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Targeting strategies of mHealth interventions for maternal health in low and middle-income countries: a systematic review protocol

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ABSTRACT

Introduction Recently, there has been a steady increase in mobile health (mHealth) interventions aimed at improving maternal health of women in low-income and middle-income countries. While there is evidence indicating that these interventions contribute to improvements in maternal health outcomes, other studies indicate inconclusive results. This uncertainty has raised additional questions, one of which pertains to the role of targeting strategies in implementing mHealth interventions and the focus on pregnant women and health workers as target groups. This review aims to assess who is targeted in different mHealth interventions and the importance of targeting strategies in maternal mHealth interventions.

Methods and analysis We will search for peer-reviewed, English-language literature published between 1999 and July 2017 in PubMed, Web of Knowledge (Science Direct, EMBASE) and Cochrane Central Registers of Controlled Trials. The study scope is defined by the Population, Intervention, Comparison and Outcomes framework: P, community members with maternal or reproductive needs; I, electronic health or mHealth programmes geared at improving maternal or reproductive health; C, other non-electronic health or mHealth-based interventions; O, maternal health measures including family planning, antenatal care attendance, health facility delivery and postnatal care attendance.

Ethics and dissemination This study is a review of already published or publicly available data and needs no ethical approval. Review results will be published in a peer-reviewed journal and presented at international conferences.

PROSPERO registration number CRD42017072280.

Strengths and limitations of this study

- The protocol adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses-Protocols guidelines for reporting a systematic review protocol.
- The protocol outlines a review process that will involve the use of a systematic literature review, an interdisciplinary team and a narrative synthesis methodology, allowing for an iterative review process.
- The proposed inclusion criteria include quantitative and qualitative studies and a narrative synthesis methodology. This combination presents an opportunity for the review to answer questions not only about 'what' "but also about 'why and how'.
- The protocol proposes the utilisation of multiple tools to assess the strength of evidence including the Downs and Black (1998) checklist for quantitative healthcare studies and the Grading of Recommendations Assessment, Development and Evaluation system.
- Narrative synthesis as a form of content methodology has been criticised for its potential to be biased, and its transparency has been challenged. We address these by using a systematic four-step approach to this synthesis.

INTRODUCTION

Mobile health (mHealth) involves the use of mobile phones or portable devices such as personal digital assistants (PDAs) for healthcare service delivery. These interventions are usually in the form of direct phone calls, short message service (SMS) messages, voice calls or mobile applications.[1] mHealth interventions have increasingly been used in improving maternal health outcomes. The range of available mHealth interventions resulted in Labrique *et al* developing a framework which identified the 12 common uses of mHealth for maternal and child health, the most predominant being its use for client education and behaviour-change communication.[2] These interventions may target the supply end of care delivery, aimed at health workers at the facility level, or individual and community levels, that is, the demand-side influencers such as household decision-makers. In this review, we will focus on the individual-level interventions which have focused on strategies shown to work for maternal health including increased

delivery assistance by a skilled birth attendant, attendance of four or more antenatal care (ANC) visits, and an increased prevalence of contraceptive usage among reproductive-aged women.[3]

mHealth studies which have focused on maternal interventions have yielded conflicting results. There is some positive evidence for the effect on mHealth interventions on outcomes such as ANC attendance and skilled birth attendance at birth and utilisation of oral contraception.[4–7] However, other studies have reported no statistically significant improvement in reproductive health outcomes following the introduction of mHealth interventions.[8–11] With the interest in mHealth interventions, there have been a number of reviews on the use of mHealth in low-income and middle-income countries (LMIC). However, they tend to focus specifically on the reproductive health outcomes or the efficacy of mHealth interventions,[12–14] the use of mHealth by health workers[15–17] or the acceptance, utilisation and evaluation of these interventions.[18–20] None of these reviews have focused on the targeting strategies of reproductive mHealth interventions, that is, who are the intervention targets and to what extent this influences observed outcomes.

Literature on maternal health provides strong evidence for the targeting of individuals other than pregnant women. For example, there is evidence that in many contexts husbands play significant and important roles in reproductive health decision-making.[21 22] This variation in decision-makers is rarely addressed and sometimes strategically excluded from the review, as in Lee *et al*.[12] In addition, other factors that influence reproductive health decision-making and healthcare-seeking behaviour such as literacy, socioeconomic status or access to care are discussed as secondary findings. As a result, there is as yet not much of an understanding regarding whom mHealth interventions are to be designed for, and the relation between targeting strategies in mHealth interventions and reproductive health outcomes.

