

BMJ Open

BMJ Open is committed to open peer review. As part of this commitment we make the peer review history of every article we publish publicly available.

When an article is published we post the peer reviewers' comments and the authors' responses online. We also post the versions of the paper that were used during peer review. These are the versions that the peer review comments apply to.

The versions of the paper that follow are the versions that were submitted during the peer review process. They are not the versions of record or the final published versions. They should not be cited or distributed as the published version of this manuscript.

BMJ Open is an open access journal and the full, final, typeset and author-corrected version of record of the manuscript is available on our site with no access controls, subscription charges or pay-per-view fees (<http://bmjopen.bmj.com>).

If you have any questions on BMJ Open's open peer review process please email info.bmjopen@bmj.com

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2024-088342
Article Type:	Original research
Date Submitted by the Author:	03-May-2024
Complete List of Authors:	Bulcha, Gebeyehu; Jimma University, Health, Behavior and Society; Oromia Regional Health Bureau, Maternal, Neonatal and Child Health Gutema, Hordofa; Jimma University, Department of Health, Behavior Society Amenu, Demisew ; Jimma University, Obstetrics and Gynaecology Birhanu, Zewdie ; Jimma University College of Public Health and Medical Sciences, Department of Health, Behavior, and Society, Faculty of Public Health, Jimma University, Jimma, Ethiopia
Keywords:	Pregnant Women, Pregnancy, Health Education, Health Literacy

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 1
4
5
6 2
7
8
9
10 3 Perceived Acceptability, Barriers, and Enablers in Implementing
11
12 4 Mobile Phone Messaging-Based Message Framing Intervention for
13
14
15
16 5 Improved Maternal and Newborn Care in Jimma Zone, Ethiopia
17
18
19 6
20
21
22 7
23
24 8
25
26
27 9
28
29

30 10 Gebeyehu Bulcha ^{1,2*}, Hordofa Gutema ¹, Demisew Amenu ³, Zewdie Birhanu ¹
31
32
33 11
34
35 12
36

37 13 ¹Department of Health, Behavior, and Society, Faculty of Public Health, Institutes of Health,
38
39 14 Jimma University, Jimma, Ethiopia
40

41
42 15 ²Oromia Regional State Health Bureau, Jimma Zone Health Office, Department of Maternal,
43
44 16 Newborn and Child Health, Jimma, Ethiopia
45

46 17 ³Department of Obstetrics and Gynaecology, Faculty of Medical Sciences, Institutes of
47
48 18 Health, Jimma, Jimma University, Ethiopia
49
50

51 19
52
53 20 * Corresponding Author
54

55
56 21 Email: gebeyehubulcha@gmail.com
57
58
59 22
60

23 Abstract

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

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

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

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

1
2
3 47 maximize the impact of mobile health messaging and ensure broad and effective reach, it's
4
5 48 crucial to address barriers by fostering existing enablers.
6
7
8 49 **Keywords:** mHealth, Ethiopia, mobile phone messaging, perceived acceptability, barrier and
9
10 50 facilitator
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.
Enseignement Supérieur (ABES)

52 **Background**

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

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

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

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

1
2
3 77 most popular mobile phone communication systems (18), and Multimedia Messaging Service
4
5 78 (MMS) was recently added as a communication feature to ethio-telecom services (19).
6
7
8 79 Despite its promising effectiveness, the successful implementation of mobile phone
9
10 80 messaging interventions depends on a range of obstacles and enablers (20). Researchers have
11
12 81 identified multiple challenges that influence the acceptance and implementation of mobile
13
14 82 health interventions including low literacy rates, inadequate awareness of mobile health, poor
15
16 83 network coverage, and technical challenges, (15,21,22). A study conducted by Donson et.al
17
18 84 identified a range of obstacles, including network connectivity issues, privacy concerns, and
19
20 85 the need for culturally sensitive messaging (23). Studies have further explored the challenges
21
22 86 associated with mobile phone access (24), affordability (25,26), and concerns about message
23
24 87 reliability (24,26). Low smartphone penetration and limited digital literacy among women in
25
26 88 rural areas are also major challenges to the implementation of mHealth (27). Sunday O.
27
28 89 Oyeyemi and Rolf Wynn addressed challenges such as message delivery delays and
29
30 90 participant concerns regarding message accuracy (28). Restricted mobile phone ownership is
31
32 91 a major barrier to the effectiveness of mobile phone messaging interventions in maternal and
33
34 92 newborn health in rural areas. Rural women's ownership of mobile phones is often
35
36 93 significantly lower than that of their urban counterparts, and unreliable access to electricity
37
38 94 for charging mobile devices and receiving text messages further compounded this issue
39
40 95 (29,30).
41
42
43
44
45
46 96 Despite these challenges, various enablers have been identified to increase the uptake and
47
48 97 effectiveness of mobile phone messaging to improve maternal and newborn health including
49
50 98 interactive messaging & personalized content (31) engagement of community health workers
51
52 99 in supporting mobile phone interventions significantly improved its acceptability and
53
54 100 effectiveness in enhancing healthcare delivery (32), feedback, and privacy (33).
55
56
57
58
59
60

1
2
3 101 The use of mHealth interventions in Ethiopia has yielded promising results in improving
4
5 102 maternal and child health. However, there is a lack of comprehensive knowledge regarding
6
7 103 the extensive utilization of mHealth interventions in Ethiopia, specifically regarding pregnant
8
9 104 women's opinions, challenges, cultural aspects, perceived benefits, and enablers (34,35).
10
11 105 This study was conducted before the eight-month (May –December 2023) cluster randomized
12
13 106 controlled trial (cRCT) project to inform the design and implementation of mobile phone
14
15 107 messaging-based message framing intervention. This study aimed to deploy a qualitative
16
17 108 assessment approach to better understand the barriers and enablers of mobile phone
18
19 109 messaging interventions to improve maternal health service uptake and neonatal health
20
21 110 practice in the Jimma Zone.

25 111 **Method and materials**

26
27
28 112 The trial protocol has been accepted for publication (36) and the trial was registered on 04
29
30 113 January 2022 with Clinical Trials (trial identifier PACTR202201753436676) and can be
31
32 114 accessed at <https://pactr.samrc.ac.za>.

33 115 **Study setting and period**

34
35
36 116 The study was conducted in the Dedo, Shabe Sombo, and Manna districts of the Jimma Zone.
37
38 117 Together the three districts had a total population of 624,534, of which 21,671 were pregnant
39
40 118 women. This study was conducted between March 5 and March 20, 2023. The study sites
41
42 119 were selected purposively to ensure a representation of characteristics within the study area
43
44 120 and to gain insights, into both challenges and enablers related to mobile phone messaging
45
46 121 interventions.

47 122 **Study design**

48
49
50 123 We conducted a qualitative study to explore perceived acceptability, barriers and enablers of
51
52 124 mobile phone messaging-based message-framing interventions to improve maternal and
53
54 125 newborn health practices.

126 **Population and sampling**

127 The study population included a more specific and targeted group of individuals from a
128 broader source population, including pregnant women, male partners, health extension
129 workers, midwives, primary healthcare unit (PHCU) directors, district maternal and child
130 health (MCH) coordinators, and local ethio-telecom experts. Participants were chosen based
131 on their relevance to the study's objectives. Purposive sampling was used to select both In-
132 depth Interviews (IDIs) and key informant interviews (KIIs) participants within the
133 intervention target areas. Key informants with more than one year of work experience were
134 included in the study. In-depth Interview (IDI) participants were selected based on their
135 experience in terms of usage of MCH services, and other background variables such as
136 residence and educational level, which helped to ensure diversity of perspectives and views.
137 The actual sample size depends on the saturation of ideas, where further data collection does
138 not yield new insights. Both IDIs and KIIs were continuously reviewed to determine whether
139 additional sampling was necessary to ensure a comprehensive range of perspectives within
140 the study population.

141 **Data collection methods and procedures**

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

1
2
3 150 duration from 40 to 60 minutes, were recorded using a digital voice recorder, complemented
4
5 151 by note-taking during the interview process.
6
7

8 152 **In-depth interviews with pregnant women and male partners**

9
10 153 In-depth interviews were conducted with 12 participants (six pregnant mothers and six male
11
12 154 partners). The interviews were randomly selected from three distinct arms (four interviews
13
14 155 per arm). To ensure diversity and representation, participants were purposefully sampled
15
16 156 considering variables such as urban-rural distribution (eight from rural areas and four from
17
18 157 urban areas), gestational age (nine participants beyond 20 weeks and three below 20 weeks),
19
20 158 and proximity to network towers. The inclusion criteria were based on individuals'
21
22 159 experiences with maternal and newborn services and their utilization of mobile phones,
23
24 160 facilitating the exploration of a broad context of experiences related to mobile phone usage,
25
26 161 as well as associated challenges and facilitators. The interviews were conducted by well-
27
28 162 trained qualitative researchers and transcribed verbatim into English. To ensure patient
29
30 163 privacy and ensure their comfort, all interviews were conducted in private settings.
31
32

33 164 **Key informant interviews with health workers and ethio-telecom experts**

34
35
36 165 To triangulate the findings of the IDI, 14 key informants were interviewed with purposively
37
38 166 selected healthcare providers and ethio-telecom experts. Diverse groups of health care
39
40 167 providers including health extension workers, midwives, PHCU directors, MCH focals, and
41
42 168 ethio-telecom experts were included in the key informant interviews. To ensure diversity of
43
44 169 experience, healthcare providers were also purposively selected considering the duration of
45
46 170 their experiences. The KIIs were conducted by well-trained qualitative researchers. The data
47
48 171 collectors were recruited only to conduct and transcribe the interviews and they did not have
49
50 172 any interest in this study.
51
52
53
54
55
56
57
58
59
60

173 **Data analysis**

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

187 **Quality control**

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

1
2
3 198 Additionally, we increased the generalizability of the findings by incorporating diverse
4
5 199 representations from rural and urban settings.
6
7

8 200 **Results**

10 201 **Background characteristics**

12
13 202 A total of 26 participants (12 for IDI and 14 for KII) were interviewed for this study. The
14
15 203 mean age of study participants was 28 with SD \pm 6. The predominant (65.4%) level of
16
17 204 education was tertiary education. More than three-fourths (84.6%) of the study participants
18
19 205 were Oromo. Among pregnant women participants, 41.7% had access to electricity, 16.7%
20
21 206 were primigravida, 66.7% were at or beyond 20 weeks gestation, and 66.7% attended up to
22
23 207 the fourth antenatal care visit. On average, each woman had 1.6 children, with a maximum of
24
25 208 7. The majority (71.4%) of the key informants had over five years of experience (see Table 1).
26
27
28

29 209 **Emergent themes and categories**

30
31 210 The results are presented in five key thematic groups including awareness, perceived
32
33 211 relevance, usefulness, and benefits of mobile messaging; prior experience or exposure to
34
35 212 mobile phone messaging; willingness and readiness to receive and engage in mobile phone
36
37 213 messaging; perceived barriers and challenges to mobile phone messaging, and enablers &
38
39 214 facilitators to mobile phone messaging (Fig. 1).
40
41
42

43 215 **Awareness, perceived relevance, usefulness, and benefits of mobile messaging**

44
45 216 **Awareness:** The majority of the study participants are aware of how mobile phone-based
46
47 217 intervention can promote the health of mothers and newborns. According to them, mobile
48
49 218 health is a powerful strategy for promoting the health of mothers and their newborns. They
50
51 219 explained that by using mobile technology, personalized health messages, and advice can be
52
53 220 directly sent to mothers or family members' mobile devices, making it easy and accessible to
54
55 221 receive the care they need at their convenience.
56
57
58
59
60

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

224 **Perceived usefulness and relevance:** According to the majority of the study participants
225 mobile phone-based messaging can ensure that pregnant women receive care at the right time
226 by persuading them to visit health facilities at appropriate times. It also empowers them to
227 maintain a healthy life of their own and their babies throughout the pregnancy spectrum and
228 beyond by promoting self-care, adhering to advice, sharing responsibility, and improving
229 health-seeking behaviour, which can result in favourable health outcomes for both mother
230 and baby while also enhancing their satisfaction, with the care they receive.

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

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

237 **Prior experience or exposure to mobile phone messaging**

238 **Access to and source information on maternal and newborn care:** The majority of KII
239 and IDI participants reported that health extension workers, community meetings, women
240 development groups, health workers, and media outlets like radio and television serve as
241 common sources of health-related information. Rural communities rely heavily on health
242 extension workers and radio broadcasts, while urban communities access health information
243 through televised programs, radio, and health workers.

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

1
2
3 247 **Mobile phone availability and usage:** Participants reported significant differences in mobile
4
5 248 phone availability and usage between urban and rural areas. Urban households typically have
6
7 249 up to four phones in the household, but usage is mainly limited to voice calls, overlooking
8
9 250 incoming (short message service) SMS due to low literacy and promotional texts. In rural
10
11 251 settings, in most households at least one mobile phone is available and its usage is also
12
13 252 similar to their urban counterparts. In rural areas, for some only male partners have autonomy
14
15 253 over mobile phone usage.

16
17 254 *"... mobile phones is by low literacy levels, high dose of promotional messages and digital*
18
19 255 *divide among family members." HEWs, 28 years old, urban*

20
21 256 **Experiences:** The majority of the study participants revealed that there are no mobile health
22
23 257 (mHealth) interventions for pregnant women in our area. Health messages can only be
24
25 258 accessed based on subscription, this also only works for general health information.

26
27 259 *"...there are no specific health messages sent our mobiles to promote maternal and newborn*
28
29 260 *health"* – *pregnant woman, 26 Years old*

30
31 261 Few of the participants reported a mobile-based intervention called ComCare was piloted five
32
33 262 years ago, according to our observation these interventions can *ensure optimal pregnancy and*
34
35 263 *newborn care* by enhancing access to health information, supporting health workers in
36
37 264 delivering high-quality care, and empowering women and their families to make informed
38
39 265 decisions about their health.

266 **Willingness and readiness to receive and engage in mobile phone messaging**

267 Willingness: Participants at all research sites consistently showed positive willingness, and
268
269 readiness to engage in Mobile Phone Messaging Interventions for improving maternal and
270
271 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.

272 *"... I am pleased to see that more and more people are willing to participate in mobile-based*
273 *interventions..." HEW, 29 years old*

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

281 *"... involving all family members in the intervention can help promote shared responsibility*
282 *for the family's health."* **Male Partner, 41 years old**

283 **Best time for mothers to receive and read messages:** The best times to receive messages
284 are around noon, and early in the morning (between 12-1 o'clock). During these hours,
285 women are more likely to be free from work commitments and other engagements, making
286 them more receptive to receiving messages.

287 **Preferences for language and mode of message delivery:** Majority of the participants
288 expressed a preference for Afan Oromo.

289 *"... the use of multiple languages would help overcome language barriers and improve the*
290 *effectiveness of interventions, however we prefer Afan Oromo in our context."* **Male Partner,**
291 **38 years old**

292 **Perceived barriers and challenges to mobile phone messaging**

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

296 **Low mobile health literacy:** According to our result, challenges related to mobile health
297 literacy encompass issues such as a lack of reading culture for messages, low literacy levels

1
2
3 298 among pregnant women and their partners, and difficulties in comprehending the messages
4
5 299 received due to literacy barriers.

