, and health workers so that they can actively promote mobile use for receiving health messages, fostering trust and encouraging participation. Another significant facilitator is reinforcing factors like women's forums, availability of community health workers in each kebele, and home-to-home visits to complement and strengthen mobile phone messaging. Similarly, One study found success in using community health workers (CHWs) as intermediaries for mobile health messages due to their embedded trust and community presence, enabling effective health communication (58). Mobile phone penetration and positive attitude were other enablers for mobile phone messaging-based intervention. Positive attitudes set the stage for a receptive environment, nurturing engagement with the potential benefits they offer. This is supported by a study that shows high mobile phone penetration and positive attitudes increase the effectiveness of intervention (59). Traditional community networking, such as idirs, ikubs, and social groups, was another facilitator of mobile phone-based 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 to mothers. Similarly, a rural Ethiopian case study showed the positive influence of traditional community networks in a mobile health intervention (60).

Conclusion

The study identified that participants generally know the benefits of mobile phone messaging in improving maternal and newborn health, perceiving it as a relevant and useful tool for enhancing health knowledge, care-seeking behaviors, and confidence in caring for mothers and babies. Rural women lack confidence in reading and comprehending SMS messages. Despite limited prior experience with mobile health messaging and a lack of confidence in reading and comprehending SMS messages, there was a 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 like low mobile health literacy, gender and cultural barriers, technology-related issues, preference for traditional healing practices, urban-rural disparities in mobile phone access and male dominance in resource control could 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 programs. To maximize the impact of mobile phone messaging, stakeholders must ensure cultural sensitivity, address 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 intervention.

Understanding potential barriers and enablers can serve as 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 the effectiveness of the intervention. Additionally, tailoring messages to accommodate multiple mobile phones within a family is crucial for ensuring optimal reach and impact.

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Abbreviations

CHW	Community Health Workers
ETB	Ethiopian Birr
HEW	Health Extension Workers
IDI	In-depth Interview
IRB	Institute of Review Board
KII	Key Informant Interview
MCH	Maternal and Child Health
PHCU	Primary Health Care Unit
SMS	Short Message Service
TV	Television

Declarations

Ethics approval and consent to participate

Ethical approval was obtained from the Ethical Review Board of Jimma University. All study participants were given detailed information about the study, provided verbal consent before participation, and were willing to participate in the study. The information gathered was kept confidential and was only used for the agreed-upon purpose. Only the core research team has access to the data, which is stored on password-protected computers and laptops. At the time of data entry, each study participant's identity was delinked from their identification code.

Consent for publication

Not applicable

Data availability

Not applicable

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Competing interests

The authors declare that there are no competing interests.

Authors' contributions

GB contributed to the inception, design, analysis, and manuscript writing. HG was involved in the inception, design, and critical review of the manuscript. DA participated in the design and review of the manuscript. ZB was involved in the design process and critical review of the manuscript. The final manuscript was read and approved by all authors.

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Annex

Table 1: Characteristics of study participants, Jimma Zone, Ethiopia

Variables	Category	# (%)
Mean Age (n=26)		28±6
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 Yrs	4(28.6)
	> 5 Yrs	10(71.4)
Monthly Income (n=26)	<5000 ETB	12(46.2)
	>5000ETB	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 (n=6)	<20 Weeks	2(33.3)
	≥20 weeks	4(66.7)
ANC status (n=6)	Attended	4(66.7)
	Not attended	2(33.3)