OBJECTIVE AND RESEARCH QUESTIONS

The aim of this review is to understand the effects of targeting strategies applied in mHealth interventions for maternal health in LMIC. To address this aim, the following research questions were developed:

1. Who in the community (ie, non-health professionals) a targeted in maternal mHealth interventions?
2. Do targeting strategies differ across LMIC contexts, such as by programme type, funder and so on?
3. What are the sociodemographic characteristics of those targeted in the described mHealth interventions, and what is the nature of mHealth interventions used for these groups?
4. What are the reported intervention outcomes based on characteristics of targeted participants and how are these differences explained?

METHODS AND ANALYSIS

Protocol registration

The review protocol was preregistered in the PROSPERO database (CRD42017072280). This protocol adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses-Protocols 2015 guidelines for preparing protocols of systematic reviews[23] (online supplementary material).

STUDY DESIGN

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) will guide the review.

STUDY ELIGIBILITY

Eligible studies will include:

- randomised and non-randomised controlled trials
- cross-sectional
- longitudinal studies
- case studies
- ethnographies and other types of qualitative research (eg, grounded theory, action research)
- systematic review and meta-analyses.

Eligible papers will address the question of 'who in the community are targeted in mHealth intervention?' Studies will be selected if mHealth interventions fit the definition of mHealth by Robert *et al*[1]: 'mobile computing, medical sensor, and communications technologies for health care'.[24] Furthermore, studies will need to be captured within one of the 12 common ICT application frameworks for maternal health proposed by Labrique *et al*.[25] These criteria are further discussed in the following section on study inclusion and exclusion.

Inclusion/exclusion

The participants, interventions, comparators and outcomes for this review are:

Participants (P)

All individuals or groups within communities (eg, husbands/spouses, mothers-in-law, family members, household members) (excluding health workers) who have been involved in a mHealth intervention geared at improving maternal health knowledge, behaviours and outcomes. Participants will be limited to those in LMIC as defined by the World Bank's classification scheme.[26]

Interventions (I)

mHealth interventions including SMS or text messages, mobile applications and phone calls which address maternal health issues, such as attendance at ANC visits, receipt and consumption of folic acid tablets, delivering with a skilled birth attendant or at a health institution, use of family-planning services, will be included. Health technologies will also include unidirectional or multidirectional messaging services (SMS or voice messages). Applications installed on patient smartphones/tablets or PDAs or those used by health

workers, to promote maternal health-seeking behaviour in (pregnant) women or women of reproductive age, for which maternal health outcomes were measured. mHealth interventions that include women as direct end-users, alongside health workers or professionals for which maternal health outcomes were measured, will also be included.

In table 1 we present an overview of the 12 common mHealth and information communication technology applications based on Labrique *et al*,[25] examples of mobile phone functions and our decision to include or exclude. For example, the first group of applications is for use in client education and behaviour-change communication. When these are used among participants of interest in the review, this category is applicable and thus included. Conversely, electronic health records are not applicable to our participants and thus such applications will be excluded.

Comparators (C)

Control groups may have received either the standard of care or other maternal interventions without an mHealth component.

Outcomes (O)

Four primary maternal health outcomes will be identified (a) knowledge-related outcomes, including knowledge of required of ANC visits, danger signs during pregnancy and delivery, appropriate contraceptive use; (b) attitudinal changes, such as increased willingness to attend ANC and motivation; (c) perceptions of recommended maternal health and family planning behaviours and quality of care; (d) change in maternal health-seeking behaviours or family planning practices, such as increased attendance at antenatal clinics, delivery at health facilities and utilisation of family-planning method. For our review, we have adopted an expanded definition of maternal health which includes family planning as a key component in reducing maternal mortality.

Exclusion criteria

Studies will be excluded if they focus on outcomes not directly related to maternal health as defined earlier. This includes studies on sexually transmitted infections such as chlamydia or HIV. Studies on specific subpopulations such as sex workers will also be excluded. Protocols for research studies or reviews will be excluded.

Search criteria

Searches will be conducted on articles published between 1999 and July 2017, to capture all articles since the emergence of mHealth technology in the health literature.[27]

We will search the following databases: PubMed, Web of Knowledge (Science Direct, EMBASE) and Cochrane Central Registers of Controlled Trials. Reference lists of included articles will also be reviewed for other relevant articles for inclusion. We will also search other databases for grey literature including 'mHealth Alliance' and 'mHealth Evidence'.[28] Searches will be limited to English articles. Search terms will consist of Medical Subject Headings (MeSH), title/abstract (tiab) and text words (tw). Search terms will focus on mHealth, LMIC and maternal health. The proposed strategy can be found in table 2.

