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Study title: Development and Pilot Test of an mHealth Interactive Education and Social Support Intervention for Improving Postnatal Health – Phase 1

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Specific Aims: We propose developing a mobile interactive education and support group intervention, *Maa Shishu Swasthya Sahayak Samooh (MeSSSSage),* to improve the health and well-being of Indian women and infants in the postnatal period using a provider-moderated group approach. *MeSSSSage* will provide culturally tailored educational programming, increase women's health-related communication with providers, refer women in a timely and appropriate manner, and connect them with a virtual social support group of other new mothers. *MeSSSSage* aims to reduce postnatal care barriers arising from distance, economic burden, cultural practices, and fatigue, and provide social support in this time to help reduce women's postpartum isolation.

Postnatal health care includes education and clinical care necessary for ensuring maternal and infant health: neonatal care practices (breastfeeding, newborn hygiene, etc.), prevention activities (immunization, recognition of infant danger signs, etc.), assessment of maternal physical recovery from childbirth, postpartum mental health, and postnatal contraception adoption. Postnatal care improves maternal physical and mental health, and well-being.[1–3] In Haryana state, India, only 40% of women received at least one postnatal health check in the two months after delivery.[4] Extending group-based pregnancy care or women's group models that have proven successful in improving maternal and neonatal outcomes in South Asia and elsewhere to the postnatal period could show health improvements.[2] However, barriers exist to successfully implement postpartum group care, including logistical challenges of traveling to the facility or group meeting with a young baby and limited mobility in South Asia, including postnatal seclusion.[6] Applying an mHealth approach to postnatal care may help new mothers overcome such challenges, and high mobile phone penetration in Haryana state, India, supports the feasibility of testing a group mHealth intervention in this population.

Most mHealth interventions for maternal and child health (MCH) in low and middle-income countries, including India, have focused on unidirectional and non-interactive approaches, primarily text messaging.[5] However, ample evidence suggests that provider-led, interactive educational programming and social support are key for improving health behaviors and outcomes.[7,8] Thus innovative mHealth approaches that promote interactive education and facilitate social support have great potential to improve MCH outcomes. The two-phase development of *MeSSSSage* will include Phase 1: exploratory development on functions and platforms and Phase 2: a mixed-methods randomized pilot study using a factorial design of specific intervention functions and platforms confirmed in Phase 1. The specific aims of this study are:

Aim 1. To develop optimal intervention functions, processes, and mHealth platforms for education and peer support among postnatal women in rural India. In Phase 1, we will explore potential interactive education and peer support group intervention functions (education, emotional support, instrumental support, referrals, linkages, follow-up on postnatal visits), processes (group interactions; frequency, length and timing of groups; engagement opportunities, participant profiles) and mHealth delivery platforms (voice, text chat, app options, interaction features). This two-month developmental component will include four groups (n=48; 12 per group) to assess different modalities and functions. We will ascertain women's preferences for functions, processes, and platform features using survey and in-depth interviews (IDIs), and capture levels of engagement via back-end data. This process will also inform the intervention's health information content. Findings will be used to formalize the group mobile intervention details to be examined in Phase 2.

Aim 2. To assess the feasibility and acceptability of the optimized *MeSSSSage* intervention. In Phase 2 we will evaluate the feasibility and acceptability of two intervention components using a controlled 4-arm factorial design (n=160; 40 per arm): 1) real-time mobile voice information and support group alone, 2) asynchronous/ on-demand text-based group support only, and 3) real-time mobile voice information and support group plus asynchronous/on-demand text-based group support. Feasibility and acceptability will be assessed via back-end data, surveys, and IDIs with purposively selected participants (n=30) and moderators.

Aim 3. To explore the preliminary effectiveness of the optimized *MeSSSSage* intervention components on six-month maternal and neonatal health outcomes. Phase 2 data will help us develop a preliminary understanding of the impacts of the intervention components on MCH health-related knowledge, behaviors and outcomes including exclusive breastfeeding, immunization, family planning uptake, postnatal visits, mental health and empowerment; however, it is not statistically powered to formally assess effectiveness.

