Development and testing of mobile phone text messages for improving maternal and newborn care practice in Jimma Zone, Ethiopia: a user-centered design approach

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Abstract

Background Mobile phone-based messaging for maternal education has indicated promising outcomes in promoting maternal and newborn care practices. However, most mobile phone-based messaging interventions are not tested before their implementation, and the evidence on the message content development process and methods is limited and underreported. The aim of this study was to develop and test text messages for interventions designed to improve maternal services utilization and newborn care practices.

Methods The development process has 4 phases: engaging pregnant mothers and experts in selected districts of the Jimma Zone, Ethiopia. During phase 1, the draft messages were developed based on the message framing concept, and the number of messages was reduced after review. In phase 2, 12 mothers participated in card sorting and the messages were refined. In phase 3, 8 experts evaluated the messages using 10 items with a 5-point Likert scale. In phase 4, a pilot study ($n = 30$) was conducted to evaluate the messages and their delivery when they were sent to individuals' mobile telephones. In this phase, a system usability scale was also used to assess the usability of the planned intervention.

Results An initial bank of 120 messages was developed, 42 of which were discarded during the development process. Of these, 32 were discarded by the research team at phase 1, and 10 were discarded during the card sorting at phase 2. Based on the experts' evaluations, 14 messages were reworded and refined in phase 3. During the pilot testing phase, the majority (80%) of the participants mentioned that the time they had been receiving the message was early, and 66.7% of the participants preferred the time to receive text messages about health. The mean SUS score was 72.26, which is acceptable for the usability of the mobile phone-based messaging intervention.

Conclusion A final bank of 78 (39 for each framing type) messages was obtained after refinement according to feedback from participants. The SUS showed an acceptable score for the planned intervention. This message development process confirms that the messages are acceptable, and important for improving maternal and newborn health care practices.

Trial registration PACTR202201753436676.

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Key messages

• What uncertainties existed regarding the feasibility?

Although it is recommended to document the development process of mobile phone messaging-based intervention, this part of interventions is limited and underreported in literature. In addition to this, from published mobile phone messaging-based intervention that described about development process, some lack detail information and other focused only on software development process.

• What are the key feasibility findings?

In this message development process, end users (pregnant mothers) and experts were involved for their perspective on the draft messages and a total of 78 final messages were obtained through refinement based on their feedback. The usability test finding has confirmed acceptability of the intervention. End-users' preference such as frequency, timing and language for receiving text messages were identified.

• What are the implications of the feasibility findings for the design of the main study?

End-user and expert involvement in this development process believed to facilitate the feasibility, acceptability, and engagement in the future intervention. Finding at in each phase of the development process has helped modifying messages content and messaging system used for the main intervention. Finding on end-user time and frequency preferences to receive text messages has also informed the revision of the message scheduling of main intervention.

Keywords Maternal health, Newborn care, Text message, Development process, User-centered design

Background

Every day, an estimated 800 women die due to preventable causes related to pregnancy and childbirth, and 6500 newborns die mainly due to complication of premature birth, birth asphyxia and infections. Additionally, 94% of all maternal and neonatal deaths occur in low- and middle-income countries [1–3]. Maternal and newborn deaths occur mainly from preventable causes, such as infectious diseases and complications during pregnancy, labor, childbirth, and the postpartum period [4]. Despite the government's commitment to improving maternal and newborn health [5], Ethiopia's maternal mortality ratio is 267 deaths per 100,000 live births and its neonatal mortality rate is 27 deaths per 1000 live births [2, 6]. These figures put Ethiopia among the top countries in terms of maternal and neonatal mortality rates [3]. Providing education to mothers during the antenatal and postnatal periods has effectively improved maternal and neonatal health service utilization and newborn care practices [7] and reduced overall neonatal mortality [8].

Introducing new strategies such as mHealth is accepted as a suitable means for reducing high maternal and child death rates in low-income nations [9, 10]. From mHealth technology, short message service (SMS) is an acceptable and widely used tool for educating mothers to promote antenatal delivery, newborn care, and postnatal care utilization [11, 12]. SMS-based intervention has been successfully implemented and has indicated promising outcomes in promoting maternal and child health care services [13–16] due to its greater readership and greater engagement advantage over other means of communication [17], providing short, timely information for behavior change [18]. Text message-based interventions should incorporate how the message is developed on its theoretical basis, cultural adaptation to the end user, and context before it is implemented [19, 20] for utility [21, 22].