727

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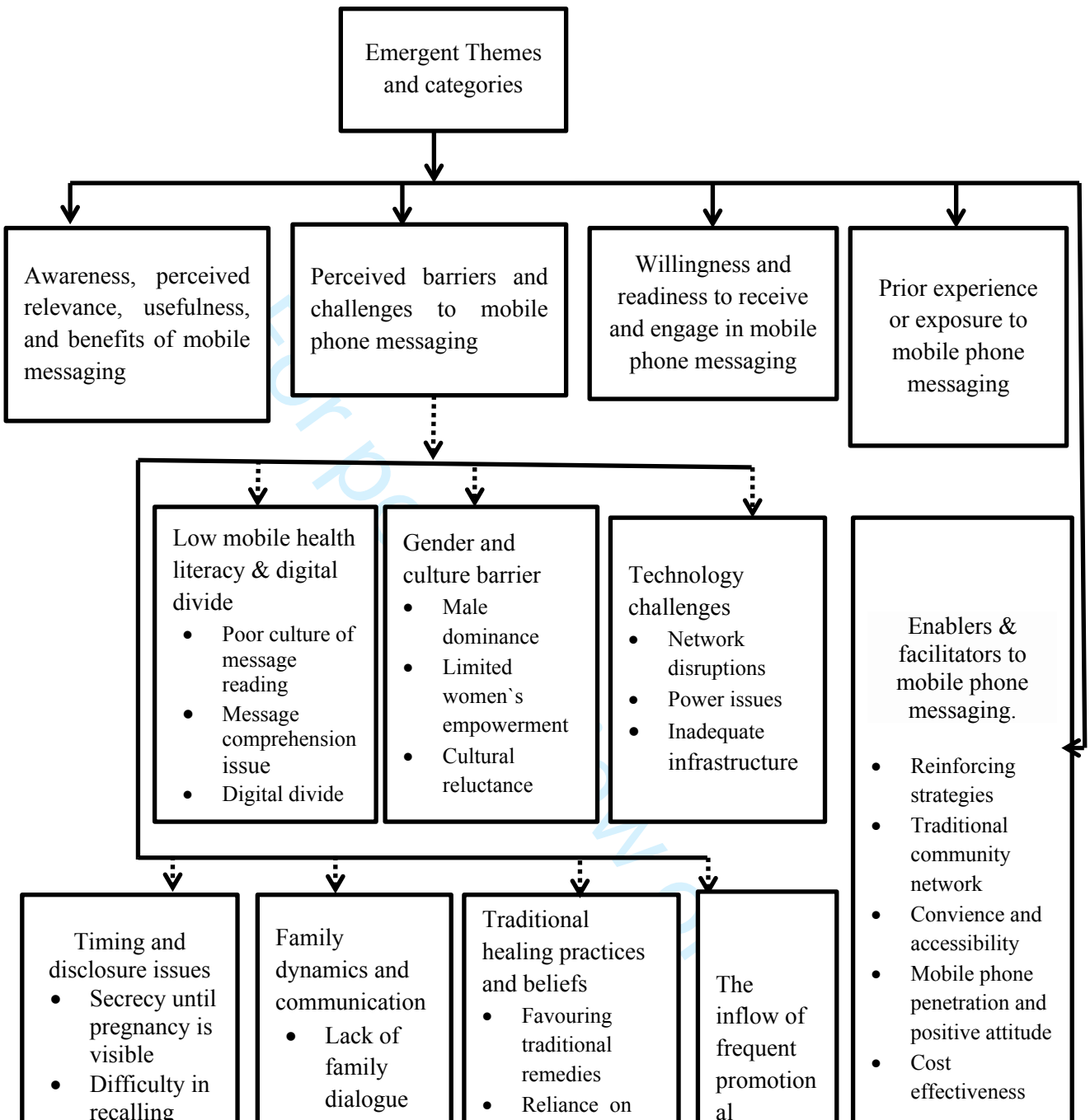

Figure 1. Emerged themes and categories in the study of barriers and enablers in implemnting mobile phone messaging based message framing intervention to improve maternal and newbor health

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Perceived Acceptability, Barriers, and Enablers in Implementing Mobile Phone Messaging-Based Message Framing Intervention for Improved Maternal and Newborn Care in Jimma Zone, Ethiopia: A Qualitative Study

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Perceived Acceptability, Barriers, and Enablers in Implementing Mobile Phone Messaging-Based Message Framing Intervention for Improved Maternal and 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 messaging-based 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 and key informant interviews.

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

Participants: We conducted 12 in-depth interviews and 14 key informant interviews 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 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 recognized 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 messaging interventions. The identified barriers were categorized as technological, social, cultural, behavioral and contextual. To maximize the impact of mobile health messaging and ensure broad and effective reach, it is crucial to address these barriers while leveraging existing enablers.