6
7 300 *"...we (pregnant women) are less educated and unable to read and comprehend mobile*
8
9 301 *phone-based messages. "Pregnant Women, 22 years old*

10 302 **Gender and cultural barrier:** In this study, one of the obstacles to implementing mobile
11
12 303 phone-based messaging is gender and cultural barriers. This encompasses challenges related
13
14 304 to male dominance in decision-making, limited empowerment of women to engage with
15
16 305 mobile health interventions, and cultural reluctance or taboos that hinder effective
17
18 306 communication and message reception. According to the majority of study participants, there
19
20 307 is male dominance over economic affairs of families, which can hinder pregnant mothers'
21
22 308 ability to act on the key messages and reminders sent via mobile-based interventions.

23
24 309 *".. male partners have more access to mobile phones and have decision power over other*
25
26 310 *household resources ." Pregnant Women, 35 years old*

27
28 311 **Technology-related challenge:** According to this study challenges like network disruptions,
29
30 312 power-related issues (e.g., frequent power outages affecting phone usage), and inadequate
31
32 313 technological infrastructure in certain areas can impede the smooth delivery and reception of
33
34 314 mobile health messages.

35
36 315 *"... network dropouts are common, lasting up to 1-2 days at times. Power is another obstacle,*
37
38 316 *women often have to travel to urban areas to charge their mobile devices." HEWs, 31 years*
39
40 317 *old, rural*

41
42 318 Mobile network coverage varies between urban and rural areas, with the averagely best
43
44 319 coverage found in urban areas. Residents in urban areas enjoy relatively uninterrupted
45
46 320 connectivity, allowing them to access a variety of mobile services. However, in rural areas,
47
48 321 there is limited network service, which challenges residents to access a variety of mobile
49
50 322 services.

1
2
3 323 “...mobile network is relatively good in urban areas compared to rural one, there are more
4
5 324 complaints from rural communities than urban regarding network connectivity.” *Ethio-*
6
7 325 *telecom Expert, 26 years old*

9 326 **Family Dynamics and Communication:** the result of this study shows issues such as limited
10
11 327 family dialogue, and challenges in ensuring that health information reaches all relevant
12
13 328 family members. Some of the study participants reported that there may be a lack of
14
15 329 discussion within families, where messages sent to one mobile device are not discussed
16
17 330 among family members, limiting the intervention's reach and impact.

18
19 331 **Traditional healing practice and beliefs:** This includes challenges related to community
20
21 332 reliance on traditional healing rituals and preferences for traditional medicine over modern
22
23 333 health interventions, particularly during complications or pregnancy-related issues. Often,
24
25 334 pregnant women opt for traditional medicine, and in many instances, families employ local
26
27 335 rituals and traditional remedies for the treatment of newborns.

28
29 336 “... women visit health facilities when the condition gets worse, otherwise they prefer
30
31 337 traditional medicine.” *Pregnant women, 29 years old*

32
33 338 **Timing and disclosure issue:** in this study, challenges like late pregnancy disclosure,
34
35 339 where pregnancies are not disclosed until they are visibly evident, lead to delayed antenatal
36
37 340 and potential care seeking. There are also difficulties in accurately recalling the last menstrual
38
39 341 period. The majority of study participants have indicated that it is not customary to reveal a
40
41 342 pregnancy due to concerns about potential adverse outcomes such as abortion, fetal death,
42
43 343 and other related issues. Pregnancy becomes publicly known within the community when the
44
45 344 woman's abdomen visibly enlarges to the point where it becomes difficult to conceal. Women
46
47 345 tend to seek antenatal care and related services when the pregnancy naturally becomes
48
49 346 evident due to the increase in abdominal size.
50
51
52
53
54
55
56
57
58
59
60

1
2
3 347 *"...we keep our pregnancy a secret until our belly visibly grows larger. Even if we faced any*
4
5 348 *health issues during this period, we chose to consult traditional healers instead."* **Pregnant**
6
7 349 **Women, 28 years old**

9 350 According to the majority of study participants, women often struggle to recall the exact date
10
11 351 of their last menstruation. Healthcare providers opt for rough estimations or rely on
12
13 352 associations with various events to determine a woman's last menstrual period follow fundal
14
15 353 height measurement or rely on ultrasound readings where available.

16
17 354 *"...they (women) were unable to recall their last menstrual period, which hinders*
18
19 355 *interventions that rely on this information."* **Midwives, 30 years old**

20
21 356 **Frequent promotional messages:** According to most study participants, essential messages
22
23 357 may go unnoticed or disregarded among the constant entry of promotional messages to their
24
25 358 mobile phones from ethio-telecom. According to them, the community may link the
26
27 359 intervention with the overwhelming volume of messages they receive on their mobile phones.

28
29 360 *"...we almost ignored reading incoming messages due to the high volume of promotional*
30
31 361 *messages."* **Male Partner, 37 years old**

362 **Enablers and facilitators of mobile phone messaging**

363 **Reinforcing strategies:** According to the majority of the study participants, the availability
364
365 of women's forums and home-to-home visit strategies can support the implementation of
366
367 mobile phone messaging-based intervention, enabling mothers to put into practice what they
368
369 have learned through the messaging intervention. Health extension workers can conduct
370
371 home visits to locate and encourage mothers to act upon the messages.

372
373 368 *"... pregnant women and home-to-home visits by HEWs can support the mobile phone-based*
374
375 369 *messaging intervention."* **Midwives, 24 years old**

376
377 370 **Traditional community networking:** Acknowledged by study participants, community-
378
379 371 oriented networking like idirs, ikubs, and social groups enhance maternal and newborn health

1
2
3 372 through timely pregnancy detection, adherence to treatment plans, and support for pregnant
4
5 373 mothers.

6
7 374 *“...community-based organizations can support Mobile phone messaging intervention*
8
9 375 *through early pregnancy identification and notification.” -MCH focal, 27 years old*

10 376 **Mobile phone penetration and positive attitude:** Participants across the study sites spoke
11
12 377 that, the community has a positive perception towards mobile phone-based messaging
13
14 378 interventions. According to the study participants, mobile phone-based interventions can be
15
16 379 effective in improving antenatal care uptake, promoting birth preparedness & complication
17
18 380 readiness, and increasing rates of timely postnatal care and exclusive breastfeeding.

19 381 **Convenience and accessibility:** The majority of the study participants reported that
20
21 382 mobile phone messaging is convenient and can provide instant communication, regardless of
22
23 383 distance or time limitations. According to them, users have the flexibility to send and receive
24
25 384 messages whenever they want, allowing for asynchronous communication.

26 385 **Cost-effectiveness:** The majority of the study participants reported that no costs are
27
28 386 associated with being involved in mobile phone-based messaging intervention except indirect
29
30 387 costs like moving to urban to recharge batteries.
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

389 Discussion

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

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

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

1
2
3 414 members to bridge the digital divide and ensure equitable access to vital health information
4
5 415 for all pregnant women, regardless of their geographical location and residence. The current
6
7 416 study's findings indicated a prevailing male dominance over resource control at a household
8
9
10 417 level, this affects women's access to the use of mobile devices thereby potentially affecting
11
12 418 the effectiveness and reach of messaging through mobile phones. This result echoes with
13
14 419 findings from Sub-Saharan Africa research (50). In this study, technical challenges like poor
15
16 420 signal strength and electricity interruptions may pose significant obstacles to access and reach
17
18 421 of mobile phone messages. These challenges could lead to unreliable mobile network
19
20 422 coverage and frequent power disruptions, hampering the delivery of health messages and the
21
22 423 functionality of mobile devices. This finding aligns with existing literature, emphasizing the
23
24 424 universal importance of reliable network connectivity and alternative power sources for
25
26 425 sustaining effective mobile health interventions (51). The study reveals a notable deficiency
27
28 426 in family discussions regarding maternal and newborn health across the study areas, which
29
30 427 could result in a lack of sharing/discussion of the message received through mobile
31
32 428 messaging intervention. This significantly reduces the effectiveness of text messages via
33
34 429 mobile phones. This finding is consistent with one realistic synthesis in low and middle-
35
36 430 income countries(52). The delay in revealing pregnancies until they are visibly apparent, and
37
38 431 the challenge of inaccurately estimating gestational age due to difficulties in recalling the last
39
40 432 menstrual period was another barrier identified by this study. This finding aligns with
41
42 433 findings from existing studies that highlight similar challenges faced by women in delaying
43
44 434 pregnancy disclosure and accurately estimating gestational age (53–56). These challenges
45
46 435 may impede the timely and effective delivery of interventions aimed at improving maternal
47
48 436 and newborn health. According to the literature, the frequent inflow of promotional messages
49
50 437 is another challenge reported by the majority of participants. Continuous exposure to
51
52 438 promotional content breeds consumer skepticism, making individuals question the
53
54
55
56
57
58
59
60

1
2
3 439 authenticity and motives of health messages, leading to decision fatigue and hindering
4
5 440 individuals from prioritizing and acting on health recommendations (57). It is essential to
6
7 441 develop strategies to ensure that health messages stand out and become unique among a sea
8
9 442 of information entering mobile phones.

10 443 This study also identified various factors that enable the implementation of mobile phone
11
12 444 messaging-based message framing intervention. One of the major enablers identified was
13
14 445 community engagement towards mobile phone messaging. This suggests the need to engage
15
16 446 community leaders, and health workers so that they can actively promote mobile use for
17
18 447 receiving health messages, fostering trust and encouraging participation. Another significant
19
20 448 facilitator is reinforcing factors like women's forums, availability of community health
21
22 449 workers in each kebele, and home-to-home visits to complement and strengthen mobile
23
24 450 phone messaging. Similarly, One study found success in using community health workers
25
26 451 (CHWs) as intermediaries for mobile health messages due to their embedded trust and
27
28 452 community presence, enabling effective health communication (58). Mobile phone
29
30 453 penetration and positive attitude were other enablers for mobile phone messaging-based
31
32 454 intervention. Positive attitudes set the stage for a receptive environment, nurturing
33
34 455 engagement with the potential benefits they offer. This is supported by a study that shows
35
36 456 high mobile phone penetration and positive attitudes increase the effectiveness of
37
38 457 intervention (59). Traditional community networking, such as idirs, ikubs, and social groups,
39
40 458 was another facilitator of mobile phone-based messaging interventions. These community-
41
42 459 rooted networks can contribute to the effectiveness of mobile phone-based messaging by
43
44 460 assisting with pregnancy detection, treatment adherence, and providing support to mothers.
45
46 461 Similarly, a rural Ethiopian case study showed the positive influence of traditional
47
48 462 community networks in a mobile health intervention (60).
49
50
51
52
53
54
55
56
57
58
59
60

464 **Conclusion**

465 The study identified that participants generally know the benefits of mobile phone messaging
466 in improving maternal and newborn health, perceiving it as a relevant and useful tool for
467 enhancing health knowledge, care-seeking behaviors, and confidence in caring for mothers
468 and babies. Rural women lack confidence in reading and comprehending SMS messages.
469 Despite limited prior experience with mobile health messaging and a lack of confidence in
470 reading and comprehending SMS messages, there was a strong willingness and readiness
471 among participants to receive and engage with mobile phone messaging interventions,
472 indicating a positive outlook for the implementation of mobile messaging interventions.

473 This study identified challenges like low mobile health literacy, gender and cultural barriers,
474 technology-related issues, preference for traditional healing practices, urban-rural disparities
475 in mobile phone access and male dominance in resource control could limit the effectiveness
476 of these interventions. Despite these challenges, enablers such as community-based support
477 networks, traditional community structures like idirs and ikubs, home-to-home visits, the high
478 penetration of mobile phones in urban areas, and positive community attitudes towards
479 mobile-based interventions can support the success of mobile messaging programs. To
480 maximize the impact of mobile phone messaging, stakeholders must ensure cultural
481 sensitivity, address infrastructural challenges, and foster a supportive environment. Engaging
482 community leaders, health workers, and families, along with reinforcing strategies such as
483 women's forums and community health workers, will be key to the effectiveness and reach of
484 mobile phone messaging-based message framing intervention.

485 Understanding potential barriers and enablers can serve as evidence-based support for
486 initiatives that consider mobile health solutions to promote healthy practices in maternal and
487 newborn care. Considering the preferred language, timing, and modes of message delivery,
488 providing orientation to study participants and their families before rolling out the

1
2
3 489 intervention, and actively involving families in the intervention process are all essential for
4
5 490 the effectiveness of the intervention. Additionally, tailoring messages to accommodate
6
7
8 491 multiple mobile phones within a family is crucial for ensuring optimal reach and impact.
9

10 492 **Acknowledgments**

11
12 493 We extend heartfelt gratitude to the Jimma Zone Health Office for their unwavering support.

13
14 494 We also appreciate the study participants for their valuable contributions and the time they
15
16
17 495 generously dedicated to this research.
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

1
2
3 **497 Abbreviations**
4

5
6 498 CHW Community Health Workers
7
8 499 ETB Ethiopian Birr
9
10 500 HEW Health Extension Workers
11
12 501 IDI In-depth Interview
13
14 502 IRB Institute of Review Board
15
16 503 KII Key Informant Interview
17
18 504 MCH Maternal and Child Health
19
20 505 PHCU Primary Health Care Unit
21
22 506 SMS Short Message Service
23
24 507 TV Television
25
26
27
28

29 **508 Declarations**

30
31
32 **509 Ethics approval and consent to participate**
33

34 510 Ethical approval was obtained from the Ethical Review Board of Jimma University. All study
35
36 511 participants were given detailed information about the study, provided verbal consent before
37
38 512 participation, and were willing to participate in the study. The information gathered was kept
39
40 513 confidential and was only used for the agreed-upon purpose. Only the core research team has
41
42 514 access to the data, which is stored on password-protected computers and laptops. At the time
43
44 515 of data entry, each study participant's identity was delinked from their identification code.
45
46
47

48 **516 Consent for publication**

49
50 517 Not applicable
51

52 **518 Data availability**

53
54
55 519 Not applicable
56
57
58
59
60

1
2
3 **520 Funding**
4

5
6 **521** This work was funded by grants for postgraduate students from Jimma University, as well as
7
8 **522** smaller grants from the same institution; it does not necessarily reflect the interest of these
9
10 **523** organizations.