Although it is recommended to start documenting the development of any mHealth-based intervention planned to promote behavior changes during the early stages of the protocol [23], evidence of the content development process and testing methods are limited and underreported in the literature [20, 24]. Among the published text messaging interventions that describe development and testing processes, some lack detailed information about the process [20, 25], and others focus on the messaging system development process, ignoring the message content [26].

For a successful SMS-based intervention, the target audience should provide feedback on the message content and learn the language preferences, timing, and number of text messages they receive [13, 27]. End-user involvement in the mHealth intervention development process facilitates the feasibility, acceptability, and engagement of the intervention [28]. In addition, health workers' expectations and readiness to implement the suggested interventions when developing digital interventions are needed [29]. The perspectives of these end users and implementers can be addressed by applying a user-centered design approach [30]. User-centered design is a multidisciplinary and iterative design approach based

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on the active involvement of users in each phase of the design process to improve the understanding of users and requirements [31]. This approach uses methods such as focus group discussion, survey, interview, usability testing, card sorting, and participatory design. However, there is inconsistency in the utilization of these methods; for example, some researchers have used card sorting with end users [30, 32, 33], others have used expert evaluation [24, 30, 34–36], while focus group discussion [24, 36, 37] and pilot with members of the end user [30, 38, 39] have been used by some of the researchers. Moreover, to our knowledge, none of the mHealth interventions conducted in Ethiopia reported the development and testing of message content tailored to the local context.

Considering the variation in the methods used and the limited literature on the design and development of mobile phone-based messaging interventions for improving maternal and newborn health in rural areas of Ethiopia, this study presents the development and testing process by integrating different methods previously used. The message content was drafted based on the concept of framing. Framing is the way information is presented to individuals by emphasizing the benefits of taking action (i.e., a gain-framed) or the costs of failing to take action (i.e., a loss-framed message) to influence subsequent decisions of individuals [40]. However, to the best of our knowledge, mHealth interventions that are implemented in Ethiopia has not used and evaluated the effect of message framing approach on promote maternal and newborn health. Hence, the current development process was carried out by integrating user-centered design approach methods: card sorting, interviews, pilot testing, system usability testing and expert review. In addition to adding the mobile phone-based messaging intervention development process to the body of knowledge, this study provides recommendations and lessons learned from the process for similar interventions targeting pregnant mothers.

Method
Overview
This text message development and testing is part of a cluster randomized control trial (the trial identifier is PACTR202201753436676). This trial examines the effectiveness of a mobile phone messaging-based message framing intervention designed for improving maternal and newborn health in the Jimma Zone, Oromia, Ethiopia. This paper explains the development process of text messages targeting pregnant mothers for improving maternal and newborn health outcomes. The development of the messages involved four phases: research team feedback, user center design techniques

(card sorting, interviews, and survey), expert review, and pilot testing(Fig. 1).

Phase I: message drafting
The initial messages concerning different issues were drafted based on what pregnant women should be counseled during pregnancy and childbirth and after according to the Ethiopian Ministry of Health guidelines for antenatal care [41] and the World Health Organization (WHO) antenatal and postnatal care guidelines [42]. These messages were developed based on the concept of message framing, where half of them developed in the form of a gain frame—emphasizing the benefit of maternal and newborn health care practices—and the other half developed as a loss frame—emphasizing loss as a result of not utilizing maternal health services and practicing newborn care. Since the maximum number of characters allowed for text messages is limited to 160, including spaces, the content of the messages was developed within that character count. The draft messages were reviewed by other research teams, and the number of messages was reduced. Once a decision was made on the number and which messages should be included in the next phase, the messages were translated from English into the local language Afan Oromoo by maternal and child health experts and back-translated to English by a language expert who is fluent both in English and Afan Oromoo.

Phase II: end-user content testing
In this phase, a closed-card sorting activity was carried out to determine the level at which the pregnant mothers understood each message. The card sorting activity was conducted with pregnant mothers who had been residents of the study area for at least 6 months and who could speak and read the Afan Oromoo. Twelve (6 for each message type) pregnant mothers who were selected using a convenient sampling technique participated in this activity. Participants were provided with cards that had Afan Oromoo version messages selected in phase one and then asked to sort the messages into predefined piles named with different topic areas related to maternal and newborn health. The participants were also provided with a blank card if they had any suggestions to add more messages.