This study is significant and innovative in addressing key priorities of NICHD's Pregnancy and Perinatology Branch and using systematic, user-centered and experience-driven design approach. These results will inform the most acceptable, feasible, and potentially efficacious intervention design to be robustly tested through an R01 mechanism to assess effectiveness for maternal and infant health outcomes, explore other research questions relevant to intervention development and scale-up for postnatal health among South Asian women, and explore generalizability across populations.

Significance

Postnatal care and support improve both infant and maternal health and save lives. However, the majority of interventions are focused on antenatal care, skilled delivery, and family planning; substantially less attention has been paid to the postnatal period. The government of India's Reproductive and Health Program recommends three postnatal visits; however, these are infrequently achieved.[4,9] Recent Indian studies found postnatal checkups to be associated with reduced neonatal mortality.[2] Furthermore, postnatal care and support can help improve practices essential for newborn health, including exclusive breastfeeding and immunization, which were at 50.3% and 62.2%, respectively, in Haryana state, the site of this study, according to the most recent Indian Demographic and Health Survey.[4] Postnatal care, in addition to antenatal care and facility delivery, is associated with women's uptake of family planning in India.[10] Haryana state is designated as a high focus state for family planning by the Indian Ministry of Health and Family Welfare,[11] and unmet need for family planning is high; one study reported that 64% of Indian women had an unmet need for family planning in the early postnatal period.[12]

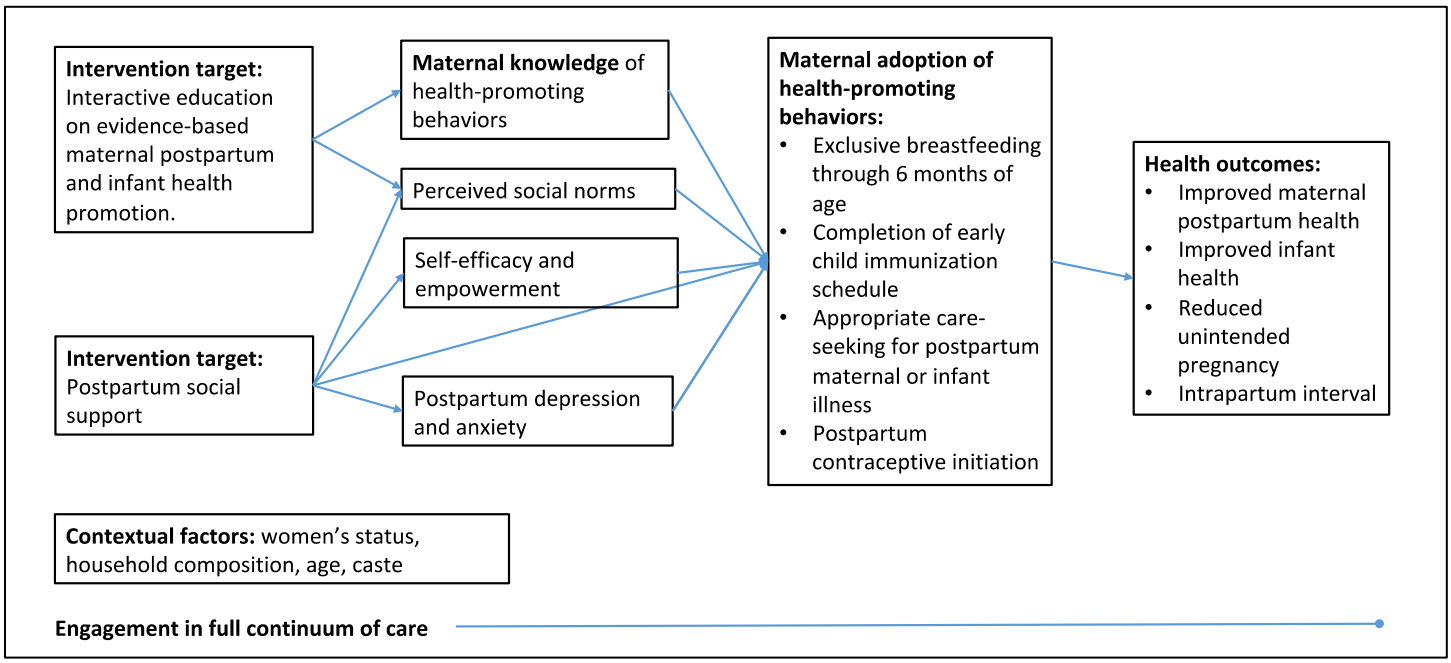
Women's groups and group-based care models are promising for improving perinatal health. Group-participatory learning and action models have significantly improved a variety of maternal and neonatal health indicators[13,14] and group-based care provision models such as Centering Pregnancy,[15] group-based prenatal care, and others have found increased rates of exclusive breastfeeding, increased postnatal contraceptive uptake, reduced postnatal depression, and increased immunization.[16–19] Health improvement through women's groups and group-based care models capitalize on improved efficiency of education and information delivery associated with the group setting and through strengthening social support networks.[20] Furthermore, the group delivery model is acceptable to women. Social support is positively associated with postnatal health,[21,22] particularly for the prevention of postnatal depression and anxiety[23,24] and for breastfeeding maintenance.[25,26] Group care has been associated with women's empowerment.[27] Extending group care into the postnatal period is an innovating and promising approach for improving health outcomes for the mother and neonate.