11
12
13 **524 Competing interests**
14

15 **525** The authors declare that there are no competing interests.
16

17 **526 Authors' contributions**
18

19
20 **527** GB contributed to the inception, design, analysis, and manuscript writing. HG was involved
21
22 **528** in the inception, design, and critical review of the manuscript. DA participated in the design
23
24 **529** and review of the manuscript. ZB was involved in the design process and critical review of
25
26 **530** the manuscript. The final manuscript was read and approved by all authors.
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

532 References

- 533 1. Haileamlak A. Maternal and Newborn Mortality- Still the Greatest Disparity between
534 Low-Income and High-Income Countries. *Ethiop J Health Sci.* 2018;28(4):368.
- 535 2. Bauserman M, Thorsten VR, Nolen TL, Patterson J, Lokangaka A, Tshefu A, et al.
536 Maternal mortality in six low and lower-middle income countries from 2010 to 2018:
537 risk factors and trends. *Reprod Health [Internet].* 2020;17(Suppl 3):1–10. Available
538 from: <http://dx.doi.org/10.1186/s12978-020-00990-z>
- 539 3. WHO. Maternal health. *Who [Internet].* 2018;(May):1–47. Available from:
540 <http://ci.nii.ac.jp/ncid/AN0022863X.bib>
- 541 4. National Academies of Sciences, Engineering and M. Global health and the future
542 role of the United States. Washington, DC. *Global Health and the Future Role of the*
543 *United States.* The National Academies Press; 2017.
- 544 5. Huck W. Goal 3 Ensure healthy lives and promote well-being for all at all ages.
545 *Sustain Dev Goals.* 2023;21–3.
- 546 6. Unicef. UNICEF DATA SEARCH Back to SDG overview. 2018;1–6.
- 547 7. Solnes Miltenburg A, Kvernflaten B, Meguid T, Sundby J. Towards renewed
548 commitment to prevent maternal mortality and morbidity: learning from 30 years of
549 maternal health priorities. *Sex Reprod Heal Matters.* 2023;31(1):1–11.
- 550 8. USAID. Preventing Child and Maternal Deaths. 2023;
- 551 9. Coleman J, Eriksen J, Black V, Thorson A, Hatcher A. The Mobile Alliance for
552 Maternal Action Text Message-Based mHealth Intervention for Maternal Care in
553 South Africa: Qualitative User Study. *JMIR Hum factors.* 2020 Jun;7(2):e14078.
- 554 10. WHO. Maternal mortality fact sheet. 2023; Available from:
555 <https://www.who.int/news-room/fact-sheets/detail/maternal-mortality#:~:text=Almost>
556 95%25 of all maternal,lives of women and newborns.

- 1
2
3 557 11. Ayele AA, Getaye Tefera Y, East L. Ethiopia's commitment towards achieving
4 558 sustainable development goal on reduction of maternal mortality: There is a long way
5 559 to go. *Women's Heal.* 2021;17:0–3.
- 6
7
8
9
10 560 12. Lunze K, Higgins-Steele A, Simen-Kapeu A, Vesel L, Kim J, Dickson K. Innovative
11 561 approaches for improving maternal and newborn health - A landscape analysis. *BMC*
12 562 *Pregnancy Childbirth* [Internet]. 2015;15(1). Available from:
13 563 <http://dx.doi.org/10.1186/s12884-015-0784-9>
- 14
15
16
17
18
19 564 13. Kifle D, Azale T, Gelaw YA, Melsew YA. Maternal health care service seeking
20 565 behaviors and associated factors among women in rural Haramaya District, Eastern
21 566 Ethiopia: a triangulated community-based cross-sectional study. *Reprod Health.*
22 567 2017;14(1):1–11.
- 23
24
25
26
27
28 568 14. Musiimenta A, Tumuhimbise W, Mugenyi G, Katusiime J, Atukunda E, Pinkwart N.
29 569 A Mobile Phone-based Multimedia Application Could Improve Maternal Health in
30 570 Rural Southwestern Uganda: Mixed Methods Study. *Online J Public Health Inform.*
31 571 2020;12(1):1–17.
- 32
33
34
35
36
37 572 15. Murthy N, Chandrasekharan S, Prakash MP, Ganju A, Peter J, Kaonga N, et al. Effects
38 573 of an mHealth voice message service (mMitra) on maternal health knowledge and
39 574 practices of low-income women in India: findings from a pseudo-randomized
40 575 controlled trial. *BMC Public Health.* 2020 Jun;20(1):820.
- 41
42
43
44
45
46
47 576 16. De P, Pradhan MR. Effectiveness of mobile technology and utilization of maternal and
48 577 neonatal healthcare in low and middle-income countries (LMICs): a systematic review.
49 578 *BMC Womens Health.* 2023;23(1):1–9.
- 50
51
52
53
54 579 17. Coleman J, Black V, Thorson AE, Eriksen J. Evaluating the effect of maternal
55 580 mHealth text messages on uptake of maternal and child health care services in South
56 581 Africa: a multicentre cohort intervention study. *Reprod Health.* 2020 Oct;17(1):160.
- 57
58
59
60

- 1
2
3 582 18. Ethiopian Public Health Institute (EPHI), ICF. Ethiopia Mini Demographic and Health
4
5 583 Survey 2019: Final Report [Internet]. 2021. 1–207 p. Available from:
6
7 584 <https://dhsprogram.com/pubs/pdf/FR363/FR363.pdf>
8
9
10 585 19. Telecom E, Lte V. Ethio Telecom Introduces New Communication Services.
11
12 586 2023;(December):3–4.
13
14 587 20. Berardi C, Hinwood M, Smith A, Melia A, Paolucci F. Barriers and facilitators to the
15
16 588 integration of digital technologies in mental health systems: A protocol for a
17
18 589 qualitative systematic review. PLoS One. 2021;16(11 November):1–19.
19
20 590 21. Chowdhury S, Chakraborty P pratim. Universal health coverage - There is more to it
21
22 591 than meets the eye. J Fam Med Prim Care [Internet]. 2017;6(2):169–70. Available
23
24 592 from: [http://www.jfmprc.com/article.asp?issn=2249-](http://www.jfmprc.com/article.asp?issn=2249-4863;year=2017;volume=6;issue=1;spage=169;epage=170;aulast=Faizi)
25
26 593 [4863;year=2017;volume=6;issue=1;spage=169;epage=170;aulast=Faizi](http://www.jfmprc.com/article.asp?issn=2249-4863;year=2017;volume=6;issue=1;spage=169;epage=170;aulast=Faizi)
27
28 594 22. Zoltán Rónay, Ewelina K Niemczyk. New Challenges to Education: Lessons from
29
30 595 Around the World. 2021.
31
32 596 23. Dobson R, Whittaker R, Bartley H, Connor A, Chen R, Ross M, et al. Development of
33
34 597 a Culturally Tailored Text Message Maternal Health Program: TextMATCH. JMIR
35
36 598 Mhealth Uhealth [Internet]. 2017 Apr;5(4):e49. Available from:
37
38 599 <http://www.ncbi.nlm.nih.gov/pubmed/28428159>
39
40 600 24. Choudhury A, Choudhury M. Mobile for Mothers mHealth Intervention to Augment
41
42 601 Maternal Health Awareness and Behavior of Pregnant Women in Tribal Societies:
43
44 602 Randomized Quasi-Controlled Study. JMIR mHealth uHealth. 2022 Sep;10(9):e38368.
45
46 603 25. Lee SH, Nurmatov UB, Nwaru BI, Mukherjee M, Grant L, Pagliari C. Effectiveness of
47
48 604 mHealth interventions for maternal, newborn and child health in low–and middle–
49
50 605 income countries: Systematic review and meta–analysis. J Glob Health. 2016;6(1):1–
51
52 606 17.
53
54
55
56
57
58
59
60

- 1
2
3 607 26. Ye M. Use of Mobile Phone to Promote Governance and Equity within the Health
4
5 608 System: Experience of Rural Health District in Burkina Faso. *J Healthc Commun.*
6
7 609 2016;1(3):1–11.
8
9
10 610 27. Chib A. Afterword: Reflections on a Decade of mHealth Innovation in Asia. *Mobile*
11
12 611 *Communication in Asia*. 2018. 123–131 p.
13
14 612 28. Oyeyemi SO, Wynn R. The use of cell phones and radio communication systems to
15
16 613 reduce delays in getting help for pregnant women in low- and middle-income countries:
17
18 614 a scoping review. 2015;1.
19
20 615 29. Scott K, Shinde A, Ummer O, Yadav S, Sharma M, Purty N, et al. Freedom within a
21
22 616 cage: How patriarchal gender norms limit women’s use of mobile phones in rural
23
24 617 central India. *BMJ Glob Heal*. 2021;6:1–11.
25
26 618 30. Bhattacharya A. Rural Indian women are lagging far behind their urban counterparts in
27
28 619 mobile phone usage. 2018;1–11. Available from: [https://qz.com/india/969565/rural-](https://qz.com/india/969565/rural-indian-women-are-lagging-far-behind-their-urban-counterparts-in-mobile-phone-usage)
29
30 620 [indian-women-are-lagging-far-behind-their-urban-counterparts-in-mobile-phone-usage](https://qz.com/india/969565/rural-indian-women-are-lagging-far-behind-their-urban-counterparts-in-mobile-phone-usage)
31
32 621 31. Abane AM, Mariwah S, Owusu SA, Kasim A, Robson E, Hampshire K. Mobile phone
33
34 622 use and the welfare of community health nurses in Ghana: An analysis of unintended
35
36 623 costs. *World Dev Perspect* [Internet]. 2021;23:100317. Available from:
37
38 624 <https://www.sciencedirect.com/science/article/pii/S245229292100031X>
39
40 625 32. Amare D, Addis Alene K, Ambaw F. Acceptability of integrating traditional
41
42 626 tuberculosis care with modern healthcare services in the Amhara Regional State of
43
44 627 Northwest Ethiopia: A qualitative study. *Prev Med Reports* [Internet].
45
46 628 2023;34(May):102231. Available from: <https://doi.org/10.1016/j.pmedr.2023.102231>
47
48 629 33. Bhandari B, Narasimhan P, Jayasuriya R, Vaidya A, Schutte AE. Effectiveness and
49
50 630 Acceptability of a Mobile Phone Text Messaging Intervention to Improve Blood
51
52 631 Pressure Control (TEXT4BP) among Patients with Hypertension in Nepal: A
53
54
55
56
57
58
59
60

- 1
2
3 632 Feasibility Randomised Controlled Trial. *Glob Heart*. 2022;17(1).
4
5 633 34. Nigussie ZY, Zemicheal NF, Tiruneh GT, Bayou YT, Teklu GA, Kibret ES, et al.
6
7 634 Using mhealth to improve timeliness and quality of maternal and newborn health in
8
9 635 the primary health care system in ethiopia. *Glob Heal Sci Pract*. 2021;9(3):668–81.
10
11 636 35. Gilano G, Dekker A, Fijten R. The role of mHealth intervention to improve maternal
12
13 637 and child health: A provider-based qualitative study in Southern Ethiopia. *PLoS One*
14
15 638 [Internet]. 2024;19(2 February):1–19. Available from:
16
17 639 <http://dx.doi.org/10.1371/journal.pone.0295539>
18
19 640 36. Bulcha G, Abdissa HG, Noll J, Sori DA, Birhanu Z. Effectiveness of Mobile Phone
20
21 641 Messaging Based Message Framing Intervention for Improving Maternal Health
22
23 642 Service Uptake and New-born Care Practice in Rural Jimma Zone, Ethiopia: Protocol
24
25 643 for Cluster Randomized Controlled Trial. *HMIR Res Protoc* [Internet]. 2024;
26
27 644 Available from: <https://preprints.jmir.org/preprint/52395>
28
29 645 37. Peiris DR, Wijesinghe MSD, Gunawardana BMI, Weerasinghe WMPC, Rajapaksha
30
31 646 RMNU, Rathnayake KM, et al. Mobile Phone-Based Nutrition Education Targeting
32
33 647 Pregnant and Nursing Mothers in Sri Lanka. *Int J Environ Res Public Health*.
34
35 648 2023;20(3).
36
37 649 38. Hersh S, Nair D, Komaragiri PB, Adlakha RK. Patchy signals: Capturing women's
38
39 650 voices in mobile phone surveys of rural India. *BMJ Glob Heal*. 2021;6(2).
40
41 651 39. Okonofua F, Ntoimo L, Johnson E, Sombie I, Ojuolape S, Igboin B, et al. Texting for
42
43 652 life: a mobile phone application to connect pregnant women with emergency transport
44
45 653 and obstetric care in rural Nigeria. *BMC Pregnancy Childbirth* [Internet].
46
47 654 2023;23(1):1–8. Available from: <https://doi.org/10.1186/s12884-023-05424-9>
48
49 655 40. Mekonnen ZA, Gelaye KA, Were MC, Tilahun B. Acceptability , Barriers and
50
51 656 Facilitators of Mobile Text Message Reminder System Implementation in Improving
52
53
54
55
56
57
58
59
60

- 1
2
3 657 Child Vaccination : A Qualitative Study in Northwest Ethiopia. *J Multidiscip Healthc.*
4
5 658 2021;14:605–16.
6
7 659 41. Gebremariam KT, Zelenko O, Hadush Z, Mulugeta A, Gallegos D. Could mobile
8
9 phone text messages be used for infant feeding education in Ethiopia? A formative
10 660
11 qualitative study. *Health Informatics J.* 2020;26(4):2614–24.
12 661
13
14 662 42. Alsahli S, Hor SY, Lam M. Factors Influencing the Acceptance and Adoption of
15 663
16 Mobile Health Apps by Physicians During the COVID-19 Pandemic: Systematic
17 664
18 Review. *JMIR mHealth uHealth.* 2023 Nov;11:e50419.
19 665
20
21 665 43. Walle AD, Hunde MK, Demsash AW. Healthcare professionals' intention to adopt
22 666
23 mobile phone-based SMS and its predictors for adherence support and care of TB
24 667
25 patients in a resource-limited setting: a structural equation modelling analysis. *BMJ*
26 668
27 *Open.* 2023;13(12):1–9.
28 669
29
30 669 44. Materia FT, Smyth JM, Puoane T, Tsolekile L, Goggin K, Kodish SR, et al.
31 670
32 Implementing text-messaging to support and enhance delivery of health behavior
33 671
34 change interventions in low- to middle-income countries: case study of the Lifestyle
35 672
36 Africa intervention. *BMC Public Health.* 2023;23(1):1–14.
37 673
38
39 673 45. Feroz A, Jabeen R, Saleem S. Using mobile phones to improve community health
40 674
41 workers performance in low-and-middle-income countries. *BMC Public Health.*
42 675
43 2020;20(1):1–6.
44 676
45
46 676 46. Ji H, Dong J, Pan W, Yu Y. Associations between digital literacy, health literacy, and
47 677
48 digital health behaviors among rural residents: evidence from Zhejiang, China. *Int J*
49 678
50 *Equity Health* [Internet]. 2024;23(1):1–20. Available from:
51 679
52 <https://doi.org/10.1186/s12939-024-02150-2>
53 680
54
55 680 47. Davis TC, Arnold CL. Health Literacy Research in Rural Areas. *Stud Health Technol*
56 681
57 *Inform.* 2020;269:241–7.
58
59
60