The card sorting data were entered into an adapted Excel spreadsheet template that was developed for analyzing the cards [43]. The analysis was performed to evaluate the card-level agreement of the original thematic area. The messages on the cards were considered for the next phase if ≥50% of participants had sorted the card into the intended thematic area.

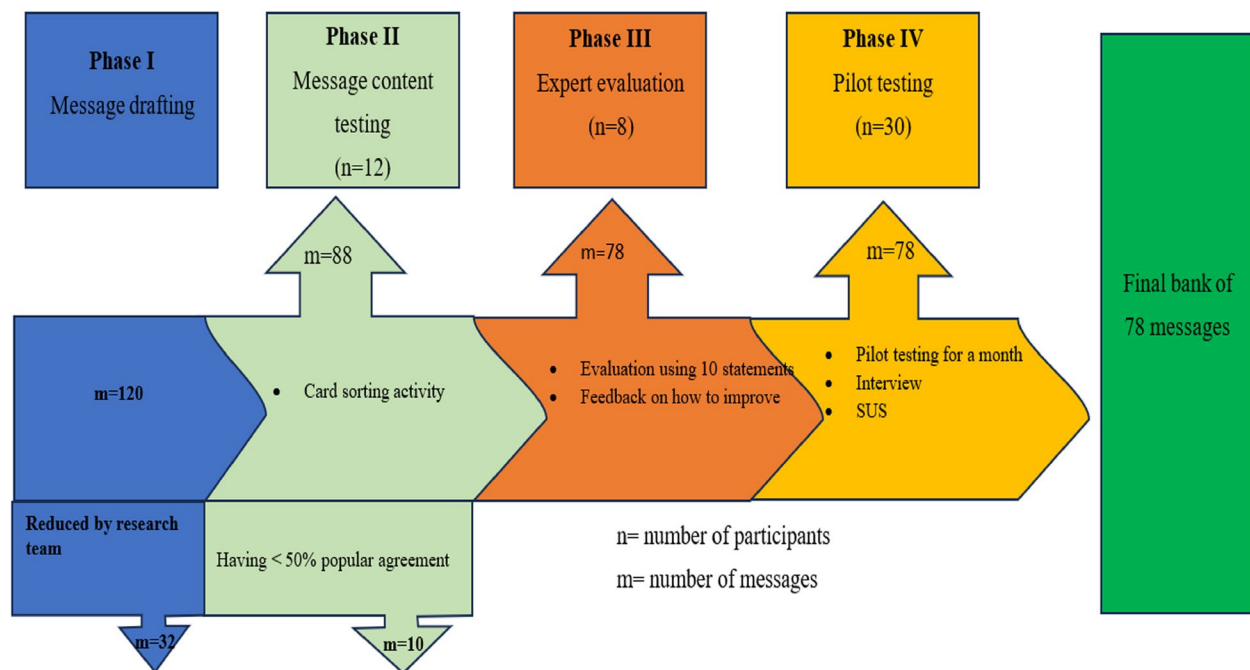Abdissa *et al. Pilot and Feasibility Studies* (2025) 11:46

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Fig. 1 Phases and methods of the message development process for Mobile phone messaging-based intervention for improving maternal and newborn health in Jimma Zone, Ethiopia

Phase III: expert evaluation

Health communication experts and health workers who are providing maternal and newborn health services evaluated the message content for clarity, ease, tone, believability, benefit, receiving attention, appropriate language and offensiveness. A total of 8 (4 for each message form) experts who were working in the study area for at least 6 months before this evaluation and who could speak and read the Afan Oromoo were purposively selected and took part in this evaluation. The evaluation was performed online using a Google form link shared with the participants through their email. The participants were provided with all the messages selected in phase II and asked to rate each message using 10 five-point Likert scale items that were developed based on the criteria for reviewing health communication messages [38]. The response of each expert to the messages was entered into SPSS 25. A total sum score was created for each message by combining scores for all 10 questions, ranging from 10 to 50. Messages with an average sum score ≥ 33.3 and suggested to be selected with original content or modification were considered in the next phase. Messages with an average sum score lower than 33.3 were considered for discarding with the option for revisions based on participant feedback. Following this rating, the experts were asked for their recommendation on whether to use, discard, or modify the message and why they recommend removing it or modifying it. Then, they were asked to

suggest how to improve the message that was recommended to be removed or modified. The messages evaluated in this phase were refined and incorporated into the developed message dispatching platform for the next phase of testing.