Significant logistical barriers prevent mothers from physically attending postnatal social support groups at facilities or other locations that may be far from their homes, particularly in India.[28] mHealth approaches offer an innovative opportunity to overcome these barriers. Common logistical challenges of transportation and scheduling are exacerbated in India by rural geographic distances, cultural and linguistic barriers to care, women's practice of postnatal seclusion and generally low levels of mobility in marriage; all combine to significantly reduce care access.[29–31] Further intergenerational and gender-based hierarchical roles structure decision-making in Indian households, particularly for couples living in extended-family households, with decision-making largely outside of the hands of mothers[32], especially those who are young and newly married. Despite women's physical mobility limitations in this setting, there is broad access to cellular telephones in India with 88% of households nationally owning a mobile phone.[33] In our target region Haryana state, 51% of women own their own feature mobile phone.[34] Mobile learning platforms have been successfully used for training among other populations such as community health workers in constrained environments by members of our research team.[35] Testing the acceptability, feasibility, and effectiveness of a group care mHealth model is exciting and practical given increasing access to mobile technology globally, and such a model overcomes the physical and cultural barriers inherent to in-person group models.

Providing targeted education and support to women in the postnatal period through a mobile social network holds potential to improve postnatal recovery, neonatal care practices, nutritional status, general health, knowledge and care seeking - positively impacting maternal and child health. Mobile support and education groups are based on prominent health behavior change theories such as the capabilities and motivation constructs of the COM-B framework,[18,19] and have positively impacted a variety of other health outcomes in both developed and developing world settings.[2,10] Targeted interactive education and support to women in the postnatal period through a mobile social network is hypothesized to meet their knowledge needs, improve self-efficacy and maternal mental health, and alter perceived social norms. All of these are important for appropriately identifying infant and maternal danger signs and timely care seeking for routine and emergency visits (including referrals), and reduce infant and maternal mortality and morbidity (**Figure 1**). Furthermore, mHealth group support could help encourage and sustain exclusive breastfeeding, and improve uptake of postnatal family planning and childhood vaccination, which positively impact maternal and child health in both short and long term. The social support component will encourage free discussion, allowing women to share experiences and tips for success (advice on soothing a crying baby, balancing family obligations with caring for her own healing body, etc.), providing informational social support. Interventions targeting informational and

emotional social support have previously resulted in improved maternal and neonatal health, including reduced postnatal depression[36,37].