Trial registration: This study was conducted as part of a larger cluster randomized controlled trial at Clinical trials PACTR202201753436676, 4th January 2022.

Keywords: mHealth, Ethiopia, mobile phone messaging, perceived acceptability, barriers and facilitators

Strengths and Limitations of this Study

- This study provides detailed insights into the barriers and enablers of mobile phone messaging interventions in a rural Ethiopian setting.
- The use of in-depth and key informant interviews allowed for the inclusion of diverse perspectives from stakeholders, including both experienced and less-informed participants.
- The findings may have limited applicability to settings with different socio-cultural and technological contexts.
- The qualitative nature of the study makes it difficult to quantitatively assess the magnitude of the identified barriers and enablers.

Background

Maternal and newborn health is a critical global public health concern, with a key priority being the reduction of maternal mortality [1,2]. Despite some progress in recent years in reducing maternal and neonatal mortality rates, siginificant 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 100,000 live births, while neonatal mortality is around 29 per 1,000 live births. Rural areas are disproportionately affected due to poor access to healthcare and suboptimal health-seeking behaviors [3–5].

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 behaviors, and enhance communication between healthcare providers and patients [3,6–10].

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 utilization [9,11,12]. 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 [13].

The increasing penetration of mobile phones allows mHealth interventions to close the access gaps in health care, mainly in rural areas where health services may not be readily available [14]. However, several challenges may hinder the successful implementation of mHealth

interventions, including low literacy rates, poor network coverage, technical difficulties [9,15,16], poor access to mobile phones [17], unreliable message delivery [17,18], message delays [19], low smartphone penetration [20], affordability constraints [18,21], unreliable electricity access [22,23], and cultural barriers [24].

Despite these barriers, enablers such as interactive messaging, which enhances two way communuication [25], engagement of community health workers, who provide personalized support and followup [26], and tailored content, that aligns with local languages and cultural contexts [27].These would help in improving user engagement, understanding, and compliance with the recommended maternal health practices, and therefore 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`s regarding such interventions [28,29]. Moreover, there is a gap in the literature on the relative effectiveness of different message-framing techniques, such as gain- and loss-framed messaging, in influencing maternal health behaviors [30]. 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 programs also need to be explored [31]. 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 finding have informed the design and implementation of the cluster randomized controlled trial (cRCT).

Method and materials

The study has followed the SRQR checklist for reporting, which ensures transparency and consistency in the study(Supplementary file 1). A three-arm cluster-randomized trial (cRCT) was conducted in 21 health posts in Jimma Zone, Ethiopia, to assess the effectiveness of a mobile phone messaging-based message framing intervention in improving maternal and newborn health service utilization. The study randomly assigned 588 pregnant women (16–20 weeks gestation) to the gain-framed arm (emphasizing benefits), loss-framed arm (emphasizing risks), and control arm (no SMS). The intervention was implemented from May to December 2023. Primary outcomes included maternal service utilization and newborn care practices, while secondary outcomes encompassed knowledge, self-efficacy, and adherence to iron supplementation. A qualitative component involved 12 indept 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 [32] and was registered on January 4, 2022, with Clinical Trials under the identifier PACTR202201753436676, available 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 districts had a total population of 624,534, including 21,671 pregnant women. This study was conducted between March 5 and March 20, 2023. Study sites were selected purposively to ensure a representation of characteristics 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 into the perceived acceptability and contextual factors influencing the interventions. Thematic analysis was used to explore participants' perceptions within a qualitative paradigm. A constructivist stance recognized knowledge as being co-constructed between the researcher and participants, while a descriptive qualitative design provided insights into perceive 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. 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 randomization to minimize selection bias.

The qualitative component involved purposive sampling of In-depth Interviews (IDIs) and Key Informant Interviews (KIIs) within the intervention target areas. Participants were selected based on their relevance to the study`s objectives. Key informants with more than one year of work experience were included. The selection of Ethio-Telecom were based on their involvement in mobile health implementation, experience with networking and mobile messaging systems, and at least one year of work experience in the sector. IDI participants were selected based on their experience with MCH service utilization 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 yield 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.

Ethics approval and informed consent

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 organization, participant identities 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.