Phase IV: pilot testing

In this phase, the messages and their delivery were evaluated when the messages were sent to individual mobile telephone devices. The messages were dispatched using software that was locally developed by software programmers based on input from the research team. This software works in combination with the internet, a computer, and a phone to send messages to multiple phone numbers. A domain and short code were purchased from Ethiotelcom Company, and the short code was named "Ulfa Mijuu". The software program has an interface to enter the participant's name, gestational week, mobile phone number, message type (loss or gain frame), message category, language option, report generation and feedback options. Before carrying out the pilot study, the software underwent unit testing in eight key dimensions: message functionality, contact management, security, user interface, connectivity, performance, integration, and compatibility. The testing confirmed the software's reliability, effectiveness, versatility, and dependable messaging capabilities under various network conditions. However, multiple mobile management, language, report

generation, and feedback options were incorporated following the testing.

Thirty pregnant mothers who voluntarily provided their mobile phone numbers to take part and give feedback in the pilot test were selected. Fifteen participants were randomly assigned to the gain frame messages, and the other 15 were assigned to the loss frame messages. Twenty messages were sent sequentially in the morning every day during the weekday for a month. The research team had been calling the participants every other day to ask them what they were experiencing with receiving messages, give feedback on the message content, and encourage them to engage and minimize dropout during the pilot testing. At the end of the pilot test, all of the participants were interviewed using a questionnaire that addressed the timing, preferred language and timing of receiving messages; clarity, and understandability; and length of the message. Participants were also asked to rate the usability of the planned mobile phone-based messaging intervention using the adapted System Usability Scale (SUS). The SUS tool consists of 10 statements that are scored on a 5-point Likert scale (1 = strongly disagree and 5 = strongly agree) [44]. SPSS 25 was used for entering, and descriptive analyses, such as frequency, mean, standard deviation, and percent analysis, were performed. The participants' scores for each statement of the SUS were added together and then multiplied by 2 to convert the original scores from 5–50 to 10–100. Scores for the SUS range from 10 to 100.

Results

Phase I: message drafting

HG and GB wrote the initial 120 messages to provide one-way information about maternal and newborn care during pregnancy to the postnatal period based on the topic area that pregnant women should be counseled according to the Ethiopian Ministry of Health guidelines for antenatal care [41] and World Health Organization (WHO) antenatal and postnatal care guidelines [42]. The messages were developed under 10 thematic areas, namely, nutrition, lifestyle modification, danger signs, birth preparedness and complication readiness, breastfeeding practice, labor, newborn care, immunization, and antenatal and postnatal care utilization. Following the initial development, the research team reviewed the messages, discussed the negative effect of dispatching 120 messages during the pregnancy period and reduced the number of messages to 88 (44 for each message type) by removing a minimum of one message from each thematic area and merging the content of some messages. Example draft messages under each thematic area are presented in Table 1.

Phase II: end-user content testing

Based on the predetermined criteria for card sorting activity, 39/44 (88.6%) of the cards of gain-framed messages had ≥ 50% placement in the corresponding category. Of these cards, except for card number 44 (content is about nutrition during postnatal care), which was placed in the breastfeeding category, all of them were placed in the originally set corresponding thematic area. Card numbers 6, 11, 15, 21, and 32 were not categorized by the majority of participants and were placed in many categories. Hence, those 39 messages with ≥ 50% card-level agreement with the original category were considered in the next phase (Table 2).

In addition, 39/44 (88.6%) of the cards in the loss-framed messages had ≥ 50% placement in the original corresponding category. Except for cards numbers 7 and 9, which were placed under nutrition while supposed to be placed under the lifestyle modification category, all of these cards were placed in the original corresponding category. Similarly, in the gain-framed message type, card numbers 6, 11, 15, 21, and 32 of the loss-framed messages were not categorized in any preset categories by the majority of participants. Hence, those 39 loss-framed messages with a card-level agreement ≥ 50% in the corresponding category were considered to be in the next phase for expert review (Table 3).