Figure 1. Conceptual Framework of MeSSSSage Intervention Targets and Outcomes



Innovation. This proposal extends the current evidence in two primary ways:

1. This study seeks to develop an mHealth group care intervention, combining the potential for mHealth to reach vulnerable populations in lower resource settings with the key health benefits of multidirectional, social interactions with both social support and health care providers. Most mHealth interventions are unidirectional, do not involve social support, or are targeted towards health providers, rather than clients themselves.
2. We extend the solid evidence base for group care in pregnancy to the postnatal period, a neglected and vital period for infant heath outcomes, as well as maternal mental and physical health outcomes. Postnatal care is especially challenging in settings like rural India where women live far from facilities, have restrictions on physical mobility, and practice seclusion after childbirth.

The approach taken in this research will add to the scientific understanding of whether mHealth interventions can successfully include group components and interaction between users. It will also expand our toolkit of approaches for intervening in the postnatal period, with applications for other times in the life course and populations. If proven successful, this study will lead to the development of a tested tool ready for next steps in scale up process to robustly test effectiveness that is likely to improve both maternal and infant health outcomes.

Approach

The mobile platform we will be adapting was developed by members of our IIIT-Delhi team, and has been tested with the implementing partner (SWACH). This innovative platform provides a single collaborative learning environment that is optimized for use by both basic feature phones and smartphones. This simultaneously lowers the cost and increases the reachability while accommodating increasing technology access. The back-end of the systems is built on Interactive Voice Recognition (IVR) technology that allows easy data collection that can then be used for analysis on user participation. Moreover, the system allows the storage of the knowledge generated in an interactive session. Recently the system has been extended by applying state-of-the-art natural language processing techniques to extract the audio and create a knowledge base which can then be used to deliver automated answers.[38] It has previously been tested for feasibility with SWACH in the general population, and as a training for health workers and found improvements in health worker knowledge.[35,39] Members of the team have also developed a platform similar to WhatsApp that may be integrated into this design or added on to support the *MeSSSSage* design.

Study Site and Population: This study will occur in Kurukshetra district, Haryana state, India. Household mobile phone ownership is high, with 90% of households, and 50% of women, in this district owning a mobile phone.[4]

The current national guidelines for postnatal care in India are for women to receive three home visits from an ASHA within the first week following childbirth.[4,9] In this setting, women are seen by an Accredited Social Health Activists (ASHA) in pregnancy and postpartum. The role of the ASHA in postnatal care is to counsel the mother on recognition of and referral for complications. The ASHA also counsels the mother on adoption of postpartum family planning. For newborns, the ASHA provides skin, eye and cord care, monitors infant weight gain, supports exclusive breastfeeding, and provides general newborn care and referral. **However, data from our study state, Haryana, suggest that less than half of women receive any postnatal care,**[4] and ASHA visits are typically short, all of which restricts the information and support that women receive in the postnatal period.

Phase 1: Aim 1. To develop optimal intervention functions and mHealth technology delivery platforms for education and peer support among postnatal women in rural India: The prototype *MeSSSSage* will include a weekly mobile call-in group meeting, including recently delivered women and moderated by one trained health worker, an experienced ASHA facilitator. Each group will consist of 12 women whose infants were born within approximately two weeks of each other. Women will attend these group meetings by calling in on their mobile phone, and the meetings will last approximately one hour. In each group, the ASHA facilitator will provide approximately 20 minutes of health education specifically tailored to the common health needs of the mother and infant at the specific infant age, followed by 40 minutes for group discussion. Aim 1 will inform exact length of education and discussion per meeting), and if and at what frequency reminder messages are required.

Development of optimal modalities: We will pilot the prototype *MeSSSSage* platform in three groups of recently delivered women for a period of two months by testing different modalities over that time, as described in **Table 1** (N=48). The goal of this formative phase is to orient women to a variety of experiences to reflect on when seeking their feedback, so as to design the most appropriate intervention for full piloting.

Table 1: Modalities to be explored to identify optimal intervention functions, processes and platforms (Phase 1).