Selection of studies

After the search strategy has been finalised and run on all search engines, they will be extracted. All extracted articles will be stored and managed in Mendeley reference manager. Duplicates will be identified and deleted using Mendeley duplicate identification tools. First-level inclusion: OI and I-OOA will conduct title and abstract screening of articles based on the inclusion and exclusion criteria. Second-level inclusion: full-text reading of all included articles by OI and I-OOA. SVB and MD will make the final decisions whenever the first two authors are unable to reach a consensus. Reasons for decisions taken at both levels of inclusion will be noted in an Excel sheet. The inclusion and exclusion processes will also be reported in a PRISMA flow chart.[23]

Data extraction

OI will develop a data-extraction form to be used throughout the review process. OI and I-OOA will pilot the form on a subset of 10 articles to assess the functionality and suitability of the form. Discussions will be held with the entire review team (OI, I-OOA, SVB, AB, JEWB and MD) and adjustments made to the form before data extraction commences. Key information to be extracted can be found in table 3.

Data synthesis

Extracted data will be summarised using narrative synthesis (NS) as described by Popay *et al*.[29] NS primarily involves the usage of words and text to summarise review findings. NS has four key elements which we present below[29] :

1. Developing a theory of how the intervention works, why and for whom: there are no specific tools recommended for the design of a programme theory. The development of a programme theory will be guided by findings from the other three elements of an NS.
2. Developing a preliminary synthesis of findings of included studies: tabulation will be used to represent the quantitative and qualitative studies included in the review. This will include information on the study design, participant characteristics, intervention details, setting/context and outcome measures.
3. Exploring relationships in the data: conceptual/thematic models/groups will be developed across and within groups of similar articles. These groups would allow for the identification of similar findings.
4. Assessing the robustness of the synthesis: quality of the synthesis will be assessed through a critical reflection on the synthesis process. This will be presented in the Discussion section of the systematic review and will

Table 1 Intervention inclusion and exclusion list based on 12 common applications and a visual framework (Labrique *et al*)[25]

Common mHealth and ICT applications	Examples of mobile phone functions	Decision
Client education and behaviour-change communication	► SMS ► MMS ► IVR ► Voice communication/audio clips ► Video clips ► Images	Included
Sensors and point-of-care diagnostics	► Mobile phone camera ► Tethered accessory sensors, devices ► Built-in accelerometer ► SMS ► Voice communication ► Digital forms	Included if community members/patients participate in the diagnostic process.
Registries and vital events tracking	► SMS ► Voice communication ► Digital forms	Included if community members/patients are responsible for data collection.
Electronic health records	► SMS ► Digital forms ► Mobile web	Excluded
Data collection and reporting	Digital forms ► Voice communication	Excluded
Electronic decision support (information, protocols, algorithms, checklists)	► Mobile web (WAP/GPRS) ► Stored information 'apps' ► IVR	Excluded
Provider-to-provider communication (user groups, consultation)	► SMS ► MMS ► Mobile phone camera	Excluded
Provider work planning and scheduling Provider training and education	Interactive electronic client lists ► SMS alerts ► Mobile phone calendar	Included only if outcomes are related to community members/patients perceptions of maternal and reproductive health services as a consequence of an mHealth-based provider training and education intervention.
Human resource management	► MMS ► IVR ► Voice communication ► Audio or video clips, images ► Web-based performance dashboards ► GPS ► Voice communication ► SMS	Excluded
Supply chain management	► Web-based supply dashboards ► GPS ► Digital forms ► SMS	Excluded
Financial transactions and incentives	► Mobile money transfers and banking services ► Transfer of airtime minutes	Included when patients/community members directly receive incentives as part of the mHealth intervention and maternal and reproductive health outcomes are reported.

GPRS, general packet radio service; GPS, global positioning service; ICT, information communication technology; IVR, interactive voice response; mHealth, mobile health; MMS, multimedia messaging service; SMS, short message service; WAP, wireless application protocol.