Phase III: expert evaluation

According to our expert review, 39 (100%) gain-framed messages received an average sum score > 33.3. None of the participants suggested discarding these messages, and only one message about personal hygiene was suggested to be modified; 38/39 messages were suggested to be used with the original content by all of the participants. Regarding the loss-framed message type, 37/39 (94.8%) of the messages received an average sum score > 33.3. Messages about coffee consumption and extra meals during pregnancy had average summed scores of 27.4 and 29.4, respectively. From all loss-framed messages, it was suggested that three messages be discarded by only one participant, while 11 of them were suggested for modification. All of the loss-framed messages were suggested to be used with original content by at least 50% of the participants, while 26/39 (66.6%) of the messages were suggested to be used with the original concept by four of the participants. Comparing the evaluations of the experts among the message types, gain-framed messages have a higher average sum than loss-framed messages with equivalent meanings. One-third of the loss-framed messages were suggested to be modified, three were suggested for discarding, one was suggested for modification, and no message was suggested for discarding from

Table 1 Example draft messages from each category for gain and loss framed messages

Message category	Gain framed messages	Loss framed messages
Antenatal care schedule	For normal pregnancy, experts recommend 8 antenatal contacts. If you follow recommended and regular antenatal care visits, you and your baby will be best protected	For normal pregnancy, experts recommend 8 antenatal contacts. If you do not follow recommended and regular, antenatal care visits, you and your baby will not be best protected
Nutrition	Eating a balanced diet with high of whole grains, vegetables, fruits, low fat dairy, and lean protein to remains healthy and have a healthy baby	If you don't eat a balanced diet with high of whole grains, vegetables, fruits, low fat dairy, and lean protein, your chance of illness and having ill baby will increase,
Lifestyle modification	Avoiding unwashed vegetables and fruit, raw milk, processed/packed food for your health and your baby	Consuming unwashed vegetables and fruit, raw milk, processed/packed food can make you ill
Danger sign	If you contact health worker when you notice decreased or lost fetal movement, you can learn what is abnormal and get early treatment	If you don't contact health worker when you notice decreased or lost fetal movement, you cannot learn what is abnormal and do not get early treatment
Birth preparedness	By having 2 clothes ready to 1 to dry and 1 to wrap after birth, you will take advantage of keeping your baby warm so that he/she will be healthy	By failing to have 2 clothes ready to 1 to dry and 1 to wrap after birth, you won't take advantage of keeping your baby warm so that he/she will become ill
Breastfeeding practices	Choosing to put your new baby to the breast in the first hour he/she is born will in increases a baby's protection from many diseases and illnesses	Failing to put your new baby to the breast in the first hour he/she born will lowers a baby's protection from many diseases and illnesses
Newborn care	If you sponge the cord with clean water, leave it uncovered to dry and put nothing on it, you will prevent cord infection which make your baby very ill	If you don't sponge the cord with clean water, covered it and put anything on it, you will not prevent cord infection which make your baby very ill
Child immunization	By vaccinating your child according to a schedule, you will take advantage of your child protection against contracting many diseases	By not vaccinating your child according to a schedule, you will fail to protect your child against contracting many diseases
Laboring	Strong contractions and jelly like substance on underwear are a sign of labor. By going to health facility on time, you will have better pregnancy outcome	Strong contractions and jelly like substance on underwear are a sign of labor. Failing to go to health facility on time, may lead to bad pregnancy outcome
Postnatal care	One of the greatest advantages of going to health facility when there are severe headaches, blurred vision and high fever after child birth is saving oneself	One of the greatest disadvantages of not going to health facility when there are severe headaches, blurred vision and high fever after child birth is failing to saving oneself

Table 2 Average placement agreement and category per card for card sorting activity for gain-framed messages by pregnant mothers in the Jimma Zone, Ethiopia