Modality	Description of modalities	Goal
Group structure	(1) Frequency: How often groups are held (2) Length: How long groups last (3) Timing: What time of day/day of week	To determine the best group structure
Participants	(1) Number (2) Breadth of gestational age (3) Age of respondents	To determine the best group structure
Group Interaction type	(1) Women have to "raise their hand" virtually, by typing a specified number into their phones if they have a question or comment, and then the moderator gives "permission" to women to speak one by one (2) Open line where women can speak at any point. (3) Moderator call out individual women to ask if they have questions or comments	To measure: ● Level of comfort with participation ● Amount of engagement and interactions between participants ● Conversation dominated by certain participants ● Communication patterns
Content	(1) Additional information desired (2) Level of detail of information (3) Language and approach used by moderators	To adjust and expand the content/topics covered
Text-based group addition	Offer an additional freer-form, ongoing, text-based group (e.g., WhatsApp)	To determine: ● Number of interactions ● Barriers for women with low literacy ● Group sense of support

Procedures: Primiparous women will be recruited in their last month of pregnancy by the ASHA and an accompanying research assistant during the ASHA's regular home visit. At the time of enrollment, the study protocol and informed consent will be described to the women, written informed consent will be obtained from

interested women, and their phone numbers collected (and tested). Women who do not personally own a phone will be provided with a phone. Airtime for all participants will be covered during this two-month preliminary phase of the project. Consent will also be obtained from family members given the cultural practices in the study population. Consent will cover both the intervention and the evaluation components of our phase 1 assessment.

Women are eligible if they are over the age of 18 and this is their first birth. Women with high risk pregnancies will be ineligible for participation, and women will be removed from the study if they deliver preterm, suffer severe maternal complications (c-section or hospitalization), or they or their baby are otherwise sick in the first week postnatal. When the women deliver their infants, the ASHA and facilitator will inform the research team, and women will be assigned to groups based on date of delivery, since women in each group ideally will have all delivered their babies within approximately two weeks of each other.

Back-end data will be captured from all participants. After two months (eight group meetings) we will conduct a brief phone survey with all participants and in-depth interviews with a subset of approximately half of the participants, purposively selected to obtain a range of frequency and intensity of participation.

Surveys and backend data: All 48 respondents will be called via phone to participate in a short (10 min) survey about their experiences with *MeSSSSage* group components, including preferences regarding functions and modalities and level of satisfaction with each, using likert-type response scales (1-5). Data will be recorded on a tablet confidentially. We will calculate means and standard deviations for each of the preferences and function variables. Additionally, each group discussion will be audio recorded, transcribed, and translated into English. We will analyze the content of the group discussions for function, using Atlas.ti software. We will also review level of intervention engagement including text-messaging (number and topic), the number of participants per session, number of participants who engage with the health worker and each other, etc. The study team has analyzed the data collected in previous technological studies, and we will use a similar method. Data will be analyzed using STATA version 15 (College Station, Tx).

In-depth interviews (IDIs): We will recruit a subset of Phase 1 participants (n=30), equal numbers from each group, to participate in IDIs. The interviews will be used to explore women's experiences participating in *MeSSSSage*, the components they liked and disliked, and how to improve the programming. Specifically, we will focus on the timing and frequency of the group meetings, as well as feedback on the modalities tested in the different arms. We will explore their experience of the social support component of *MeSSSSage* and how this, or another, mobile technology might be used to increase the support available to them. In addition to gathering information their experience with *MeSSSSage*, we will also explore which health topics related to postnatal maternal and infant health are they most interested in, and their main health-related concerns. IDIs will also be conducted with the ASHA facilitators who will be delivering the educational content of the mobile voice groups and moderating the mobile text groups to understand their own preferences around the group components, their experiences conducting the sessions, and their perspectives on mobile provision of education, care, and support. IDIs will take place the respondent's home, or another private location of their preference. IDIs will be transcribed and translated into English. IDI data will then be coded by a team of both India and US-based researchers using a grounded theory framework, in the qualitative data analysis software Atlas-ti.