Table 2 PubMed search strategy, to be adapted for use in other database searches

#Column	Searches
#1	User-Computer Interface[Mesh] OR multimedia[Mesh] OR cell phones[Mesh] OR computers, handheld[Mesh] OR Mobile Applications[Mesh] OR mobile health[tiab] OR mhealth[tiab] OR m-health[tiab] OR ehealth[tiab] OR e-health[tiab] OR digital health[tiab] OR smartphone[tiab] OR smartphones[tiab] OR phone[tiab] OR phones[tiab] OR cellphone[tiab] OR cellphones[tiab] OR telephone[tiab] OR mobile application[tiab] OR mobile applications[tiab] OR mobile technolog*[tiab] OR health technolog*[tiab] OR health application[tiab] OR health applications[tiab] OR iPad[tiab] OR sms[tiab] OR mms[tiab] OR text messag*[tiab] OR USSD[tiab] OR pda[tiab] OR laptop*[tiab] OR palmtop*[tiab] OR palm-top*[tiab] OR Personal Digital Assistant*[tiab] OR computer*[tiab] OR interactive voice response[tiab] OR multimedia[tiab]
#2	developing country[Mesh] OR low income[tiab] OR middle income[tiab] OR developing countr*[tiab] OR resource poor[tiab] OR rural[tiab] Afghanistan [tw] OR Guinea[tw] OR Rwanda[tw] OR Benin[tw] OR Guinea-Bissau[tw] OR Senegal[tw] BurkinaFaso[tw] OR Haiti[tw] OR SierraLeone[tw] OR Burundi[tw] OR Korea, Dem. People's Rep. [tw] OR Somalia[tw] OR Central African Republic[tw] OR Liberia[tw] OR South Sudan[tw] OR Chad[tw] OR Madagascar[tw] OR Tanzania OR Comoros[tw] OR Malawi[tw] OR Togo[tw] OR Congo, Dem. Rep[tw] OR Mali[tw] OR Uganda [tw] OR Eritrea[tw] OR Mozambique[tw] OR Zimbabwe[tw] Ethiopia[tw] OR Nepal[tw] OR Gambia[tw] OR Niger[tw] OR Angola[tw] OR Indonesia[tw] OR Philippines[tw] OR Armenia[tw] OR Jordan[tw] OR São Tomé and Principe[tw] OR Bangladesh[tw] OR Kenya[tw] OR Solomon Islands[tw] OR Bhutan[tw] ORKiribati [tw] OR Sri Lanka[tw] OR Bolivia[tw] OR Kosovo[tw] OR Sudan[tw] Or Cabo Verde[tw] OR Kyrgyz Republic[tw] OR Swaziland[tw] OR Cambodia [tw] OR Lao PDR[tw] OR Syrian Arab Republic[tw] OR Cameroon[tw] OR Lesotho[tw] OR Tajikistan[tw] OR Congo, Rep. [tw] OR Mauritania[tw] OR Timor-Leste[tw] OR Côte d'Ivoire[tw] Micronesia, Fed. Sts. [tw] OR Tunisia[tw] OR Djibouti[tw] OR Moldova[tw] OR Ukraine[tw] OR Egypt, Arab Rep. [tw] OR Mongolia [tw] Uzbekistan[tw] OR El Salvador [tw] OR Morocco[tw] OR Vanuatu[tw] OR Georgia[tw] OR Myanmar[tw] OR Vietnam[tw] OR Ghana[tw] OR Nicaragua[tw] OR West Bank and Gaza[tw] OR Guatemala[tw] OR Nigeria[tw] OR Yemen, Rep. [tw] OR Honduras[tw] OR Pakistan[tw] OR Zambia[tw] OR India[tw] OR Papua New Guinea[tw] OR Albania[tw] OR Ecuador[tw] OR Nauru[tw] OR Algeria[tw] OR Fiji[tw] OR Panama[tw] OR American Samoa[tw] OR Gabon[tw] OR Paraguay[tw] OR Argentina[tw] OR Grenada[tw] OR Peru[tw] OR Azerbaijan[tw] OR Guyana[tw] OR Romania[tw] OR Belarus[tw] OR Iran, Islamic Rep. [tw] OR Russian Federation[tw] OR Belize[tw] OR Iraq[tw] OR Samoa[tw] OR Bosnia and Herzegovina[tw] OR Jamaica[tw] OR Serbia[tw] OR Botswana[tw] OR Kazakhstan[tw] OR South Africa[tw] OR Brazil[tw] OR Lebanon[tw] OR St. Lucia [tw] OR Bulgaria[tw] OR Libya[tw] OR St. Vincent and the Grenadines[tw] OR China[tw] OR Macedonia, FYR [tw] OR Suriname[tw] OR Colombia[tw] OR Malaysia[tw] OR Thailand[tw] OR Costa Rica[tw] OR Maldives[tw] OR Tonga[tw] OR Croatia[tw] OR Marshall Islands[tw] OR Turkey[tw] OR Cuba[tw] OR Mauritius[tw] OR Turkmenistan[tw] OR Dominica[tw] OR Mexico[tw] OR Tuvalu[tw] OR Dominican Republic[tw] OR Montenegro[tw] OR Venezuela, RB[tw] OR Equatorial Guinea[tw] OR Namibia[tw]
#3	maternaltiab] OR 'reproductive health' [tiab] OR family planning [tiab] OR newborn*[tiab] OR antenatal[tiab] OR obstetric[tiab] OR postnatal[tiab] OR postpartum[tiab] OR prenatal[tiab] OR perinatal[tiab] OR infant*[tiab] OR interpartum[tiab] OR neonatal[tiab] OR maternal child nursing[MeSH] OR maternal health services[MeSH] OR delivery, obstetric[MeSH] OR obstetrics[MeSH] OR reproductive health [MeSH] OR family planning OR newborn*[tiab] OR baby[tiab] OR babies[tiab]
#4	#1 AND #2 AND #3