Card title	Card no	Category											Category per card (n)
		NUT[a] %	Lifesty[b] %	DSign[c] %	BPCR[d] %	BF[e] %	NCare[f] %	Childl[g] %	Lab[h] %	PNC[i] %	AService[j] %	NC[k] %	
Balanced diet	3	100											1
Iron-folic acid supplement	5	100											1
Optimal maternal extra meal	14	83		17									2
Animal source feeding	18	86			14								2
Consumption of iodized salt	20	71	14				14						3
Alcohol consumption	4		67	33									2
Consuming raw meat	7	12	88										2
Consuming unwashed food	9	17	83										2
Avoid use of excess caffeine	12	17	83										2
Regular personal hygiene	16	29	71										2
Offensive discharge, severe headache, and fever	8			83					17				2
Decreased or loss of fetal movement	10			86				14					2
Blurred vision and vaginal bleeding	13		20	60	20								3
Sudden leaking of fluid per vagina	17			50	17				33				3
Labor, bridge presentation, and bleeding	22			67	33								2
Skilled attendance	19				86				14				2
Institutional delivery	23		14		57	29			0				3
Transportation	24				83				17				2
Preparing essential items for child-birth	25				60		20	20					3
Saving money	27		43		57								2
Early breast-feeding initiation	26					67	17					17	3
Feeding colostrum	28	14		14		71							3
Importance of breastfeeding	30	17				50	33						3
Exclusive breast feeding	31					100							1
PNC–nutrition	44					50	17			33			3
Cord care	34			9			73			18			3
Newborn danger sign 01	36						83					17	2
Skin to skin contact	38						100						1
Newborn danger sign 02	39			17			67	17					3
Baby bath	40						88					12	2
Importance of child immunization	29							86				14	2
Child Immunization-polio	33						17	66				17	3
Child Immunization-TB	35				17			83					2

Table 2 (continued)

Card title	Card no	Category											Category per card (n)
		NUT[a] %	Lifesty[b] %	DSign[c] %	BPCR[d]%	BF[e] %	NCare[f] %	Childl[g] %	Lab[h] %	PNC[i] %	AService[j] %	NC[k] %	
Laboring sign 01	37								83	17			2
Laboring sign 02	42								72	14		14	3
PNC—signs and symptoms- 01	41			14						86			2
PNC—signs and symptoms- 02	43									71		29	2
Adherence to ANC schedule	1							12			88		2
Adherence to PNC schedule	2									43	57		2
Calcium supplementation	6	17	17		17							50	4
Constipation	11		20							20		60	3
Preparing essential items	15					17		17	17		17	33	5
Physical activity	21					14		14		29		43	4
Designating a decision maker	32		14		14		14					57	4

[a] Nutrition

[b] Lifestyle modification

[c] Danger sign

[d] Birth preparedness and complication readiness

[e] Breastfeeding practice

[f] Newborn care

[g] Child immunization

[h] Laboring

[i] Postnatal care

[j] Adherence to service schedule

[k] Not categorized

Table 3 Average placement agreement and category per card for card sorting activity for loss-framed messages by pregnant mothers in the Jimma Zone, Ethiopia

Card title	Card no	Category											Category per card (n)
		NUT[a] %	Lifesty[b] %	DSign[c] %	BPCR[d] %	BF[e] %	NCare[f] %	Childl[g] %	Lab[h] %	PNC[i] %	AService[j] %	NC[k] %	
Balanced diet	3	100											1
Iron-folic acid supplement	5	100											1
Consuming raw meat	7	60	40										2
Consuming unwashed food	9	57	43										2
Optimal maternal extra meal	14	100											1
Animal source feeding	18	80		20									2
Consumption of iodized salt	20	86	14										2
Alcohol consumption	4		80	20									2
Avoid use of excess caffeine	12	25	75										2
Regular personal hygiene	16	14	86										2
Offensive discharge, severe headache	8		20	80									2
Decreased fetal movement	10			80	20								2
Blurred vision and vaginal bleeding	13			100									1
Sudden leaking of fluid per vagina	17			75	25								2
Labor, bridge presentation, and bleeding	22			83								17	2
Skilled attendance	19				100								1
Institutional delivery	23				86	14							2
Transportation	24				50				25	25			3
Preparing essential items for child-birth	25				67		17	17					3
Saving money	27			20	80								2
Early breast-feeding initiation	26					60	20					20	3
Feeding colostrum	28					83		17					2
Importance of breastfeeding	30	20				60	20						3
Exclusive breast feeding	31					86					14		2
Cord care	34						100						1
Newborn danger sign 01	36						80					20	2
Skin to skin contact	38					25	75						2
Newborn danger sign 02	39						100						1
Baby bath	40						86					14	2
Importance of child immunization	29						17	67				17	3
Child immunization-polio	33						20	80					2
Child immunization-TB	35							100					1
Laboring sign 01	37								100				1

Table 3 (continued)