Phase 2: Pilot test of optimized intervention, assessment of feasibility and acceptability (Aim 2) and preliminary effectiveness on maternal and infant health outcomes (Aim 3). After analysis of Phase 1 data, *MeSSSSage* will be adapted based on participant feedback and content will be expanded to cover topics relevant to the first six months of the postnatal period. If data from Phase 1 suggest that the tested mobile group forum modalities are not appropriate for this population, we will adapt our study protocol to explore other feasible means of providing information and support (e.g., SMS or video). We anticipate developing and testing two different modalities of postnatal education and support in a factorial design with an additional control arm for a total of four different group compositions. All women, including the control group, will receive the standard of care provided by the Government of India and described above. We will conduct a pilot test of the intervention using two groups per intervention modality for a total of eight separate groups, a total of 160 women (Table 2). Exact group structure and duration will be informed by Aim 1, but we anticipate the following:

Table 2: *MeSSSSage* components to be tested in feasibility and acceptability assessment (Phase 2).

	Arm 1	Arm 2	Arm 3	Control
Real-time live voice call group meeting: Interactive educational program with scripted didactic component plus discussion/question. Lead and moderated by health professional.	X		X	
Text-based, asynchronous, on-demand social support: App-based small group text-based communication. Moderated by health professional.		X	X	
Standard of care: 3 visits in the first 7 days postnatal (facility and home)	X	X	X	X

Procedures: Unless found not feasible or acceptable within Phase 1 activities, women will be recruited using the approach described above (Aim 1). At the time of enrollment, the study protocol will be described to the women following informed consent procedures and written informed consent will be obtained from interested women, and their phone numbers will be collected (and tested). Women who do not have a phone will be provided with a phone and all participants' airtime will be covered for the length of the six-month research project. If they consent to participate, women will be randomly enrolled into one of the three study arms, or control, using a random number generator. We will test each study condition using two groups of women, with intervention initiation staggered one month apart. Women in the control group will receive the standard of care for women in this population. All women will be given 50 Indian Rupees for participation in each session (in addition to airtime and phone if needed), and ASHAs will receive 150 Indian Rupees for moderating each session. Assessment of feasibility and acceptability (Aim 2) and preliminary effectiveness (Aim 3) will be accomplished using a mixed-methods approach that will include quantitative surveys, in-depth interviews, and technology assessment.

Survey data collection: At study enrollment, a baseline survey will be administered by a research assistant in the respondent's home. Roughly six months postnatal, after having the opportunity to participate in approximately 24 *MeSSSSage* sessions (final number to be determined in Phase 1 activities), women will be visited in their homes for the endline survey. We will also capture women's health record cards and ASHA registers to validate self-reported health outcome data. Data will be collected on a tablet using REDCap mobile research administration software (a highly secure platform), stored in a password protected database at UCSF, and no identifiable information will be included with the data (names, phone numbers, and addressed will be stored separately and linked by an ID).

In-depth interviews: Additionally, in-depth interviews (IDIs) will be conducted with a selection of 10 women from each intervention condition (30 IDIs), purposively sampled based on high/low participation rates determined by the end line survey. We will collect data on experiences with *MeSSSSage* and how to improve it.

Technology assessment: Finally, we will collect and analyze the quantitative backend data from the prototype to gain more insight into women's participation in the intervention, including attendance and level of participation in group interactive educational sessions, use of mobile social support platform (number of posts, frequency, topic), etc. Text data from transcripts of the educational sessions and content of group messaging will be analyzed for content in order to understand primary educational needs and interests for postnatal women.

Group moderator survey and interview: ASHA facilitators moderating the groups will be asked to respond to a short questionnaire after each group session to understand: preparation and delivery time, content, efficiency, acceptability and satisfaction with the group model, perspectives of impact, challenges, and any follow-up/referral necessary.[40] Regarding facilitation of groups that receive the text-based messaging intervention component only, ASHA facilitators will report on experiences in the prior week. We will also conduct monthly semi-structured interviews with each of the ASHA facilitators to understand their own preferences around the group components, their experiences preparing for and conducting the sessions, and their perspectives on mobile provision of education, care, and support.