- 1
2
3 682 48. Okobi E, Adigun AO, Ozobokeme O emi, Emmanuel O, Akinsanya PA, Okunromade
4
5 683 O, et al. Examining Disparities in Ownership and Use of Digital Health Technology
6
7 684 Between Rural and Urban Adults in the US: An Analysis of the 2019 Health
8
9 685 Information National Trends Survey. *Cureus*. 2023;15(5).
- 10
11
12 686 49. Divide D, Connectivity I, Residents R, Communities S, Adoption T. Home broadband
13
14 687 adoption , computer ownership vary by race , ethnicity in the U . S . Mobile
15
16 688 Technology and Home Broadband 2021 34 % of lower-income home broadband users
17
18 689 have had trouble paying for their service amid COVID- Mobile Technology and Home
19
20 690 Broad. 2024;8–10.
- 21
22
23 691 50. Ferrer M hélène, Perrin C, February LUCJ. Publish d on All About Fin nc Sub-S h r n
24
25 692 Afric : th fin nci l b tw n m n nd wom n nd r p. 2023;2023.
- 26
27
28 693 51. Andresen AX, Kurtz LC, Hondula DM, Meerow S, Gall M. Understanding the social
29
30 694 impacts of power outages in North America: a systematic review. *Environ Res Lett*.
31
32 695 2023;18(5).
- 33
34
35 696 52. Kabongo EM, Mukumbang FC, Delobelle P, ... Explaining the impact of mHealth on
36
37 697 maternal and child health care in low-and middle-income countries: a realist synthesis.
38
39 698 *BMC pregnancy ...* [Internet]. 2021; Available from:
40
41 699 <https://link.springer.com/article/10.1186/s12884-021-03684-x>
- 42
43
44 700 53. UNFPA. Seeing the unseen. The case for action in the neglected crisis of unintended
45
46 701 pregnancy. *State world Popul 2022*. 2022;1–160.
- 47
48
49 702 54. Kingdon C, Downe S, Betran AP. Interventions targeted at health professionals to
50
51 703 reduce unnecessary caesarean sections: A qualitative evidence synthesis. *BMJ Open*.
52
53 704 2018;8(12):1–14.
- 54
55
56 705 55. Goldberg JD, El-sayed YY. *Methods for Estimating the Due Date*. 2017;(700).
- 57
58 706 56. Majola L, Budhram S, Govender V, Naidoo M, Godlwana Z, Lombard C, et al.
59
60

- 1
2
3 707 Reliability of last menstrual period recall, an early ultrasound and a Smartphone App
4
5 708 in predicting date of delivery and classification of preterm and post-term births. BMC
6
7 709 Pregnancy Childbirth. 2021 Jul;21(1):493.
- 8
9
10 710 57. Mao B, Jia X, Huang Q. How do information overload and message fatigue reduce
11
12 711 information processing in the era of COVID-19? An ability–motivation approach. J Inf
13
14 712 Sci. 2022;
- 15
16
17 713 58. Piwowar H, Priem J, Larivière V, Alperin JP, Matthias L, Norlander B, et al. The state
18
19 714 of OA: A large-scale analysis of the prevalence and impact of Open Access articles.
20
21 715 PeerJ. 2018;2018(2):1–23.
- 22
23
24 716 59. Yang Q, Van Stee SK. The comparative effectiveness of mobile phone interventions in
25
26 717 improving health outcomes: Meta-analytic review. JMIR mHealth uHealth.
27
28 718 2019;7(4):1–14.
- 29
30
31 719 60. Mengesha EW, Tessema GA, Assefa Y, Alene GD. Social capital and its role to
32
33 720 improve maternal and child health services in Northwest Ethiopia: A qualitative study.
34
35 721 PLoS One [Internet]. 2023;18(4 April):1–21. Available from:
36
37 722 <http://dx.doi.org/10.1371/journal.pone.0284592>
38
39
40 723

725 Annex

726 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)

		<20 Weeks	2(33.3)
	Gestational Stage (n=6)	≥20 weeks	4(66.7)
		Attended	4(66.7)
	ANC status (n=6)	Not attended	2(33.3)

727

For peer review only

729

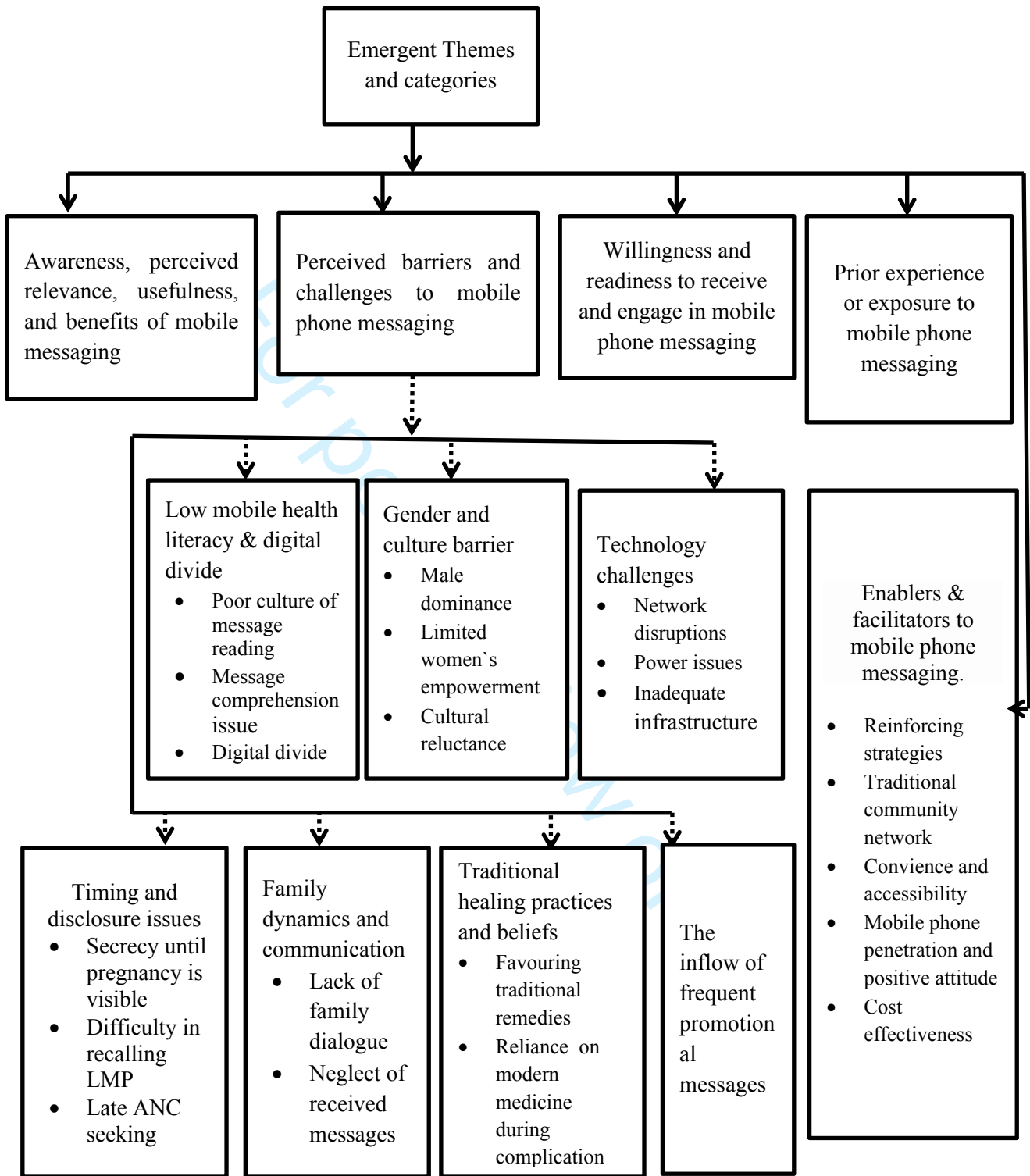


Figure 1. Emerged themes and categories in the study of barriers and enablers in implementing mobile phone messaging based message framing intervention to improve maternal and newborn health

Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies. Ensignement Supérieur (ABES)

BMJ Open

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

Journal:	<i>BMJ Open</i>
Manuscript ID	bmjopen-2024-088342.R1
Article Type:	Original research
Date Submitted by the Author:	14-Feb-2025
Complete List of Authors:	Bulcha, Gebeyehu; Jimma University, Health, Behavior and Society; Oromia Regional Health Bureau, Maternal, Neonatal and Child Health Gutema, Hordofa; Jimma University, Department of Health, Behavior Society Amenu, Demisew ; Jimma University, Obstetrics and Gynaecology Birhanu, Zewdie ; Jimma University College of Public Health and Medical Sciences, Department of Health, Behavior, and Society, Faculty of Public Health, Jimma University, Jimma, Ethiopia
Primary Subject Heading:	Health services research
Secondary Subject Heading:	Health services research, Health informatics, Qualitative research, Public health
Keywords:	Pregnant Women, Pregnancy, Health Education, Health Literacy

SCHOLARONE™
Manuscripts



I, the Submitting Author has the right to grant and does grant on behalf of all authors of the Work (as defined in the below author licence), an exclusive licence and/or a non-exclusive licence for contributions from authors who are: i) UK Crown employees; ii) where BMJ has agreed a CC-BY licence shall apply, and/or iii) in accordance with the terms applicable for US Federal Government officers or employees acting as part of their official duties; on a worldwide, perpetual, irrevocable, royalty-free basis to BMJ Publishing Group Ltd ("BMJ") its licensees and where the relevant Journal is co-owned by BMJ to the co-owners of the Journal, to publish the Work in this journal and any other BMJ products and to exploit all rights, as set out in our [licence](#).

The Submitting Author accepts and understands that any supply made under these terms is made by BMJ to the Submitting Author unless you are acting as an employee on behalf of your employer or a postgraduate student of an affiliated institution which is paying any applicable article publishing charge ("APC") for Open Access articles. Where the Submitting Author wishes to make the Work available on an Open Access basis (and intends to pay the relevant APC), the terms of reuse of such Open Access shall be governed by a Creative Commons licence – details of these licences and which [Creative Commons](#) licence will apply to this Work are set out in our licence referred to above.

Other than as permitted in any relevant BMJ Author's Self Archiving Policies, I confirm this Work has not been accepted for publication elsewhere, is not being considered for publication elsewhere and does not duplicate material already published. I confirm all authors consent to publication of this Work and authorise the granting of this licence.

1
2
3 1
4
5
6 2
7
8
9
10 3 Perceived Acceptability, Barriers, and Enablers in Implementing
11
12 4 Mobile Phone Messaging-Based Message Framing Intervention for
13
14
15
16 5 Improved Maternal and Newborn Care in Jimma Zone, Ethiopia: A
17
18 6 Qualitative Study
19
20
21
22 7
23
24 8
25
26
27 9
28

29 10 Gebeyehu Bulcha ^{1,2*}, Hordofa Gutema ¹, Demisew Amenu ³, Zewdie Birhanu ¹
30
31
32 11
33
34 12
35

36 13 ¹Department of Health, Behavior, and Society, Faculty of Public Health, Institutes of Health,
37
38 14 Jimma University, Jimma, Ethiopia
39

40
41 15 ²Oromia Regional State Health Bureau, Jimma Zone Health Office, Department of Maternal,
42
43 16 Newborn and Child Health, Jimma, Ethiopia
44

45 17 ³Department of Obstetrics and Gynaecology, Faculty of Medical Sciences, Institutes of
46
47 18 Health, Jimma, Jimma University, Ethiopia
48
49

50 19
51
52 20 * Corresponding Author
53

54 21 Email: gebeyehubulcha@gmail.com
55
56
57 22
58
59 23
60

24 Abstract

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

28 **Design:** A qualitative study employing thematic analysis of data collected through in-depth
29 and key informant interviews.

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

32 **Participants:** We conducted 12 in-depth interviews and 14 key informant interviews with
33 pregnant women, male partners, health extension workers, healthcare providers, and Ethio-
34 Telecom experts across the three districts. Thematic analysis was used to identify patterns
35 and themes in the data.

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

38 **Key Areas of Exploration:** The study explored participants' awareness, perceived relevance,
39 acceptability, and barriers and enablers, as well as participants' engagement with mobile
40 health messaging interventions.

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

49 **Conclusions:** Participants in this study generally recognized and accepted the benefits of
50 mobile phone messaging for improving maternal and newborn health. Although rural women
51 faced challenges in reading and understanding short messages, they demonstrated a strong
52 willingness to engage with mobile health messaging interventions. The identified barriers
53 were categorized as technological, social, cultural, behavioral and contextual. To maximize
54 the impact of mobile health messaging and ensure broad and effective reach, it is crucial to
55 address these barriers while leveraging existing enablers.

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

1
2
3 58 **Keywords:** mHealth, Ethiopia, mobile phone messaging, perceived acceptability, barriers
4 and facilitators
5

6
7 60 **Strengths and Limitations of this Study**
8

- 9
10
11 61 • This study provides detailed insights into the barriers and enablers of mobile phone
12 messaging interventions in a rural Ethiopian setting.
13
14 62 • The use of in-depth and key informant interviews allowed for the inclusion of diverse
15 perspectives from stakeholders, including both experienced and less-informed
16 63 participants.
17
18 64 • The findings may have limited applicability to settings with different socio-cultural
19 and technological contexts.
20
21 65 • The qualitative nature of the study makes it difficult to quantitatively assess the
22 magnitude of the identified barriers and enablers.
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

71 **Background**

72 Maternal and newborn health is a critical global public health concern, with a key priority
73 being the reduction of maternal mortality [1,2]. Despite some progress in recent years in
74 reducing maternal and neonatal mortality rates, significant challenges persist in many
75 developing countries, including Ethiopia, which bears one of the highest burdens of maternal
76 and neonatal mortality. In Ethiopia, maternal mortality is estimated at approximately 412 per
77 100,000 live births, while neonatal mortality is around 29 per 1,000 live births. Rural areas
78 are disproportionately affected due to poor access to healthcare and suboptimal health-
79 seeking behaviors [3–5].

80 Technological innovations, particularly mobile health (mHealth) interventions, have shown
81 promise in improving maternal and newborn health outcomes. These interventions primarily
82 use mobile phone messaging to provide timely health information, promote healthy behaviors,
83 and enhance communication between healthcare providers and patients [3,6–10].

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

93 The increasing penetration of mobile phones allows mHealth interventions to close the access
94 gaps in health care, mainly in rural areas where health services may not be readily available
95 [14]. However, several challenges may hinder the successful implementation of mHealth

1
2
3 96 interventions, including low literacy rates, poor network coverage, technical difficulties
4
5 97 [9,15,16], poor access to mobile phones [17], unreliable message delivery [17,18], message
6
7 98 delays [19], low smartphone penetration [20], affordability constraints [18,21], unreliable
8
9 99 electricity access [22,23], and cultural barriers [24].

10
11
12 100 Despite these barriers, enablers such as interactive messaging, which enhances two way
13
14 101 communication [25], engagement of community health workers, who provide personalized
15
16 102 support and followup [26], and tailored content, that aligns with local languages and cultural
17
18 103 contexts [27]. These would help in improving user engagement, understanding, and
19
20 104 compliance with the recommended maternal health practices, and therefore make mobile
21
22 105 health interventions more effective.