Card title	Card no	Category											Category per card (n)
		NUT[a] %	Lifesty[b] %	DSign[c] %	BPCR[d] %	BF[e] %	NCare[f] %	Childl[g] %	Lab[h] %	PNC[i] %	AService[j] %	NC[k] %	
Laboring sign 02	42								86			14	2
PNC—signs and symptoms- 01	41								20	80			2
PNC—signs and symptoms- 02	43									100			1
PNC—Nutrition	44					40				60			2
Adherence to ANC schedule	1									0	100		1
Adherence to PNC schedule	2									43	57		2
Calcium supplementation	6	25										75	3
Constipation	11	17		17		17						50	4
Preparing essential items	15					25			25			50	3
Physical activity	21		20				20			20		40	4
Designating a decision maker	32			25				25				50	3

[a] Nutrition

[b] Lifestyle modification

[c] Danger sign

[d] Birth preparedness and complication readiness

[e] Breastfeeding practice

[f] Newborn care

[g] Child Immunization

[h] Laboring

[i] Postnatal care

[j] Adherence to service schedule

[k] Not categorized

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the gain-framed message type. An additional file shows the findings of expert reviews in more detail [see Additional file 1].

For messages that were suggested for modification, the experts were asked to recommend what should be changed and how it should be improved. The main recommendations they provided for improving these messages were to shorten the length of the messages (for which the translated version of the message is a little bit longer than the English version) and rewrite the messages using the dialects of the local community to make them more accepted. Considering the economic situation of the community while providing information about nutrition was also suggested. For instance, it was suggested that personal hygiene messages from both message types be modified by adding a phrase about what to use for hand washing when there is no soap in the household. One of the experts also suggested not using loss frame messages because they indicate bad outcomes that may annoy the mothers. Some terms that can be difficult for mothers to understand were also suggested to be replaced by other words with the same meaning. For instance, the Afan Oromoo version of the word "complication" was suggested to be replaced with another word because a mother cannot understand its meaning, and it was modified based on the given suggestion. All (13 loss-framed and 1 gain-framed) messages that were suggested for modification were modified and refined based on the experts' recommendations. Based on the preset criteria, all 78 messages (39 from each message type) were refined and considered for the next phase of development, which was pilot testing. Although they had a lower average sum score, messages about coffee consumption and extra meals during pregnancy from the loss frame type were also considered for the next phase after modification based on the participants' suggestions.

Phase IV: pilot testing
The findings of the pilot test are presented in Table 4. The mean age of the participants was 25.4 years, and their average gestational age was 24.3 weeks. All of the participants had never previously taken part in any mobile phone-based messaging intervention. A majority (80%) of the participants mentioned that the time they had been receiving the message was early, and 66.7% of the participants preferred the afternoon to receive text messages about health. For 46.7% of the participants, 2 messages per week was the preferred frequency of receiving the messages, and the Afan Oromoo was the preferred language for 29 (96.7%) of them. On average, 17 out of the 20 messages were read by the participants. A majority (60%) of the participants stated that the message they received was of the right length. Fourteen (46.7%) of the

participants said the message they received was very clear, while only one of them said it was unclear. A large number (86.7%) of the participants stated that the content and meaning of the messages were easy to understand. The mean SUS score was 72.26, with a SD of 7.2 and a range of 58–88; this mean score was above 68 for 27/30 (90%) of the participants. In the pilot test, all 20 text messages were automatically dispatched from the application software to the participants.

Discussion
Message development, testing and refinement process in this study involved card sorting, interviews, expert review, pilot testing, and system usability testing. Previous studies that presented text message development for health intervention have also used methods such as applying behavior change theory [24, 45], card sorting with end users [32, 33], expert evaluation, focus group discussion [24, 36, 37] and pilot study with the end user [30, 38, 39]. However, the current development process integrates different methods. Using the system usability scale during the pilot phase also helped to identify the acceptability of the message content and the messaging software program. Integrating various methods in the message development process is achievable and leads to important feedback that improves the usability of messages.

In phase 1, the research team discussed and reduced the draft 120 messages to 88 (44 for each message type), considering the negative effect of sending too many messages that may lead to burdensome, boring, and tiresome [39]. Based on the card sorting activity in phase 2, 78/88 (88.6%) were considered the next phase. Except one card from nutrition category but placed in the breastfeeding category, all of gain-framed messages were placed in the preset thematic category. The difference observed with this specific message might be due to the presence of the phrase "breastfeeding" in the content of this message, which elaborates on the importance of extra meals during breastfeeding. Two cards with loss-framed messages were misplaced under nutrition category while they were supposed to be under the lifestyle modification category. The content of the message on these cards includes information about food preparation and eating raw meat, and we beilive this misled the participants to place it under nutrition category. Ten messages were removed because they had low average placement scores and were not placed in any preset category. Although the analysis took a long time, the card-sorting activity technique was quick and produced clear and consistent findings. Thus, card sorting is an important technique when engaging end users and providing feedback for the text message development process are needed.