Measures: The baseline survey content will include sociodemographic characteristics and knowledge about maternal and infant health, self-efficacy, and perceived social norms regarding MCH-related health promoting behaviors. The endline survey will include acceptability questions such as women's satisfaction with and perceptions of *MeSSSSage*, maternal and infant knowledge-, behavior-, and health-related questions including about breastfeeding, complementary food introduction, immunization, family planning uptake, maternal physical and mental health, etc. which have previously been used in this setting (Table 3) [4].

Table 3: Participant survey measures (Phase 2)

Category	Measures
Sociodemographic characteristics	Age, age at marriage, educational attainment, caste, language spoken, household assets, women's status/decision-making, social support and relationship quality.
Health-related knowledge (effectiveness)	Knowledge on maternal and neonatal danger signs, best practices for infant care, family planning.
Health-related behaviors (effectiveness)	Breastfeeding and complementary food introduction practices (breastfeeding initiation, length of exclusive breastfeeding, length of breastfeeding, timing of complementary food introduction), appropriate management of early childhood illnesses.
Health outcomes (effectiveness)	Early childhood immunization, postnatal depression and anxiety, postnatal family planning adoption.
Intervention perspectives (feasibility, acceptability)	Self-reported engagement in intervention components and topics, satisfaction with intervention components, likelihood of participating again, likelihood of recommending program, value on knowledge and social support gained from participation.

Analysis

Aim 2. Feasibility and acceptability of the optimized MeSSSSage intervention components. We will use a mixed methods approach, triangulating data from quantitative baseline and endline data, qualitative IDIs, and technology assessment. Feasibility and acceptability will be measured by participation rates at each session, trajectories of participation over time, and user engagement (via technology assessment backend data). Women's reports of use and satisfaction in the survey and the qualitative data will shed light on barriers and facilitators to participation. Moderator acceptability will be assessed by satisfaction, fidelity to topic/content based on protocol and perspectives on impact. We will test for differences in feasibility and acceptability between the three intervention arms to understand if both components (group meetings and text) or only one is the best approach, using ANOVA for continuous outcomes and chi-square or Fisher's exact tests, as appropriate, for categorical outcomes.

Aim 3. Preliminary effectiveness of the MeSSSSage intervention components on six-month MCH outcomes. Using the quantitative survey data, we will statistically evaluate differences by study arm in improvements in women's knowledge, behaviors, and maternal and child health outcomes, compared to the control group (including effect sizes, controlling for relevant socio-demographics as necessary). Figure 1 displays the outcomes that are theoretically related to our intervention targets. Our main *knowledge* outcome will be a composite score representing the proportion of correct answers from a series of questions on knowledge of breastfeeding, newborn and infant care, maternal and infant danger signs, newborn care, and family planning, topics that will be covered within our interactive educational group component. Our main *behavior* outcome will be self-reported exclusive breastfeeding at 6 months. Our two main health related outcomes will be: (1) completion of early childhood immunization schedule; and (2) postnatal family planning uptake. We will also measure women's social support and related mental health status (depression and anxiety) using scales that have been previously validated in similar populations such as the Hopkins Symptom Checklist[41] and the Multidimensional Scale of Perceived Social Support[42]. Finally, women's empowerment will be measured using decision-making and mobility scales.[43,44]

Sample Size. This pilot development study is not formally powered to detect significant differences in outcomes, but will give insight into directionality of changes. The per group sample size was selected based on feasibility of recruitment, intervention delivery, and the interpersonal interaction important for a group-focused intervention. The sample is sufficiently large to assess the feasibility and acceptability outcomes through descriptive statistics.