23
24
25
26 106 While mHealth interventions have shown promise in Ethiopia, there remains a limited
27
28 107 understanding of the perceptions of pregnant women's regarding such interventions [28,29].
29
30 108 Moreover, there is a gap in the literature on the relative effectiveness of different message-
31
32 109 framing techniques, such as gain- and loss-framed messaging, in influencing maternal health
33
34 110 behaviors [30]. The digital divide between urban and rural areas, the influence of social and
35
36 111 gender norms on mobile phone access and decision-making, and the sustainability of
37
38 112 mHealth interventions beyond pilot programs also need to be explored [31]. This qualitative
39
40 113 study was conducted to explore the perceived acceptability, barriers, and enablers of mobile
41
42 114 phone messaging interventions that improve maternal health service uptake and neonatal
43
44 115 health practices in the Jimma Zone. The findings have informed the design and
45
46 116 implementation of the cluster randomized controlled trial (cRCT).
47
48
49
50
51
52
53
54
55
56
57
58
59
60

118 **Method and materials**

119 The study has followed the SRQR checklist for reporting, which ensures transparency and
120 consistency in the study(Supplementary file 1). A three-arm cluster-randomized trial (cRCT)
121 was conducted in 21 health posts in Jimma Zone, Ethiopia, to assess the effectiveness of a
122 mobile phone messaging-based message framing intervention in improving maternal and
123 newborn health service utilization. The study randomly assigned 588 pregnant women (16–20
124 weeks gestation) to the gain-framed arm (emphasizing benefits), loss-framed arm
125 (emphasizing risks), and control arm (no SMS). The intervention was implemented from May
126 to December 2023. Primary outcomes included maternal service utilization and newborn care
127 practices, while secondary outcomes encompassed knowledge, self-efficacy, and adherence
128 to iron supplementation. A qualitative component involved 12 indepth interviews (IDIs) with
129 pregnant women and male partners and 14 key informant interviews (KIIs) with health
130 workers, health extension workers, and Ethio-Telecom experts. The trial was published [32]
131 and was registered on January 4, 2022, with Clinical Trials under the identifier
132 PACTR202201753436676, available at <https://pactr.samrc.ac.za>.

133 **Study setting and period**

134 The study was conducted in the Dedo, Shabe Sombo, and Manna districts of the Jimma Zone.
135 Together, the three districts had a total population of 624,534, including 21,671 pregnant
136 women. This study was conducted between March 5 and March 20, 2023. Study sites were
137 selected purposively to ensure a representation of characteristics within the study area and to
138 gain insights, into both challenges and enablers related to mobile phone messaging
139 interventions.

140 **Study design**

141 We conducted a qualitative study to explore the perceived acceptability, barriers, and
142 enablers of mobile phone messaging-based message-framing interventions aimed at

1
2
3 143 improving maternal and newborn health practices. This study was nested within a cRCT to
4
5 144 gain deeper insights into the perceived acceptability and contextual factors influencing the
6
7 145 interventions. Thematic analysis was used to explore participants' perceptions within a
8
9 146 qualitative paradigm. A constructivist stance recognized knowledge as being co-constructed
10
11 147 between the researcher and participants, while a descriptive qualitative design provided
12
13 148 insights into perceive acceptability, barriers and enablers of implementation. Key
14
15 149 assumptions included honest participant responses, the suitability of thematic analysis, and
16
17 150 minimal loss of meaning in translation, ensured through meticulous transcript validation. To
18
19 151 reduce bias, researchers maintained reflexivity throughout. This approach allowed a
20
21 152 systematic investigation of the reception of interventions, challenges, and facilitators in
22
23 153 mHealth.

24 154 **Population and sampling**

25
26
27
28
29 155 The study population comprised a specific and targeted group drawn from a broader source
30
31 156 population, including pregnant women, male partners, health extension workers, midwives,
32
33 157 primary healthcare unit (PHCU) directors, district maternal and child health (MCH)
34
35 158 coordinators, and local Ethio-Telecom experts. Participants in the three intervention arms of
36
37 159 the cRCT were allocated by cluster randomization to minimize selection bias.

38
39
40 160 The qualitative component involved purposive sampling of In-depth Interviews (IDIs) and
41
42 161 Key Informant Interviews (KIIs) within the intervention target areas. Participants were
43
44 162 selected based on their relevance to the study's objectives. Key informants with more than
45
46 163 one year of work experience were included. The selection of Ethio-Telecom were based on
47
48 164 their involvement in mobile health implementation, experience with networking and mobile
49
50 165 messaging systems, and at least one year of work experience in the sector. IDI participants
51
52 166 were selected based on their experience with MCH service utilization and other background
53
54 167 factors such as residence and educational level to ensure diversity of perspectives and views.
55
56
57
58
59
60

1
2
3 168 The actual sample size was determined by data saturation, where further data collection no
4
5 169 longer yield new insights. Both IDIs and KIIs were continuously reviewed to assess whether
6
7 170 additional sampling was needed to ensure a comprehensive range of perspectives within the
8
9
10 171 study population.

12 172 **Ethics approval and informed consent**

15 173 Ethical approval was obtained from the Ethical Review Board of Jimma University (ref no-
16
17 174 JUIH/IRB/316/23). Consent details, including study objectives and participant roles, were
18
19 175 explained in the local language. All participants provided verbal consent before participation
20
21 176 and willingly took part in the study. The consent procedure was approved by the Ethical
22
23 177 Review Committee. Collected information was kept confidential and used solely for the
24
25 178 agreed-upon purpose. Only the core research team had access to the data, which was stored
26
27 179 on password-protected computers and laptops. During data transcription and organization,
28
29 180 participant identities were delinked from their identification codes. This qualitative
30
31 181 exploration was the initial step in a mobile phone messaging intervention study and had no
32
33 182 negative impact on the participants.

38 183 **Data collection methods and procedures**

40 184 Data were gathered through in-depth interviews (IDIs) and key informant interviews (KIIs)
41
42 185 with various stakeholders, including pregnant women, male partners, Health Extension
43
44 186 Workers, midwives, PHCU directors, MCH focal persons, and Ethio-Telecom experts,
45
46 187 between March 5 and March 20, 2023. IDIs focused on capturing personal experiences and
47
48 188 insights from individuals directly involved with the research topic, providing in-depth
49
50 189 perspectives on personal perceptions and attitudes. KII on the other hand, involved experts or
51
52 190 influential individuals, such as professionals or community leaders, who offered broader,
53
54 191 more strategic perspectives and contextualized the issue under study.

1
2
3 192 Before data collection begun, the research team obtained permission from the selected
4
5 193 districts and health facilities. All interviews were conducted in private settings to ensure
6
7 194 confidentiality, with only the participant and the data collector present. An open-ended
8
9 195 interview guide, pre-tested for accuracy and relevance, was employed to facilitate the
10
11 196 interviews. Interviews lasted between 40 to 60 minutes and were recorded using a digital
12
13 197 voice recorder, complemented by note-taking during the sessions.

17 198 **In-depth interviews with pregnant women and male partners**

19 199 In-depth interviews were conducted with 12 participants-six pregnant mothers and six male
20
21 200 partners (not necessarily the partners of the six pregnant women interviewed). The interviews
22
23 201 were randomly selected from three intervention arms, with four interviews per arm. To
24
25 202 ensure diversity and representation, participants were purposefully sampled based on key
26
27 203 variables including, urban-rural distribution (eight from rural areas and four from urban
28
29 204 areas), gestational age (nine participants beyond 20 weeks and three below 20 weeks), and
30
31 205 proximity to network towers, meaning the closeness or distance of participants' locations to
32
33 206 network towers, which could impact the availability and quality of mobile phone services.
34
35 207 The other inclusion criteria were individuals' experiences with maternal and newborn services
36
37 208 and their utilization of mobile phones, facilitating the exploration of a broad context of
38
39 209 experiences related to mobile phone usage, as well as associated challenges and facilitators.
40
41 210 The interviews were conducted by well-trained qualitative researchers and transcribed
42
43 211 verbatim into English. To ensure privacy and participant comfort, all interviews were
44
45 212 conducted in private settings.

51 213 **Key informant interviews with health workers and ethio-telecom experts**

52 214 To triangulate the findings of the indepth interviews (IDIs), 14 key informants were
53
54 215 purposively selected and interviewed. The key informants included a diverse group of
55
56 216 healthcare providers including health extension workers, midwives, PHCU directors, MCH
57
58
59
60

217 focals, and ethio-telecom experts. To ensure diversity of experience, healthcare providers
 218 were purposively selected based on the duration of their professional experience. The key
 219 informant interviews (KIIs) were conducted by well-trained qualitative researchers. Data
 220 collectors were responsible for conducting and transcribing the interviews but did not
 221 participate in the development of the research questions, study hypotheses, or the main trial
 222 team. Their role was limited to data collection to maintain objectivity and reduce the risk of
 223 bias in the study.

224 **Participant Recruitment Process**

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

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

Participant Group	Urban	Rural	Study Arms			Total Participants (n=26)
			Gain-framed	Loss-framed	Control	
In-Depth Interviews (n=12)						
Pregnant Women	2	4	2	2	2	6
Male Partners	2	4	2	2	2	6
Key Informant Interviews (n=14)						
Health Extension Workers	1	2	1	1	1	3
Midwives	1	2	1	1	1	3
PHCU Directors	1	1	1	1		2
MCH Coordinators	1	1		1	1	2
Ethio-Telecom Experts	4	0				4

236

238 **Data analysis**

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

244 Thematic analysis was employed to identify the patterns and themes within the data. The
245 research team familiarized themselves with the content by reviewing and analyzing the
246 transcripts, generating initial codes, and refining them as new codes emerged. ATLAS.ti 7.1
247 software was used to manage and organize the data by grouping the codes into larger
248 categories and sub-themes. The sub-themes were further reviewed to identify overarching
249 themes that accurately captured the barriers, and enablers of mobile phone messaging-based
250 message framing interventions for maternal and newborn health in the Jimma Zone, Ethiopia.
251 A multi-stage coding and discussion process was followed among the research team to ensure
252 consistency and reliability. Any discrepancies in coding were resolved by consensus, final
253 themes were checked against existing literature for validation. To enhance accuracy and
254 consistency, triangulation, and member checks were conducted. Identified themes were
255 validated member-checking, where participants were invited to review and confirm whether
256 their views were being accurately represented. Additionally, peer debriefing was utilized to
257 strengthen the credibility of the findings.

258 **Researcher characteristics and reflexivity**

259 The team of researchers was highly experienced in maternal and newborn health, mobile
260 health interventions, and behavioral sciences. This may influence not only the framing of the
261 study objectives but also the interpretation of the findings of this study. Their familiarity with
262 both mobile phone messaging interventions and message-framing techniques may have

1
2
3 263 framed their assumptions about the possible finding of the study. Although the researchers
4
5 264 were not previously involved in maternal and child health programs within the study setting,
6
7
8 265 their broader academic and professional background offered valuable insights into the
9
10 266 contextual factors that would influence mobile health interventions. The researchers had
11
12 267 linguistic and cultural knowledge of the Jimma Zone, which helped in communicating and
13
14
15 268 understanding the context but might also induce some implicit biases in the interpretation of
16
17 269 the data. These were, in turn, counterbalanced by reflexive practices from the research team:
18
19 270 triangulation, peer debriefing, and an attempt to be neutral during the interviews. That way,
20
21
22 271 the findings indeed were a representation of the participants and not some projection of the
23
24 272 researchers' presuppositions, increasing credibility and transferability of the study results.

25 26 273 **Quality control**

27
28
29 274 A rigorous quality control protocol was followed to ensure the integrity and consistency of
30
31 275 the results. Data were collected by trained qualitative researchers to enhance accuracy and
32
33 276 reliability. The training was conducted by two experienced researchers (one male and one
34
35 277 female) over a period of two days to make sure all members of the team were well-equipped.
36
37
38 278 The collected data underwent rigorous expert review to verify their suitability and relevance.
39
40 279 The collected data underwent rigorous expert review to verify their suitability and relevance.
41
42
43 280 During fieldwork, daily debriefing sessions were conducted to facilitate the selection of
44
45 281 supplementary samples, enhancing the comprehensiveness of the collected data. Observations
46
47 282 and insights from both facilitators and note-takers were meticulously documented to provide
48
49 283 a holistic overview of each data source.
50
51
52 284 Triangulation techniques were employed to strengthen the credibility of the data by
53
54 285 integrating insights from both in-depth interviews (IDIs) and key informant interviews (KIIs).
55
56 286 Additionally, the generalizability of the findings was improved by incorporating diverse
57
58
59 287 perspectives from both rural and urban settings.
60

288 **Patient and Public Involvement**

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

299 **Results**

300 **Background characteristics**

301 A total of 26 participants (12 for IDI and 14 for KII) were interviewed for this study. The
302 mean age of the study participants was 28 years. The majority (65.4%) had attained tertiary
303 education. More than three-fourths (84.6%) of the participants were Oromo, the largest ethnic
304 group in Ethiopia, with a distinct language and cultural identity. Among the pregnant women,
305 41.7% had access to electricity, 16.7% were primigravida, 66.7% were at or beyond 20 weeks
306 gestation, and 66.7% had attended up to their fourth antenatal care visit. On average, each
307 woman had 1.6 children, with a maximum of 7. The majority (71.4%) of the key informants
308 had over five years of experience (see Table 2).

309 **Emergent themes and categories**

310 The results are organized into five key thematic groups: awareness, perceived relevance,
311 usefulness, and benefits of mobile messaging; prior experience or exposure to mobile phone
312 messaging; willingness and readiness to receive and engage with mobile phone messaging;
313 perceived barriers and challenges to mobile phone messaging; and enablers & facilitators of
314 mobile phone messaging (Fig. 1).

315 **Awareness, Perceived Relevance, Usefulness, and Benefits of Mobile Messaging**

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

1
2
3 324 women, emphasized its direct applicability to their health needs, such as reminders for
4
5 325 antenatal visits and tailored advice. Male participants often described mobile health
6
7 326 interventions in terms of supporting household decision-making. Similarly, key informants
8
9 327 (KI) provided more technical insights about the feasibility and implementation of mobile
10
11 328 messaging, while in-depth interview (IDI) respondents shared more personal experiences and
12
13 329 perceptions of its usefulness in their everyday lives.

14
15
16
17 330 *"...mobile phone interventions are accessible at all times and can provide convenient and*
18
19 331 *personalized messages to pregnant women."*

20
21 332 **Perceived Usefulness and Relevance:** According to the majority of the study participants,
22
23 333 mobile phone-based messaging can ensure that pregnant women receive care at the right time
24
25 334 by encouraging them to visit health facilities when needed. It also empowers them to
26
27 335 maintain a healthy life for themselves and their babies throughout the pregnancy and beyond
28
29 336 by promoting self-care, adherence to advice, shared responsibility, and improved health-
30
31 337 seeking behavior. This, in turn, can result in favorable health outcomes for both mother and
32
33 338 baby, while also enhancing their satisfaction with the care they receive. Pregnant women
34
35 339 often have multiple household responsibilities, which can make it challenging for them to
36
37 340 access health information through conventional media such as health workers, printed
38
39 341 materials, radio, and television. In such situations, mobile phone-based interventions may be
40
41 342 the best option to educate mothers at their convenience.

42
43
44
45 343 *"...women with busy schedules prefer mobile phones over conventional media outlets to seek*
46
47 344 *health information due to time constraints."*

48 49 50 51 345 **Prior Experience or Exposure to Mobile Phone Messaging**

52
53 346 **Access to and Source of Information on Maternal and Newborn Care:** The majority of
54
55 347 KII and IDI participants reported that health extension workers, community meetings, women
56
57 348 development groups, health workers, and media outlets such as radio and television serve as

1
2
3 349 common sources of health-related information. Rural communities rely heavily on health
4
5 350 extension workers and radio broadcasts, while urban communities access health information
6
7
8 351 through televised programs, radio, and health workers.