Table 4 Descriptive results for pilot testing of messages developed for improving maternal and newborn care practices in the Jimma Zone, Ethiopia (*n* = 30)

Variables	Frequency	Percent
Age	25.4, SD 3.2	
Gestational age in weeks	24.3, SD 4.2	
Previous experience of receiving health message through SMS		
Yes	0	0
No	30	100
Number of "Ulfa mijuu" messages read	17.03, SD 1.5	
Message length		
Long	12	40
Just right	28	60
Short	0	0
The timing of received messages appropriate		
Early	25	83.3
On time	2	6.7
Late	3	10
How clear is the messages		
Somewhat unclear	1	3.3
Neutral	7	23.3
Somewhat clear	8	26.7
Very clear	14	46.7
How well understood the content and meaning of the messages		
Difficult to understand	1	3.3
Neutral	3	10
Easy to understand	26	86.7
Preferred time of day to receive the text messages		
Morning	6	20
Afternoon	20	66.7
Evening	4	13.3
Preferred frequency of the text messages		
Daily	4	13.3
Every other day	9	30
Two per week	14	46.7
Once per week	3	10
Preferred language for receiving text messages		
Afan Oromoo	29	96.7
Amharic	1	3.3
SUS score	72.26, SD 4.3	

All the experts who participated in the message evaluation in phase 3 provided positive feedback on both types of messages. All the messages used at this phase were considered for next phase after refining the message that experts suggested for modification.. Although previous studies used expert review, some used only 3 questions to address clarity, usefulness, and relevance [34, 35], while others evaluated the quality of the message using only 1 question [30]. Using 10 items that are recommended for evaluating health messages [46] for expert evaluation has

helped to obtain persuasive text messages in the current message development process. We have learned engaging experts who know the local context is crucial to identifying potential issues with message content. Considering experts suggestions and inputs are also important for quick refinement of the messages.

Based on findings from pilot testing in phase 4, the developed message is acceptable to pregnant mothers. The findings from the SUS score indicated a mean score of 72.26, which was above the minimal acceptable

score. This finding is also comparable with a previous study that revealed a mean SUS score of 71.06 for health information [47]. Taking time in the pilot testing of the development process helps individuals understand and modify messages and messaging system based on end-user preferences (such as timing, frequency, and language) for better adherence. Incorporating SUS measurements in the pilot testing phase of the message development process is important because it is quick and helps to identify the usability of the messaging system and the acceptability of the developed text messages.

As a limitation, the current study included a small sample for card sorting activity. Although the total sample was sufficient for the activity, it was too small when it was shared for each message type. Pilot-testing participants were asked how many messages they had read, but they were not asked which message they read. Furthermore, the effects of message framing on improving maternal health utilization and newborn care practices were not assessed in the pilot phase of this study.

Conclusion

A final bank of 78 (39 for each gain and loss-framed) messages was obtained through refinement based on participants' feedback at each phase of the development process. The messages were developed using national and international guidelines, theory, expert reviews, card sorting activities, interviews, the SUS and pilot testing. Although future studies are needed to test the effectiveness of loss- and gain-framed text messages, the message development process of the current study confirms that the messages are acceptable, evidence, and useful. The next step is to examine the effects of framed messages on improving maternal health service utilization and newborn care practice in a cluster randomized control trial using the final message content, information on end-user preference, and the developed software in the current study.

Abbreviations
SMS   Short message service
SPSS   Statistical Package for the Social Sciences
SUS   System usability scale
WHO   World Health Organization

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s40814-025-01632-6.

Additional file 1: Total sum score and suggestion of expert on gain and loss framed messages content in Jimma Zone, Ethiopia.

Additional file 2: Checklist for reporting intervention development studies.

Declarations

Ethics approval and consent to participate
The research method described in this study was approved by Jimma University Institute of Health, Institutional Review Board (Ref No.: JUIH/IRB/358/23).

Competing interests
The authors declare that they have no competing interests.

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