MeSH, Medical Subject Headings; tiab, title/abstract; tw, text words.

include reflection on the NS methodology, reviewers' assumptions and factors that could have influenced review findings.

Despite the linear presentation of the elements, the synthesis process is often iterative. A synthesis process flow chart will be included in the systematic review to display the process.

Missing data

When data is missing from articles and not publicly available, attempts will be made to contact study authors directly for the resource.

Quality of evidence

Quality of evidence will be assessed using method-appropriate tools. The Downs and Black[30] checklist for quantitative healthcare studies will be used for all quantitative studies. This checklist was chosen for its multiple advantages, including its usefulness for both randomised controlled studies and non-randomised control studies and its being tailored for healthcare interventions. Quality appraisal for qualitative studies will be conducted using the guidelines proposed by Mays and Pope.[31] These include questions about the worth and relevance of the work, clarity of research questions, appropriateness of the study design to the question, study context, sample and data collection, and analysis. If possible, overall quality of studies will be evaluated using the Grading of Recommendations Assessment, Development and Evaluation framework for quality of evidence.[32 33] Quality-appraisal tables and figures will be presented as additional files.

Table 3 Components of data-extraction form

Data to be extracted	Specific Items to be extracted
Article description	Authors Article title Year of publication Journal
Study setting	Study type Study design Region (sub-Saharan Africa, North Africa, Southeast Asia, etc) Country Setting (eg, rural/urban)
Theoretical/conceptual framework	Is there a theoretical or conceptual framework used? If yes, what is it? How do results and discussions relate to the theoretical or conceptual framework?
Intervention description	Type of mHealth tool use (mobile phone, smart phone, PDA, tablet) Format of intervention (unidirectional or bidirectional messaging, voice messages, application) Description of intervention implementation
Participant characteristics	Target group (women, men, grandmothers, etc) Ages Educational level Is a group described or an individual? Geared towards pregnant women or pregnant women plus? Couple? Community/groups within community? Pregnant or prepartum/post partum? Intervention delivery
Study measures and analysis	Sampling and recruitment procedure Data collection Research tools Analysis methods
Outcomes measured	Maternal or reproductive health knowledge Maternal or reproductive health-seeking attitudes Perceptions of maternal or reproductive healthcare Maternal or reproductive health-seeking behaviours
Results	Findings attributable to mHealth interventions
Authors interpretations/conclusions	Quality of evidence
Reviewers' comments	Equity/sustainability effects Implementation modalities Implementation challenges/bottlenecks

mHealth, mobile health; PDA, personal digital assistant.

ETHICS AND DISSEMINATION

The sustained and increasing interest in mHealth over the last decades has led to an increase in mHealth interventions in reproductive health in LMIC. However, it is not clear what the role of targeting strategies is in the implementation of interventions (and the achievement of outcomes) and how these are related to reproductive health decision-making roles in different contexts. An understanding of this question is fundamental in future design and implementation of maternal and reproductive mHealth, and potentially other mHealth interventions in LMIC.

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Collaborators Ralph de Vries.

Contributors OI, I-OOA, MD and SVB conceived the review design and participated in refining the manuscript. AB and JEWB contributed to refining the review design and OI drafted the manuscript. All authors read and approved the final manuscript.

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