9
10 352 *"...we get pregnancy and child care information from different places like health workers,*
11
12 353 *peers, health extension workers, the 'Hello Doctor' television (TV) program, radio, and more."*

13
14 354 **Mobile Phone Availability and Usage:** Participants reported significant differences in
15
16 355 mobile phone availability and usage between urban and rural areas. Urban households
17
18 356 typically have up to four phones, but usage is mainly limited to voice calls, with incoming
19
20 357 SMS often overlooked due to low literacy and promotional texts. In rural settings, most
21
22 358 households have at least one mobile phone, and its usage is similar to that of urban
23
24 359 counterparts. However, in rural areas, in some households, only male partners have autonomy
25
26 360 over mobile phone usage.

27
28 361 *"...the use of mobile phones is hindered by low literacy levels, a high volume of promotional*
29
30 362 *messages, and the digital divide among family members."*

31
32 363 **Experiences:** The majority of the study participants revealed that there are no mobile health
33
34 364 (mHealth) interventions for pregnant women in their area. Health messages can only be
35
36 365 accessed through subscription, and this generally applies only to general health information.

37
38 366 *"...there are no specific health messages sent to our mobiles to promote maternal and*
39
40 367 *newborn health."*

41
42 368 A few participants reported that a mobile-based intervention called ComCare was piloted five
43
44 369 years ago. According to their observations, such interventions could ensure optimal
45
46 370 pregnancy and newborn care by enhancing access to health information, supporting health
47
48 371 workers in delivering high-quality care, and empowering women and their families to make
49
50 372 informed decisions about their health.

51
52
53
54
55
56
57
58
59 373
60

374 **Willingness and Readiness to Receive and Engage in Mobile Phone Messaging**

375 **Willingness:** Participants at all research sites consistently expressed positive willingness and
376 readiness to engage in mobile phone messaging interventions aimed at improving maternal
377 and newborn health. However, it is crucial to involve indigenous communities and relevant
378 stakeholders to gain a deeper understanding of their perspectives, customs, and principles
379 regarding maternal and newborn health.

380 *“...I am pleased to see that more and more people are willing to participate in mobile-based*
381 *interventions...”*

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

389 *“... involving all family members in the intervention can help promote shared responsibility*
390 *for the family's health.”*

391 **Best time for mothers to receive and read messages:** The best times to receive messages
392 are around noon and early in the morning (between 12:00 and 1:00). During these hours,
393 women are more likely to be free from work commitments and other engagements, making
394 them more receptive to receiving messages.

395 **Preferences for language and mode of message delivery:** The majority of the participants
396 expressed a preference for Afan Oromo, which is the mother tongue of the Oromo people and
397 one of the official languages of Ethiopia.

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

400 **Perceived Barriers and Challenges to Mobile Phone Messaging**

401 The barriers to implementing mobile phone messaging interventions in maternal and newborn
402 health can be categorized into six key dimensions based on their conceptual closeness.

403 **Low Mobile Health Literacy**

404 According to our results, challenges related to mobile health literacy encompass issues such
405 as a lack of reading culture for messages, low literacy levels among pregnant women and
406 their partners, and difficulties in comprehending the messages received due to literacy
407 barriers. This poses a particularly significant problem for short messages, as they usually
408 require limited wording and may lack context or detail, making them difficult to understand
409 for low-literacy individuals. Face-to-face communication and audio-only messages can
410 provide much more clarity in tone and explanation, whereas text messages demand a certain
411 level of reading proficiency and familiarity with written health information. Moreover,
412 limited exposure to digital health communication further exacerbates these comprehension
413 difficulties.

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

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

423 *“.. male partners have more access to mobile phones and have decision making power over
424 other household resources .”*

1
2
3 425 **Technology-related challenge:** According to this study, challenges such as network
4
5 426 disruptions, power-related issues (e.g., frequent power outages affecting phone usage), and
6
7 427 inadequate technological infrastructure in certain areas can impede the smooth delivery and
8
9 428 reception of mobile health messages.

10
11
12 429 *"... network dropouts are common, lasting up to 1-2 days at times. Power is another obstacle;*
13
14 430 *women often have to travel to urban areas to charge their mobile devices."*

15
16 431 Mobile network coverage varies between urban and rural areas, with the best coverage
17
18 432 generally found in urban areas. Residents in urban areas enjoy relatively uninterrupted
19
20 433 connectivity, allowing them to access a variety of mobile services. However, in rural areas,
21
22 434 there is limited network service, which challenges residents' ability to access a range of
23
24 435 mobile services.

25
26
27 436 *"...the mobile network is relatively good in urban areas compared to rural ones. There are*
28
29 437 *more complaints from rural communities than urban regarding network connectivity."*

30
31
32 438 **Family Dynamics and Communication:** The results of this study show issues such as
33
34 439 limited family dialogue and challenges in ensuring that health information reaches all
35
36 440 relevant family members. Some of the study participants reported that there may be a lack of
37
38 441 discussion within families, where messages sent to one mobile device are not shared among
39
40 442 family members, limiting the intervention's reach and impact.

41
42
43 443 **Traditional healing practice and beliefs:** This includes challenges related to community
44
45 444 reliance on traditional healing rituals and preferences for traditional medicine over modern
46
47 445 health interventions, particularly during complications or pregnancy-related issues. Often,
48
49 446 pregnant women opt for traditional medicine, and in many instances, families employ local
50
51 447 rituals and traditional remedies for the treatment of newborns.

52
53
54 448 *"... women visit health facilities when the condition worsens; otherwise, they prefer*
55
56 449 *traditional medicine."*

1
2
3 450 **Timing and disclosure issue:** In this study, challenges such as late pregnancy disclosure,
4
5 451 where pregnancies are not revealed until they are visibly evident, lead to delayed antenatal
6
7 452 care and potential care-seeking. There are also difficulties in accurately recalling the last
8
9 453 menstrual period. The majority of study participants indicated that it is not customary to
10
11 454 disclose a pregnancy due to concerns about potential adverse outcomes such as abortion, fetal
12
13 455 death, and other related issues. Pregnancy becomes publicly known within the community
14
15 456 when the woman's abdomen visibly enlarges to the point where it becomes difficult to
16
17 457 conceal. Women tend to seek antenatal care and related services once the pregnancy naturally
18
19 458 becomes evident due to the increase in abdominal size.

20
21
22
23
24 459 *"...we keep our pregnancy a secret until our belly visibly grows larger. Even if we face any*
25
26 460 *health issues during this period, we choose to consult traditional healers instead."*

27
28 461 According to the majority of study participants, women often struggle to recall the exact date
29
30 462 of their last menstruation. Healthcare providers opt for rough estimations or rely on
31
32 463 associations with various events to determine a woman's last menstrual period follow fundal
33
34 464 height measurement or rely on ultrasound readings where available.

35
36
37 465 *"...they (women) were unable to recall their last menstrual period, which hinders*
38
39 466 *interventions that rely on this information."*

40
41
42 467 **Frequent promotional messages:** According to most study participants, essential messages
43
44 468 may go unnoticed or disregarded due to the constant entry of promotional messages from
45
46 469 Ethio-Telecom. They mentioned that the community may link the intervention with the
47
48 470 overwhelming volume of messages they receive on their mobile phones.

49
50
51 471 *"...we almost ignore reading incoming messages due to the high volume of promotional*
52
53 472 *messages."*

54 473 **Enablers and facilitators of mobile phone messaging**

55
56
57 474 **Reinforcing strategies:** According to the majority of study participants, the availability of
58
59 475 women's forums and home-to-home visit strategies can support the implementation of mobile

1
2
3 476 phone messaging-based interventions, enabling mothers to put into practice what they have
4
5 477 learned through the messaging intervention. Health extension workers can conduct home
6
7 478 visits to locate and encourage mothers to act on the messages.
8
9

10 479 *"... pregnant women forum and home-to-home visits by HEWs can support the mobile phone-*
11
12 480 *based messaging intervention."*
13

14 481 **Traditional community networking:** Acknowledged by study participants, community-
15
16 482 oriented networking like idirs, ikubs, and social groups enhances maternal and newborn
17
18 483 health through timely pregnancy detection, adherence to treatment plans, and support for
19
20 484 pregnant mothers.
21
22

23 485 *"...community-based organizations can support Mobile phone messaging intervention*
24
25 486 *through early pregnancy identification and notification."*
26
27

28 487 **Mobile phone penetration and positive attitude:** Participants across the study sites
29
30 488 mentioned that the community has a positive perception of mobile phone-based messaging
31
32 489 interventions. According to the study participants, mobile phone-based interventions can be
33
34 490 effective in improving antenatal care uptake, promoting birth preparedness and complication
35
36 491 readiness, and increasing rates of timely postnatal care and exclusive breastfeeding.
37
38

39 492 **Convenience and accessibility:** The majority of study participants reported that mobile
40
41 493 phone messaging is convenient and provides instant communication, regardless of distance or
42
43 494 time limitations. According to them, users have the flexibility to send and receive messages
44
45 495 whenever they want, allowing for asynchronous communication.
46
47

48 496 **Cost-effectiveness:** The majority of study participants reported that there are no costs
49
50 497 associated with participating in mobile phone-based messaging interventions, except for
51
52 498 indirect costs such as traveling to urban areas to recharge batteries.
53
54

55 499

56 500

57 501

502 Discussion

503 Mobile phone messaging for the promotion of healthy practices for maternal and newborn
504 health is increasingly accepted as one of the effective emerging strategies [9,33]. The current
505 study indicated that mobile phone-based messaging was perceived as highly relevant and
506 useful among the majority of participants, which aligns with studies conducted in Ethiopia by
507 Mekonnen et al. (2021) and Gebremariam et al. (2020), who highlighted the acceptability,
508 barriers, and facilitators of mobile text message reminders for child vaccination and infant
509 feeding education [34,35].

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

514 The current study also revealed that most participants expressed a high willingness and
515 readiness to receive and actively engage with mobile messaging interventions. This finding is
516 in line with studies conducted in Ethiopia by Mekonnen et al. (2021), underlining the
517 acceptability, barriers, and facilitators of mobile text message reminder systems for child
518 vaccination [34],), and a study by Walle et al. (2023), which presents healthcare
519 professionals' intention to adopt mobile phone-based SMS for adherence support and TB care
520 [37]. These findings reflect a positive attitude towards using mobile messaging as a tool to
521 promote maternal and newborn health.

522 The feasibility and scalability of mHealth interventions depend on mobile phone ownership
523 among rural women. At the national level, feature phone ownership among rural Ethiopian
524 women is low [38]. In our study area, one of the studies carried out as part of a large cRCT
525 by Abdissa et al. (2024) showed that 69.5% of women owned feature phones [39]. Given the
526 low level of mobile phone access among households, and especially among women, adding

1
2
3 527 other social and behavior change mechanisms will be important to maximize impact.
4
5 528 Community-based approaches, including involving health extension workers, community
6
7 529 volunteers, religious leaders, and women's groups, can help reinforce key maternal health
8
9 530 messages. Strengthening ANC counseling, peer support groups, and male involvement could
10
11 531 further complement mobile-based interventions for broader maternal health behavior change.
12
13 532 In this study, conventional sources of information such as community health workers,
14
15 533 community meetings, and local media outlets remain crucial, but text messaging through
16
17 534 mobile phones was rarely reported. These findings align with studies conducted by Matera et
18
19 535 al. (2023) and Feroz et al. (2020) [40,41].
20
21
22 536 The current study identified various barriers to mobile phone messaging-based message
23
24 537 framing interventions. One major barrier is low mobile health literacy, which is notably
25
26 538 pronounced among rural women. Similarly, a study by Warner et al. (2023) in Ethiopia,
27
28 539 where mobile phone penetration is increasing but digital literacy remains low, found that
29
30 540 mHealth literacy is a critical barrier [38]. There were disparities in mobile phone availability
31
32 541 and usage between urban and rural areas within the study areas. Similarly, across Ethiopia,
33
34 542 Kenya, Bangladesh, and Nigeria, urban areas consistently have higher mobile phone
35
36 543 availability and usage compared to rural areas. Rural populations, particularly women, face
37
38 544 barriers such as poor infrastructure, low income, limited education, and cultural restrictions.
39
40 545 There were disparities in mobile phone availability and usage between urban and rural areas
41
42 546 within the study areas. Similarly, across Ethiopia, Kenya, Bangladesh, and Nigeria, urban
43
44 547 areas consistently have higher mobile phone availability and usage compared to rural areas.
45
46 548 Rural populations, particularly women, face barriers such as poor infrastructure, low income,
47
48 549 limited education, and cultural restrictions [42].
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 551 The current study indicated a prevailing male dominance over resource control at the
4
5 552 household level, which affects women's access to mobile devices, potentially reducing the
6
7 553 effectiveness and reach of messaging through mobile phones. This result echoes findings
8
9 554 from a study conducted by Mars (2017) in Sub-Saharan Africa [43]. Technical challenges
10
11 555 like poor signal strength and electricity interruptions were reported by the majority of
12
13 556 participants. This finding aligns with a study by Andresen et al. (2023), which emphasizes the
14
15 557 universal importance of reliable network connectivity and alternative power sources for
16
17 558 sustaining effective mobile health interventions [44].

18
19 559 The study revealed a notable lack of family discussions regarding maternal and newborn
20
21 560 health across the study areas, which could result in a lack of sharing and discussion of
22
23 561 messages received through the mobile messaging intervention. This finding is supported by
24
25 562 the realist synthesis by Kabongo et al. (2021), which pointed out similar challenges in
26
27 563 message engagement and dissemination within families [45].

28
29 564 The delay in revealing pregnancies until they are visibly apparent, along with challenges in
30
31 565 accurately estimating gestational age due to difficulties in recalling the last menstrual period,
32
33 566 was another barrier identified by this study. This finding aligns with existing studies,
34
35 567 including UNFPA (2022), Kingdon et al. (2018), Goldberg and El-Sayed (2017), and Majola
36
37 568 et al. (2021), which highlight similar challenges in delaying pregnancy disclosure and
38
39 569 estimating gestational age [46–49]. These challenges may impede the timely and effective
40
41 570 delivery of interventions aimed at improving maternal and newborn health.