Timeline. Phase 1, which includes the intervention optimization and development period, and Aim 1 data collection, will occur in quarter 2 (Q2) of Year 1 (Y1), after Q1 is spent preparing for the study (IRB, instruments, training research team). In Y1Q3 we will finalize the details of the mhealth platform and prepare for Phase 2 (tool development, IRB modifications, training research team). From Y1Q4-Y2-Q2 we will recruit and collect data for Phase 2, which is a 6 month pilot intervention. Y2Q2-Q3 will be spent in in-depth data analysis for Aims 2 and 3. The final part of the grant (Y2Q3 and Q4) will be spent in dissemination (local and international) including meetings, presentations, academic manuscripts, and conferences. We will also apply for a larger grant to test this at scale. Please see our timeline table in the human subjects and clinical trials supplement.

Capacity building. IIIT Delhi has a new Social Science Department; however, most faculty and students have little training in research methods such as mixed-methods and qualitative research. Drs. Diamond-Smith and El Ayadi are experienced in leading workshops on study design and analysis, particularly for these topics. They will teach a one-week workshop to IIIT Delhi faculty and students on designing and evaluating interventions, and mixed-methods approaches for evaluation, including qualitative data analysis. Furthermore, IIIT PhD students will participate in this workshop and assist in collecting the qualitative interviews in Phases 1 and 2, as well as analyzing the qualitative data. Drs. Diamond-Smith and El Ayadi will mentor students throughout, including preparing manuscripts with them for publication in a 3-day writing workshop at the end of the project. The research team proposed herein has recently been awarded a two year capacity development award through the Government of India, Ministry of Human Resource Development, Scheme for Promotion of Academic and Research Collaboration to provide training on mHealth design and evaluation for maternal and child health.

Potential problems and alternate strategies

Recruitment and retention. The research team has successfully conducted research among women in the postpartum period living in this area, and have been successful in recruitment and retention. We do not anticipate challenges to recruitment of study participants or retention during the full study period. If women appear to be lost to participation, the local ASHA will be notified and she will follow up with the woman participant to determine the barriers to her participation in the intervention.

Gender gaps in mobile phone access. While mobile phone penetration is increasing dramatically across all of India, significant gender gaps exist in ownership and use of mobile technologies. For example, among the adult population, 84% of males are considered primary mobile phone owners compared to 65% of females.[34] Younger individuals have higher mobile phone ownership than older individuals; our target population of primiparous women is likely to fit within an age group of higher mobile ownership. We will provide participants who do not personally own their own phone with a phone to reduce barriers to participation resulting from multiple household phone users, and will provide airtime for the study to all participants.

Low literacy among target population. Recent data from Haryana state show that 75% of women of reproductive age are literate[4], and thus it is possible that women's low overall literacy, and potentially low technological literacy, will reduce their ability to engage in *MeSSSSage*. However, the research team's experience has not found this to be a problem for prior research projects among the target population. Additionally, given the young age of participants, we anticipate that they will be more literate and tech-savvy than average. Our experience of our team in the field at this specific study site has found that WhatsApp is extensively being used for communication and husbands are more actively involved in pregnancy and can support their wives. The *MeSSSSage* platform will allow illiterate women to speak to answer questions, thus making it more accessible to low literacy women. At enrollment, the research assistants will provide one-on-one training participation in the group meeting and text-based components of the intervention, including basic instructions on texting. Given the population we seek to generalize our findings to, we will not exclude illiterate women from this study.

Expected outcomes and future directions. Our pilot results will inform the design of a larger R01 trial to robustly test the effectiveness of *MeSSSSage* on postnatal maternal and infant health behaviors and outcomes. We expect to positively impact women's postnatal health knowledge and behaviors, and improve health outcomes for women and their infants in the first six months. We will also disseminate the findings to health professionals and community members, as well as appropriate Indian stakeholders (Government, NGO, etc.). Our study will help build the evidence on mHealth for maternal and perinatal health, and group care models for postnatal care, contributing to reducing disparities in women's access to care through the removal of geographic and social barriers.

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