Data collection methods and procedures

Data were gathered through in-depth interviews (IDIs) and key informant interviews (KIIs) with various stakeholders, including pregnant women, male partners, Health Extension Workers, midwives, PHCU directors, MCH focal persons, and Ethio-Telecom experts, between March 5 and March 20, 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 contextualized the issue under study.

Before data collection begun, 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 to 60 minutes and were recorded using a digital voice recorder, complemented by note-taking during the sessions.

In-depth interviews with pregnant women and male partners

In-depth interviews 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 with maternal and newborn services and their utilization 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.

Key informant interviews with health workers and ethio-telecom experts

To triangulate the findings of the indepth interviews (IDIs), 14 key informants were purposively selected and interviewed. The key informants included a diverse group of healthcare providers including health extension workers, midwives, PHCU 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 key informant interviews (KIIs) were conducted by well-trained qualitative researchers. Data collectors were responsible for conducting and transcribing the 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 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 in-depth interviews and 14 for key informant interviews. 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. Key informants 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).

Table 1. Summary of Participant Recruitment by Urban-Rural Distribution, Study Arms, and Participant Groups

Participant Group	**Urban**	**Rural**	**Study Arms**			**Total Participants (n=26)**
In-Depth Interviews (n=12)			Gain-framed	Loss-framed	Control	
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
PHCU Directors	1	1	1	1		2
MCH 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 analyzed 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 familiarized themselves with the content by reviewing and analyzing the transcripts, generating initial codes, and refining them as new codes emerged. ATLAS.ti 7.1 software was used to manage and organize the data by grouping the codes into larger categories and sub-themes. The sub-themes were further reviewed to identify overarching themes that accurately captured the barriers, and enablers of mobile phone messaging-based message framing interventions for maternal and newborn health in the Jimma Zone, Ethiopia. A multi-stage 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 member-checking, where participants were invited to review and confirm whether their views were being accurately represented. Additionally, peer debriefing was utilized 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 behavioral 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 finding of the study. Although the researchers were not previously involved in maternal and child health programs 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 two 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.

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 in-depth interviews (IDIs) and key informant interviews (KIIs). Additionally, the generalizability 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 in-depth and key informant interviews. 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 key informants had over five years of experience (see Table 2).

Emergent themes and categories

The results are organized 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 & facilitators of mobile phone messaging (Fig. 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, personalized 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, emphasized its direct applicability to their health needs, such as reminders for antenatal visits and tailored advice. Male participants often described mobile health interventions in terms of supporting household decision-making. Similarly, key informants (KI) provided more technical insights about the feasibility and implementation of mobile messaging, while in-depth interview (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 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 behavior. This, in turn, can result in favorable 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, and television. In such situations, mobile phone-based 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."*

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 programs, 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 mobile health (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 five 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 messages among family members and support pregnant women according to suggestions from 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: 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: 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 categorized 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 (e.g., 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 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 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 with the overwhelming volume of messages they receive 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 strategies can support the implementation of mobile

phone messaging-based interventions, enabling mothers to put into practice what they have learned 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 phone-based 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 phone-based messaging interventions, except for indirect costs such as traveling 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 [9,33]. 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. (2021) and Gebremariam et al. (2020), who highlighted the acceptability, barriers, and facilitators of mobile text message reminders for child vaccination and infant feeding education [34,35].

The majority of the study participants had limited experience with mobile phone messaging intervention. Similarly, a study conducted by Alsahli et al., (2023), showed that for many people, adopting mobile messaging for health purposes is a quite new concept—especially in low-resource settings [36].

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. (2021), underlining the acceptability, barriers, and facilitators of mobile text message reminder systems for child vaccination [34],), and a study by Walle et al. (2023), which presents healthcare professionals' intention to adopt mobile phone-based SMS for adherence support and TB care [37]. 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 [38]. In our study area, one of the studies carried out as part of a large cRCT by Abdissa et al. (2024) showed that 69.5% of women owned feature phones [39]. Given the low level of mobile phone access among households, and especially among women, adding

other social and behavior change mechanisms will be important to maximize impact. Community-based approaches, including involving health extension workers, community volunteers, religious leaders, and women's groups, can help reinforce key maternal health messages. Strengthening ANC counseling, peer support groups, and male involvement could further complement mobile-based interventions for broader maternal health behavior change.