42
43 571 The frequent inflow of promotional messages was another challenge reported by the majority
44
45 572 of participants. Similarly, a study by Mao et al. (2022) found that continuous exposure to
46
47 573 promotional content raises consumer skepticism, making individuals question the authenticity
48
49 574 and motives of health messages, leading to decision fatigue and hindering individuals from
50
51 575 prioritizing and acting on health recommendations[50]. This indicates that it is essential to
52
53
54
55
56
57
58
59
60

1
2
3 576 develop strategies to ensure that health messages stand out and become unique among a sea
4
5 577 of information entering mobile phones.
6

7
8 578 The current study also identified critical enablers to the implementation of mobile phone
9
10 579 messaging interventions. One of the main enablers reported was the use of intermediaries like
11
12 580 community health workers. Similarly, a study by Mahmood et al. (2020) found success in
13
14 581 using community health workers (CHWs) as intermediaries for mobile health messages due
15
16 582 to their embedded trust and community presence, enabling effective health communication
17
18 583 [51].
19

20
21 584 Positive attitudes were other enablers for mobile phone messaging-based interventions.
22
23 585 Positive attitudes set the stage for a receptive environment, nurturing engagement with the
24
25 586 potential benefits they offer. This is supported by a study by Yang and Van Stee (2019),
26
27 587 which found that high mobile phone penetration and positive attitudes increase the
28
29 588 effectiveness of interventions [52]. Traditional community networking, such as idirs, ikubs
30
31 589 (Ethiopian social institutions for mutual support and savings), and other social groups, was
32
33 590 another facilitator of mobile phone-based messaging interventions. These community-rooted
34
35 591 networks can contribute to the effectiveness of mobile phone-based messaging by assisting
36
37 592 with pregnancy detection, treatment adherence, and providing support to mothers. Similarly,
38
39 593 a study by Mengesha et al. (2023) in rural Ethiopia showed the positive influence of
40
41 594 traditional community networks in a mobile health intervention [53].
42
43
44
45

46
47 595 This study had some limitations. First, it is context-bound, so the generalization of the
48
49 596 findings to settings with different socio-cultural and technological backgrounds may be
50
51 597 limited. Second, the qualitative design does not allow for quantification of identified barriers
52
53 598 and enablers, making it difficult to assess the magnitude of each. Lastly, the limited mobile
54
55 599 phone ownership and digital literacy among rural women might have influenced the depth of
56
57 600 the insights obtained on mobile health interventions. Despite these limitations, this study
58
59
60

1
2
3 601 provides valuable evidence concerning the feasibility and challenges of using mobile
4
5 602 messaging for maternal and newborn health in rural Ethiopia.
6
7

8 603 **Conclusion**

9

10 604 The study identified that participants generally understand the benefits of mobile phone
11
12 605 messaging in improving maternal and newborn health, perceiving it as a relevant and useful
13
14 606 tool for enhancing health knowledge, care-seeking behaviors, and confidence in caring for
15
16 607 mothers and babies. However, rural women often lack confidence in reading and
17
18 608 comprehending SMS messages. Despite limited prior experience with mobile health
19
20 609 messaging and a lack of confidence in reading and understanding SMS messages, there was
21
22 610 strong willingness and readiness among participants to receive and engage with mobile phone
23
24 611 messaging interventions, indicating a positive outlook for the implementation of mobile
25
26 612 messaging interventions.
27
28

29 613 This study identified challenges, including low mobile health literacy, gender and cultural
30
31 614 barriers, technology-related issues, preference for traditional healing practices, urban-rural
32
33 615 disparities in mobile phone access, and male dominance in resource control, all of which
34
35 616 could limit the effectiveness of these interventions. Despite these challenges, enablers such as
36
37 617 community-based support networks, traditional community structures like idirs and ikubs,
38
39 618 home-to-home visits, the high penetration of mobile phones in urban areas, and positive
40
41 619 community attitudes toward mobile-based interventions can support the success of mobile
42
43 620 messaging interventions. To maximize the impact of mobile phone messaging, stakeholders
44
45 621 must ensure cultural sensitivity, address infrastructural challenges, and foster a supportive
46
47 622 environment. Engaging community leaders, health workers, and families, along with
48
49 623 reinforcing strategies such as women's forums and community health workers, will be key to
50
51 624 the effectiveness and reach of mobile phone messaging-based message framing interventions.
52
53
54
55
56
57
58
59
60

1
2
3 625 Understanding potential barriers and enablers can provide evidence-based support for
4
5 626 initiatives that consider mobile health solutions to promote healthy practices in maternal and
6
7 627 newborn care. Considering the preferred language, timing, and modes of message delivery,
8
9 628 providing orientation to study participants and their families before rolling out the
10
11 629 intervention, and actively involving families in the intervention process are all essential for its
12
13 630 effectiveness. Additionally, tailoring messages to accommodate multiple mobile phones
14
15 631 within a family is crucial for ensuring optimal reach and impact.

19 632 **Acknowledgments**

22 633 We extend heartfelt gratitude to the Jimma Zone Health Office for their unwavering support.
23
24 634 We also appreciate the study participants for their valuable contributions and the time they
25
26 635 generously dedicated to this research.

29 636 **Abbreviations**

31 637	CHW	Community Health Workers
33 638	ETB	Ethiopian Birr
35 639	HEW	Health Extension Workers
37 640	IDI	In-depth Interview
39 641	IRB	Institute of Review Board
41 642	KII	Key Informant Interview
43 643	MCH	Maternal and Child Health
45 644	MMS	Multimedia Messaging Services
47 645	PHCU	Primary Health Care Unit
49 646	SMS	Short Message Service
51 647	TV	Television
53 648	5G	Fifth Generation

1
2
3 650 **Declarations**

4
5
6 651 **Consent for publication**

7
8 652 Not applicable

9
10
11 653 **Data availability**

12
13 654 Not applicable

14
15 655 **Funding**

16
17
18 656 This work was funded by grants for postgraduate students from Jimma University, along with
19
20 657 additional smaller grants from the same institution; it does not necessarily reflect the interest
21
22 658 of these organizations.

23
24
25 659 **Conflicts of interests**

26
27 660 The authors declare that there are no competing interests.

28
29
30 661 **Authors' contributions**

31
32 662 GB contributed to the inception, design, analysis, and manuscript writing. HG was involved
33
34 663 in the inception, design, and critical review of the manuscript. DA participated in the design
35
36 664 and review of the manuscript. ZB was involved in the design process and critical review of
37
38 665 the manuscript. The final manuscript was read and approved by all authors. GB is the
39
40 666 guarantor of the research and is entirely responsible for the overall content, ensuring that all
41
42 667 parts of the research are correct and properly explored.

43
44
45 668 **Figure Legend:**

46
47
48 669 Fig. 1. Thematic Groups of Results. The diagram shows the five most important thematic
49
50 670 groups that were derived from the study: (A) awareness, perceived relevance, usability, and
51
52 671 utility, and benefit of mobile phone messaging; (B) pre-exposure or prior experience of
53
54 672 mobile phone messaging; (C) willingness and preparedness for receiving and reading mobile
55
56 673 phone messaging; (D) perceived limitation and constraints to mobile phone messaging; and
57
58
59
60

1
2
3 674 (E) enablers and facilitators for mobile phone messaging. These were arrived at through
4
5 675 thematic analysis and represent the study's main findings.
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.
Enseignement Supérieur (ABES)

677 **References**

- 678 1. Haileamlak, A. Maternal and Newborn Mortality- Still the Greatest Disparity between
679 Low-Income and High-Income Countries. *Ethiop. J. Health Sci.* **2018**, *28*, 368,
680 doi:10.4314/ejhs.v28i4.1.
- 681 2. Bauserman, M.; Thorsten, V.R.; Nolen, T.L.; Patterson, J.; Lokangaka, A.; Tshetu, A.;
682 Patel, A.B.; Hibberd, P.L.; Garces, A.L.; Figueroa, L.; et al. Maternal Mortality in Six
683 Low and Lower-Middle Income Countries from 2010 to 2018: Risk Factors and
684 Trends. *Reprod. Health* **2020**, *17*, 1–10, doi:10.1186/s12978-020-00990-z.
- 685 3. Coleman, J.; Eriksen, J.; Black, V.; Thorson, A.; Hatcher, A. The Mobile Alliance for
686 Maternal Action Text Message-Based MHealth Intervention for Maternal Care in
687 South Africa: Qualitative User Study. *JMIR Hum. factors* **2020**, *7*, e14078,
688 doi:10.2196/14078.
- 689 4. WHO Maternal Mortality Fact Sheet. **2023**.
- 690 5. Ayele, A.A.; Getaye Tefera, Y.; East, L. Ethiopia's Commitment towards Achieving
691 Sustainable Development Goal on Reduction of Maternal Mortality: There Is a Long
692 Way to Go. *Women's Heal.* **2021**, *17*, 0–3, doi:10.1177/17455065211067073.
- 693 6. Lunze, K.; Higgins-Steele, A.; Simen-Kapeu, A.; Vesel, L.; Kim, J.; Dickson, K.
694 Innovative Approaches for Improving Maternal and Newborn Health - A Landscape
695 Analysis. *BMC Pregnancy Childbirth* **2015**, *15*, doi:10.1186/s12884-015-0784-9.
- 696 7. Kifle, D.; Azale, T.; Gelaw, Y.A.; Melsew, Y.A. Maternal Health Care Service
697 Seeking Behaviors and Associated Factors among Women in Rural Haramaya District,
698 Eastern Ethiopia: A Triangulated Community-Based Cross-Sectional Study. *Reprod.*
699 *Health* **2017**, *14*, 1–11, doi:10.1186/s12978-016-0270-5.
- 700 8. Musiimenta, A.; Tumuhimbise, W.; Mugenyi, G.; Katusiime, J.; Atukunda, E.;
701 Pinkwart, N. A Mobile Phone-Based Multimedia Application Could Improve Maternal

- 1
2
3 702 Health in Rural Southwestern Uganda: Mixed Methods Study. *Online J. Public Health*
4
5 703 *Inform.* **2020**, *12*, 1–17, doi:10.5210/ojphi.v12i1.10557.
6
7
8 704 9. Murthy, N.; Chandrasekharan, S.; Prakash, M.P.; Ganju, A.; Peter, J.; Kaonga, N.;
9
10 705 Mechael, P. Effects of an MHealth Voice Message Service (MMitra) on Maternal
11
12 706 Health Knowledge and Practices of Low-Income Women in India: Findings from a
13
14 707 Pseudo-Randomized Controlled Trial. *BMC Public Health* **2020**, *20*, 820,
15
16 708 doi:10.1186/s12889-020-08965-2.
17
18
19 709 10. De, P.; Pradhan, M.R. Effectiveness of Mobile Technology and Utilization of Maternal
20
21 710 and Neonatal Healthcare in Low and Middle-Income Countries (LMICs): A
22
23 711 Systematic Review. *BMC Womens. Health* **2023**, *23*, 1–9, doi:10.1186/s12905-023-
24
25 712 02825-y.
26
27
28 713 11. Coleman, J.; Black, V.; Thorson, A.E.; Eriksen, J. Evaluating the Effect of Maternal
29
30 714 MHealth Text Messages on Uptake of Maternal and Child Health Care Services in
31
32 715 South Africa: A Multicentre Cohort Intervention Study. *Reprod. Health* **2020**, *17*, 160,
33
34 716 doi:10.1186/s12978-020-01017-3.
35
36
37 717 12. Ethiopian Public Health Institute (EPHI); ICF *Ethiopia Mini Demographic and Health*
38
39 718 *Survey 2019: Final Report*; 2021; ISBN 2511127547.
40
41
42 719 13. Telecom, E.; Lte, V. Ethio Telecom Introduces New Communication Services. **2023**,
43
44 720 3–4.
45
46
47 721 14. Maita, K.C.; Maniaci, M.J.; Haider, C.R.; Avila, F.R.; Torres-Guzman, R.A.; Borna, S.;
48
49 722 Lunde, J.J.; Coffey, J.D.; Demaerschalk, B.M.; Forte, A.J. The Impact of Digital
50
51 723 Health Solutions on Bridging the Health Care Gap in Rural Areas: A Scoping Review.
52
53 724 *Perm. J.* **2024**, *28*, 1–14, doi:10.7812/tpp/23.134.
54
55
56 725 15. Chowdhury, S.; Chakraborty, P. pratim Universal Health Coverage - There Is More to
57
58 726 It than Meets the Eye. *J. Fam. Med. Prim. Care* **2017**, *6*, 169–170,
59
60

- 1
2
3 727 doi:10.4103/jfmmpc.jfmmpc.
4
5 728 16. Zoltán Rónay; Ewelina K Niemczyk *New Challenges to Education: Lessons from*
6
7 *Around the World*; 2021; ISBN 9786197326116.
8 729
9
10 730 17. Choudhury, A.; Choudhury, M. Mobile for Mothers MHealth Intervention to Augment
11
12 731 Maternal Health Awareness and Behavior of Pregnant Women in Tribal Societies:
13
14 732 Randomized Quasi-Controlled Study. *JMIR mHealth uHealth* **2022**, *10*, e38368,
15
16 733 doi:10.2196/38368.
17
18 734 18. Ye, M. Use of Mobile Phone to Promote Governance and Equity within the Health
19
20 735 System: Experience of Rural Health District in Burkina Faso. *J. Healthc. Commun.*
21
22 736 **2016**, *1*, 1–11, doi:10.4172/2472-1654.100017.
23
24 737 19. Oyeyemi, S.O.; Wynn, R. The Use of Cell Phones and Radio Communication Systems
25
26 738 to Reduce Delays in Getting Help for Pregnant Women in Low- and Middle-Income
27
28 739 Countries: A Scoping Review. **2015**, *1*.
29
30 740 20. Chib, A. *Afterword: Reflections on a Decade of MHealth Innovation in Asia*; 2018;
31
32 741 ISBN 9789402412505.
33
34 742 21. Lee, S.H.; Nurmatov, U.B.; Nwaru, B.I.; Mukherjee, M.; Grant, L.; Pagliari, C.
35
36 743 Effectiveness of MHealth Interventions for Maternal, Newborn and Child Health in
37
38 744 Low-and Middle-Income Countries: Systematic Review and Meta-Analysis. *J. Glob.*
39
40 745 *Health* **2016**, *6*, 1–17.
41
42 746 22. Scott, K.; Shinde, A.; Ummer, O.; Yadav, S.; Sharma, M.; Purty, N.; Jairath, A.;
43
44 747 Chamberlain, S.; Lefevre, A.E. Freedom within a Cage: How Patriarchal Gender
45
46 748 Norms Limit Women's Use of Mobile Phones in Rural Central India. *BMJ Glob. Heal.*
47
48 749 **2021**, *6*, 1–11, doi:10.1136/bmjgh-2021-005596.
49
50 750 23. Bhattacharya, A. Rural Indian Women Are Lagging Far behind Their Urban
51
52 751 Counterparts in Mobile Phone Usage. **2018**, 1–11.
53
54
55
56
57
58
59
60