In this study, conventional sources of information such as community health workers, community meetings, and local media outlets remain crucial, but text messaging through mobile phones was rarely reported. These findings align with studies conducted by Materia et al. (2023) and Feroz et al. (2020) [40,41].

The current study identified various barriers to mobile phone messaging-based message framing interventions. One major barrier is low mobile health literacy, which is notably pronounced among rural women. Similarly, a study by Warner et al. (2023) in Ethiopia, where mobile phone penetration is increasing but digital literacy remains low, found that mHealth literacy is a critical barrier [38]. There were disparities in mobile phone availability and usage between urban and rural areas within the study areas. Similarly, across Ethiopia, Kenya, Bangladesh, and Nigeria, urban areas consistently have higher mobile phone availability and usage compared to rural areas. Rural populations, particularly women, face barriers such as poor infrastructure, low income, limited education, and cultural restrictions. There were disparities in mobile phone availability and usage between urban and rural areas within the study areas. Similarly, across Ethiopia, Kenya, Bangladesh, and Nigeria, urban areas consistently have higher mobile phone availability and usage compared to rural areas. Rural populations, particularly women, face barriers such as poor infrastructure, low income, limited education, and cultural restrictions [42].

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 (2017) in Sub-Saharan Africa [43]. 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. (2023), which emphasizes the universal importance of reliable network connectivity and alternative power sources for sustaining effective mobile health interventions [44].

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. (2021), which pointed out similar challenges in message engagement and dissemination within families [45].

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 (2022), Kingdon et al. (2018), Goldberg and El-Sayed (2017), and Majola et al. (2021), which highlight similar challenges in delaying pregnancy disclosure and estimating gestational age [46–49]. 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. (2022) found that continuous exposure to promotional content raises consumer skepticism, making individuals question the authenticity and motives of health messages, leading to decision fatigue and hindering individuals from prioritizing and acting on health recommendations[50]. 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. (2020) found success in using community health workers (CHWs) as intermediaries for mobile health messages due to their embedded trust and community presence, enabling effective health communication [51].

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 (2019), which found that high mobile phone penetration and positive attitudes increase the effectiveness of interventions [52]. Traditional community networking, such as idirs, ikubs (Ethiopian social institutions for mutual support and savings), and other social groups, was another facilitator of mobile phone-based 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 to mothers. Similarly, a study by Mengesha et al. (2023) in rural Ethiopia showed the positive influence of traditional community networks in a mobile health intervention [53].

This study had some limitations. First, it is context-bound, so the generalization 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. Lastly, the limited mobile phone ownership and digital literacy among rural women might have influenced the depth of the insights obtained on mobile 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 improving maternal and newborn health, perceiving it as a relevant and useful tool for enhancing health knowledge, care-seeking behaviors, 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, technology-related issues, preference for traditional healing practices, urban-rural disparities in mobile phone access, and male dominance in resource control, all of which could 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 toward mobile-based interventions can support the success of mobile messaging interventions. To maximize the impact of mobile phone messaging, stakeholders must ensure cultural sensitivity, address 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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Abbreviations

CHW	Community Health Workers
ETB	Ethiopian Birr
HEW	Health Extension Workers
IDI	In-depth Interview
IRB	Institute of Review Board
KII	Key Informant Interview
MCH	Maternal and Child Health
MMS	Multimedia Messaging Services
PHCU	Primary Health Care Unit
SMS	Short Message Service
TV	Television
5G	Fifth Generation

Declarations

Consent for publication

Not applicable

Data availability

Not applicable

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Conflicts of interests

The authors declare that there are no competing interests.

Authors' contributions

GB contributed to the inception, design, analysis, and manuscript writing. HG was involved in the inception, design, and critical review of the manuscript. DA participated in the design and review of the manuscript. ZB was involved in the design process and critical review of the manuscript. The final manuscript was read and approved by all authors. GB is the guarantor of the research and is entirely responsible for the overall content, ensuring that all parts of the research are correct and properly explored.

Figure Legend:

Fig. 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.