- 1
2
3 752 24. Dobson, R.; Whittaker, R.; Bartley, H.; Connor, A.; Chen, R.; Ross, M.; McCool, J.
4
5 753 Development of a Culturally Tailored Text Message Maternal Health Program:
6
7 754 TextMATCH. *JMIR Mhealth Uhealth* **2017**, *5*, e49, doi:10.2196/mhealth.7205.
8
9
10 755 25. Abane, A.M.; Mariwah, S.; Owusu, S.A.; Kasim, A.; Robson, E.; Hampshire, K.
11
12 756 Mobile Phone Use and the Welfare of Community Health Nurses in Ghana: An
13
14 757 Analysis of Unintended Costs. *World Dev. Perspect.* **2021**, *23*, 100317,
15
16 758 doi:https://doi.org/10.1016/j.wdp.2021.100317.
17
18
19 759 26. Amare, D.; Addis Alene, K.; Ambaw, F. Acceptability of Integrating Traditional
20
21 760 Tuberculosis Care with Modern Healthcare Services in the Amhara Regional State of
22
23 761 Northwest Ethiopia: A Qualitative Study. *Prev. Med. Reports* **2023**, *34*, 102231,
24
25 762 doi:10.1016/j.pmedr.2023.102231.
26
27
28 763 27. Bhandari, B.; Narasimhan, P.; Jayasuriya, R.; Vaidya, A.; Schutte, A.E. Effectiveness
29
30 764 and Acceptability of a Mobile Phone Text Messaging Intervention to Improve Blood
31
32 765 Pressure Control (TEXT4BP) among Patients with Hypertension in Nepal: A
33
34 766 Feasibility Randomised Controlled Trial. *Glob. Heart* **2022**, *17*, doi:10.5334/GH.1103.
35
36
37 767 28. Nigussie, Z.Y.; Zemicheal, N.F.; Tiruneh, G.T.; Bayou, Y.T.; Teklu, G.A.; Kibret, E.S.;
38
39 768 Eifler, K.; Hodsdon, S.E.; Altaye, D.E.; Rosenblum, L.; et al. Using Mhealth to
40
41 769 Improve Timeliness and Quality of Maternal and Newborn Health in the Primary
42
43 770 Health Care System in Ethiopia. *Glob. Heal. Sci. Pract.* **2021**, *9*, 668–681,
44
45 771 doi:10.9745/GHSP-D-20-00685.
46
47
48 772 29. Gilano, G.; Dekker, A.; Fijten, R. The Role of MHealth Intervention to Improve
49
50 773 Maternal and Child Health: A Provider-Based Qualitative Study in Southern Ethiopia.
51
52 774 *PLoS One* **2024**, *19*, 1–19, doi:10.1371/journal.pone.0295539.
53
54
55 775 30. Fetter, D.S.; Dharmar, M.; Lawry-Hall, S.; Pressman, J.; Chapman, J.; Scherr, R.E.
56
57 776 The Influence of Gain-Framed and Loss-Framed Health Messages on Nutrition and
58
59
60

- 1
2
3 777 Physical Activity Knowledge. *Glob. Pediatr. Heal.* **2019**, *6*, 2333794X19857405,
4
5 778 doi:10.1177/2333794X19857405.
6
7
8 779 31. Denizard-Thompson, N.M.; Feiereisel, K.B.; Stevens, S.F.; Miller, D.P.; Wofford, J.L.
9
10 780 The Digital Divide at an Urban Community Health Center: Implications for Quality
11
12 781 Improvement and Health Care Access. *J. Community Health* **2011**, *36*, 456–460,
13
14 782 doi:10.1007/s10900-010-9327-5.
15
16
17 783 32. Bulcha, G.; Abdissa, H.G.; Noll, J.; Sori, D.A.; Birhanu, Z. Effectiveness of Mobile
18
19 784 Phone Messaging Based Message Framing Intervention for Improving Maternal
20
21 785 Health Service Uptake and New-Born Care Practice in Rural Jimma Zone, Ethiopia:
22
23 786 Protocol for Cluster Randomized Controlled Trial. *HMIR Res. Protoc.* **2024**.
24
25
26 787 33. Peiris, D.R.; Wijesinghe, M.S.D.; Gunawardana, B.M.I.; Weerasinghe, W.M.P.C.;
27
28 788 Rajapaksha, R.M.N.U.; Rathnayake, K.M.; Ranathunga, N.; Kalupahana, S.; Supun,
29
30 789 Y.A.; Deshpande, S.; et al. Mobile Phone-Based Nutrition Education Targeting
31
32 790 Pregnant and Nursing Mothers in Sri Lanka. *Int. J. Environ. Res. Public Health* **2023**,
33
34 791 *20*, doi:10.3390/ijerph20032324.
35
36
37 792 34. Mekonnen, Z.A.; Gelaye, K.A.; Were, M.C.; Tilahun, B. Acceptability , Barriers and
38
39 793 Facilitators of Mobile Text Message Reminder System Implementation in Improving
40
41 794 Child Vaccination : A Qualitative Study in Northwest Ethiopia. *J. Multidiscip. Healthc.*
42
43 795 **2021**, *14*, 605–616.
44
45
46 796 35. Gebremariam, K.T.; Zelenko, O.; Hadush, Z.; Mulugeta, A.; Gallegos, D. Could
47
48 797 Mobile Phone Text Messages Be Used for Infant Feeding Education in Ethiopia? A
49
50 798 Formative Qualitative Study. *Health Informatics J.* **2020**, *26*, 2614–2624,
51
52 799 doi:10.1177/1460458220911779.
53
54
55
56 800 36. Alsahli, S.; Hor, S.-Y.; Lam, M. Factors Influencing the Acceptance and Adoption of
57
58 801 Mobile Health Apps by Physicians During the COVID-19 Pandemic: Systematic
59
60

- 1
2
3 802 Review. *JMIR mHealth uHealth* **2023**, *11*, e50419, doi:10.2196/50419.
- 4
5 803 37. Walle, A.D.; Hunde, M.K.; Demsash, A.W. Healthcare Professionals' Intention to
6
7 804 Adopt Mobile Phone-Based SMS and Its Predictors for Adherence Support and Care
8
9 805 of TB Patients in a Resource-Limited Setting: A Structural Equation Modelling
10
11 806 Analysis. *BMJ Open* **2023**, *13*, 1–9, doi:10.1136/bmjopen-2022-070813.
- 12
13
14 807 38. Warner, J.; Mekonnen, Y.; Habte, Y. The Digital Divide in Rural Ethiopia
15
16 808 Determinants and Implications of Sex-Disaggregated Mobile Phone Ownership and
17
18 809 Use. **2023**.
- 19
20
21 810 39. Abdissa, H.G.; Duguma, G.B.; Ababulgu, F.A.; Lemu, Y.K. Pregnant Mother ' s
22
23 811 Intention to Use Mobile Phone - Based Messaging Interventions for Improving
24
25 812 Maternal and Newborn Health Practices in Jimma Zone , Ethiopia. *BMC Digit. Heal.*
26
27 813 **2024**, doi:10.1186/s44247-024-00094-9.
- 28
29
30
31 814 40. Materia, F.T.; Smyth, J.M.; Puoane, T.; Tsolekile, L.; Goggin, K.; Kodish, S.R.; Fox,
32
33 815 A.T.; Resnicow, K.; Wertz, S.; Catley, D. Implementing Text-Messaging to Support
34
35 816 and Enhance Delivery of Health Behavior Change Interventions in Low- to Middle-
36
37 817 Income Countries: Case Study of the Lifestyle Africa Intervention. *BMC Public Health*
38
39 818 **2023**, *23*, 1–14, doi:10.1186/s12889-023-16388-y.
- 40
41
42 819 41. Feroz, A.; Jabeen, R.; Saleem, S. Using Mobile Phones to Improve Community Health
43
44 820 Workers Performance in Low-and-Middle-Income Countries. *BMC Public Health*
45
46 821 **2020**, *20*, 1–6, doi:10.1186/s12889-020-8173-3.
- 47
48
49 822 42. Matthew Shanahan, K.B. The State of Mobile Internet Connectivity. **2024**.
- 50
51
52 823 43. Mars, M. Barriers and Opportunities to Implementation of Sustainable E-Health
53
54 824 Programmes in Uganda : A Literature Review. **2017**.
- 55
56 825 44. Andresen, A.X.; Kurtz, L.C.; Hondula, D.M.; Meerow, S.; Gall, M. Understanding the
57
58 826 Social Impacts of Power Outages in North America: A Systematic Review. *Environ.*

- 1
2
3 827 *Res. Lett.* **2023**, *18*, doi:10.1088/1748-9326/acc7b9.
- 4
5 828 45. Kabongo, E.M.; Mukumbang, F.C.; Delobelle, P.; ... Explaining the Impact of
6
7 829 MHealth on Maternal and Child Health Care in Low-and Middle-Income Countries: A
8
9 830 Realist Synthesis. *BMC pregnancy ...* **2021**, doi:10.1186/s12884-021-03684-x.
- 10
11 831 46. UNFPA Seeing the Unseen. The Case for Action in the Neglected Crisis of
12
13 832 Unintended Pregnancy. *State world Popul. 2022* **2022**, 1–160.
- 14
15 833 47. Kingdon, C.; Downe, S.; Betran, A.P. Interventions Targeted at Health Professionals to
16
17 834 Reduce Unnecessary Caesarean Sections: A Qualitative Evidence Synthesis. *BMJ*
18
19 835 *Open* **2018**, *8*, 1–14, doi:10.1136/bmjopen-2018-025073.
- 20
21 836 48. Goldberg, J.D.; El-sayed, Y.Y. Methods for Estimating the Due Date. **2017**.
- 22
23 837 49. Majola, L.; Budhram, S.; Govender, V.; Naidoo, M.; Godlwana, Z.; Lombard, C.;
24
25 838 Moodley, D. Reliability of Last Menstrual Period Recall, an Early Ultrasound and a
26
27 839 Smartphone App in Predicting Date of Delivery and Classification of Preterm and
28
29 840 Post-Term Births. *BMC Pregnancy Childbirth* **2021**, *21*, 493, doi:10.1186/s12884-021-
30
31 841 03980-6.
- 32
33 842 50. Mao, B.; Jia, X.; Huang, Q. How Do Information Overload and Message Fatigue
34
35 843 Reduce Information Processing in the Era of COVID-19? An Ability–Motivation
36
37 844 Approach. *J. Inf. Sci.* **2022**, doi:10.1177/01655515221118047.
- 38
39 845 51. Mahmood, H.; Mckinstry, B.; Luz, S.; Fairhurst, K.; Nasim, S. Community Health
40
41 846 Worker-Based Mobile Health (MHealth) Approaches for Improving Management and
42
43 847 Caregiver Knowledge of Common Childhood Infections : A Systematic Review. **2020**,
44
45 848 *10*, doi:10.7189/jogh.10.020438.
- 46
47 849 52. Yang, Q.; Van Stee, S.K. The Comparative Effectiveness of Mobile Phone
48
49 850 Interventions in Improving Health Outcomes: Meta-Analytic Review. *JMIR mHealth*
50
51 851 *uHealth* **2019**, *7*, 1–14, doi:10.2196/11244.
- 52
53
54
55
56
57
58
59
60

- 1
2
3 852 53. Mengesha, E.W.; Tessema, G.A.; Assefa, Y.; Alene, G.D. Social Capital and Its Role
4
5 853 to Improve Maternal and Child Health Services in Northwest Ethiopia: A Qualitative
6
7 854 Study. *PLoS One* **2023**, *18*, 1–21, doi:10.1371/journal.pone.0284592.
8
9 855
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
25
26
27
28
29
30
31
32
33
34
35
36
37
38
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

For peer review only

Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies.
Enseignement Supérieur (ABES)

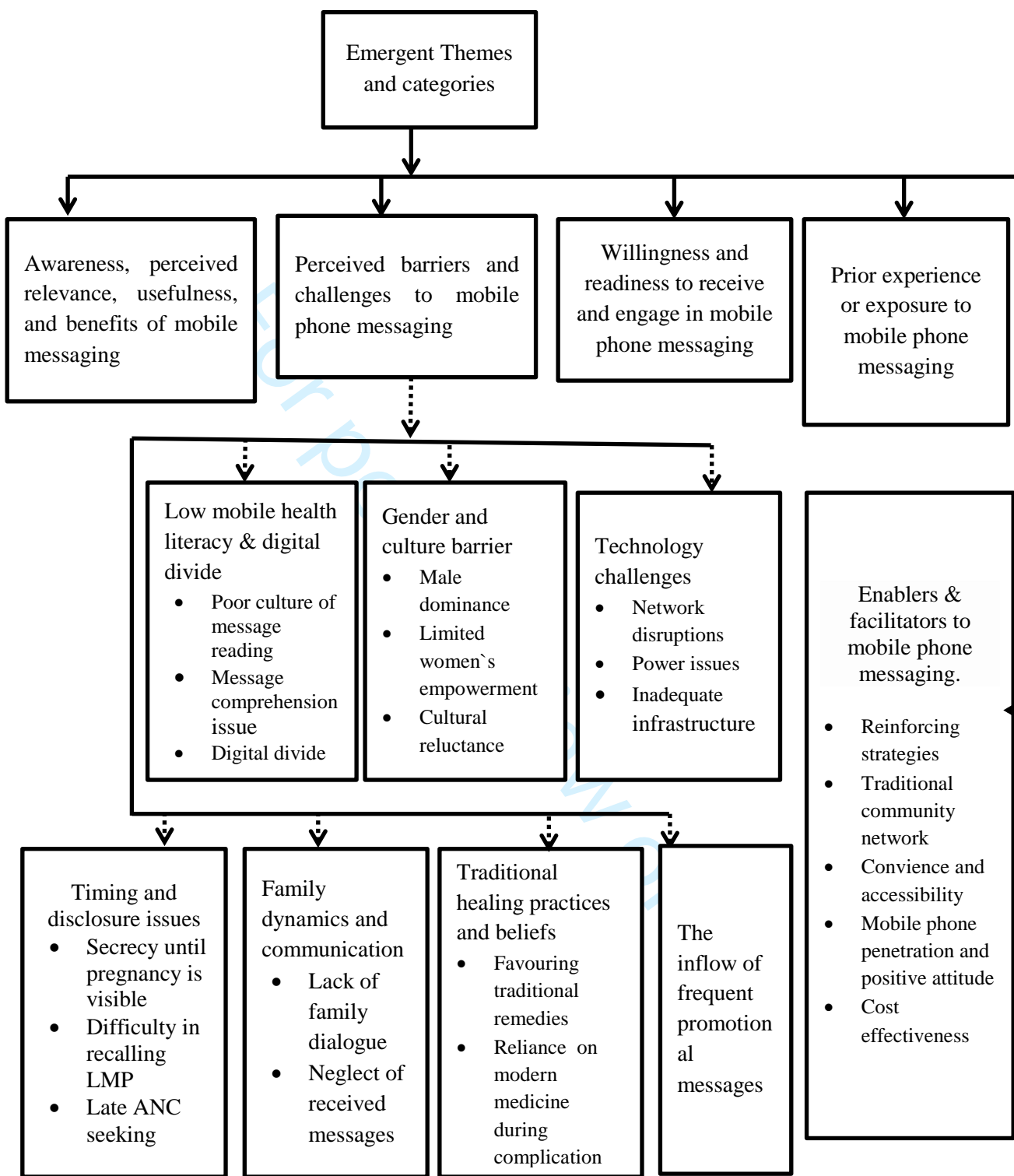
857 **Annex**

858 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)

859

860



Protected by copyright, including for uses related to text and data mining, AI training, and similar technologies. Engagement Supérieur (ABES)

Figure 1. Emerged themes and categories in the study of barriers and enablers in implementing 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

1	human subjects		consent, or explanation for lack thereof; other confidentiality and data security issues	
2	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
3				
4				
5				
6	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
7				
8				
9	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
10				
11	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
12				
13				
14				
15	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
16				
17				
18	Techniques to enhance trustworthiness	#15	Techniques to enhance trustworthiness and credibility of data analysis (e.g. member checking, audit trail, triangulation); rationale	11
19				
20	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
21				
22	Links to empirical data	#17	Evidence (e.g. quotes, field notes, text excerpts, photographs) to substantiate analytic findings	15-21
23				
24				
25	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
26				
27				
28				
29	Limitations	#19	Trustworthiness and limitations of findings	3, 25
30				
31	Conflicts of interest	#20	Potential sources of influence of perceived influence on study conduct and conclusions; how these were managed	28
32				
33	Funding	#21	Sources of funding and other support; role of funders in data collection, interpretation and reporting – no funding	28
34				
35				