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855

Annex

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 Yrs	4(28.6)
	> 5 Yrs	10(71.4)
Monthly Income (n=26)	<5000 ETB	12(46.2)
	>5000ETB	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 (n=6)	<20 Weeks	2(33.3)
	≥20 weeks	4(66.7)
ANC status (n=6)	Attended	4(66.7)
	Not attended	2(33.3)

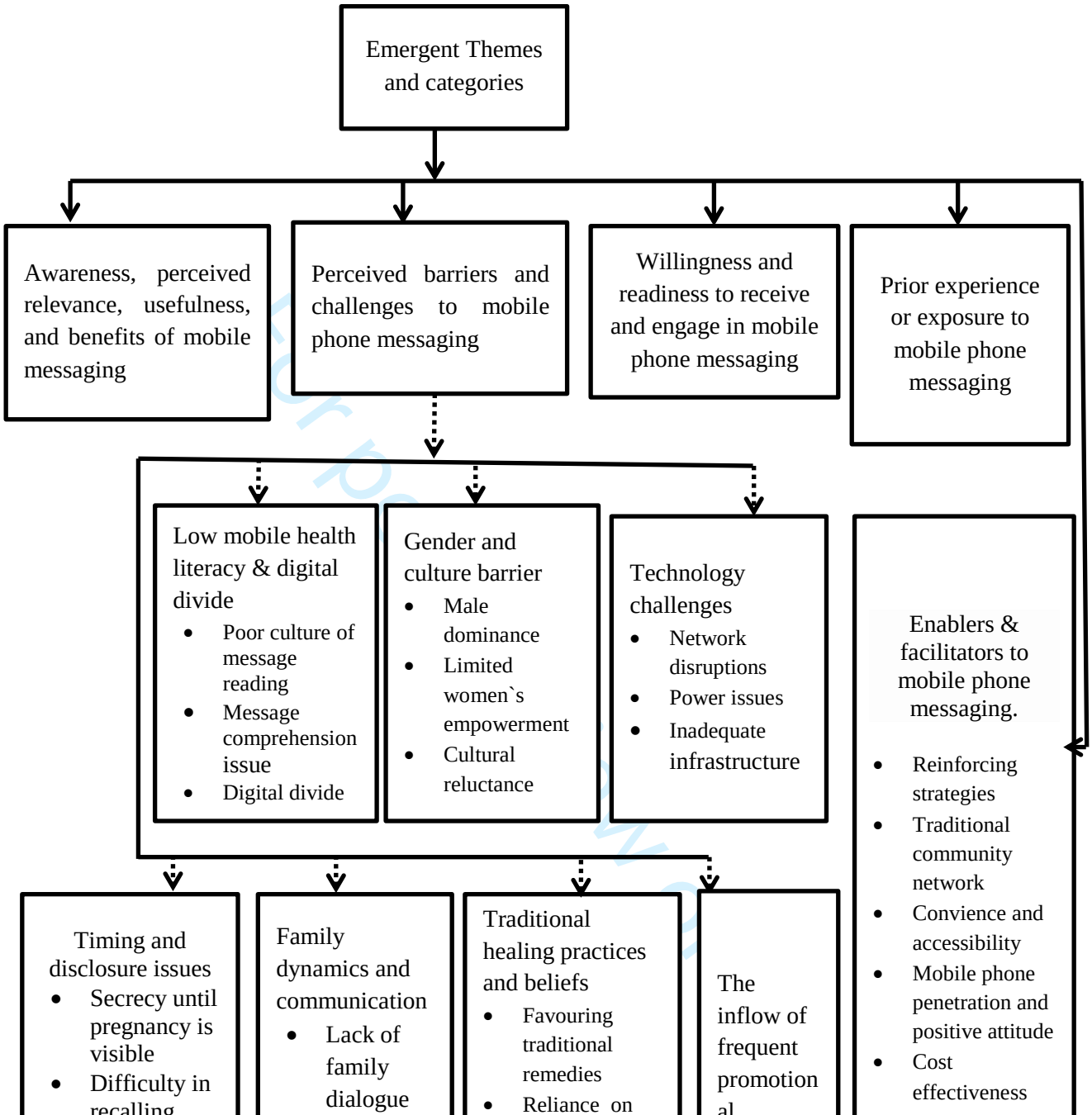

Figure 1. Emerged themes and categories in the study of barriers and enablers in implemnting mobile phone messaging based message framing intervention to improve maternal and newborn health

Reporting checklist for qualitative study.

Based on the SRQR guidelines for the Article:

Perceived Acceptability, Barriers, and Enablers in Implementing Mobile Phone Messaging-Based Message Framing Intervention for Improved Maternal and Newborn Care in Jimma Zone, Ethiopia

		Reporting Item	Page Number
	#1	Concise description of the nature and topic of the study identifying the study as qualitative or indicating the approach (e.g. ethnography, grounded theory) or data collection methods (e.g. interview, focus group) is recommended	1,2
	#2	Summary of the key elements of the study using the abstract format of the intended publication; typically includes background, purpose, methods, results and conclusions	2
Problem formulation	#3	Description and significance of the problem / phenomenon studied: review of relevant theory and empirical work; problem statement	4,5
Purpose or research question	#4	Purpose of the study and specific objectives or questions	2,5
Qualitative approach and research paradigm	#5	Qualitative approach and guiding theory if appropriate; identifying the research paradigm is also recommended; rationale. The rationale should briefly discuss the justification for choosing that theory, approach, method or technique rather than other options available; the assumptions and limitations implicit in those choices and how those choices influence study conclusions and transferability. As appropriate the rationale for several items might be discussed together.	2,7
Researcher characteristics and reflexivity	#6	Researchers' characteristics that may influence the research, including personal attributes, qualifications / experience, relationship with participants, assumptions and / or presuppositions; potential or actual interaction between researchers' characteristics and the research questions, approach, methods, results and / or transferability	11,12
Context	#7	Setting / site and salient contextual factors; rationale	6
Sampling strategy	#8	How and why research participants, documents, or events were selected; criteria for deciding when no further sampling was necessary (e.g. sampling saturation); rationale	7-10
Ethical issues pertaining to	#9	Documentation of approval by an appropriate ethics review board and participant	8

human subjects		consent, or explanation for lack thereof; other confidentiality and data security issues	
Data collection methods	#10	Types of data collected; details of data collection procedures including (as appropriate) start and stop dates of data collection and analysis, iterative process, triangulation of sources / methods, and modification of procedures in response to evolving study findings; rationale	8-10
Data collection instruments and technologies	#11	Description of instruments (e.g. interview guides, questionnaires) and devices (e.g. audio recorders) used for data collection; if / how the instruments(s) changed over the course of the study	9,10
Units of study	#12	Number and relevant characteristics of participants, documents, or events included in the study; level of participation (could be reported in results)	7,9,10
Data processing	#13	Methods for processing data prior to and during analysis, including transcription, data entry, data management and security, verification of data integrity, data coding, and anonymisation / deidentification of excerpts	11
Data analysis	#14	Process by which inferences, themes, etc. were identified and developed, including the researchers involved in data analysis; usually references a specific paradigm or approach; rationale	11,12
Techniques to enhance trustworthiness	#15	Techniques to enhance trustworthiness and credibility of data analysis (e.g. member checking, audit trail, triangulation); rationale	11
Syntheses and interpretation	#16	Main findings (e.g. interpretations, inferences, and themes); might include development of a theory or model, or integration with prior research or theory	14-21
Links to empirical data	#17	Evidence (e.g. quotes, field notes, text excerpts, photographs) to substantiate analytic findings	15-21
Intergration with prior work, implications, transferability and contribution(s) to the field	#18	Short summary of main findings; explanation of how findings and conclusions connect to, support, elaborate on, or challenge conclusions of earlier scholarship; discussion of scope of application / generalizability; identification of unique contributions(s) to scholarship in a discipline or field	2, 26,27
Limitations	#19	Trustworthiness and limitations of findings	3, 25
Conflicts of interest	#20	Potential sources of influence of perceived influence on study conduct and conclusions; how these were managed	28
Funding	#21	Sources of funding and other support; role of funders in data collection, interpretation and reporting – no funding	28