Use of Mobile Phone Technology to Support Improved Infant and Young Child Feeding Practices in Low- and Middle-income Countries: A Scoping Review

by

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A thesis submitted in conformity with the requirements for the degree of Master of Science
Department of Nutritional Sciences
University of Toronto

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Abstract

Sub-optimal Infant and Young Child Feeding (IYCF) practices persist in Low- and Middle-Income Countries (LMIC), contributing to the burden of malnutrition, morbidity and mortality. Contextualized behavior change communication (BCC) delivered through interpersonal support at the community level is effective for improving IYCF practices, but not widely available in LMIC. This scoping review examined the potential for mobile phone technology to facilitate greater access to quality BCC for IYCF. Four delivery channels were identified through a search of the published and grey literature and consultation with implementers. Direct messaging, voice counseling, job aid applications and interactive media each emphasize different BCC techniques. Four studies reported positive effects on IYCF practices with mobile phone-based BCC delivery, but contexts and designs vary. Further research is needed. The incorporation of mobile phone technology in BCC interventions should be guided by formative research to match both the content and delivery approach to the local context.
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The consultation participants enhanced this scoping review with additional project examples and valuable insights into implementation issues. It was a privilege for me to interact with so many pioneering implementers and researchers and I am very grateful for their willingness to share their expertise and experiences.

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<th>Acronym</th>
<th>Full Form</th>
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<tbody>
<tr>
<td>ANC</td>
<td>antenatal care</td>
</tr>
<tr>
<td>BCC</td>
<td>behaviour change communication</td>
</tr>
<tr>
<td>BFHI</td>
<td>Baby Friendly Hospital Initiative</td>
</tr>
<tr>
<td>CCPF</td>
<td>Chipatala Cha Pa Foni project</td>
</tr>
<tr>
<td>EBF</td>
<td>exclusive breastfeeding</td>
</tr>
<tr>
<td>FGD</td>
<td>focus group discussion</td>
</tr>
<tr>
<td>FLW</td>
<td>frontline health worker</td>
</tr>
<tr>
<td>IVR</td>
<td>Interactive Voice Response</td>
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<tr>
<td>IYCF</td>
<td>infant and young child feeding</td>
</tr>
<tr>
<td>LMIC</td>
<td>low- and middle-income countries</td>
</tr>
<tr>
<td>MAMA</td>
<td>Mobile Alliance for Maternal Action</td>
</tr>
<tr>
<td>MNCH</td>
<td>maternal, newborn and child health</td>
</tr>
<tr>
<td>NGO</td>
<td>non-governmental organization</td>
</tr>
<tr>
<td>OR</td>
<td>odds ratio</td>
</tr>
<tr>
<td>PMTCT</td>
<td>prevention of mother-to-child transmission of HIV</td>
</tr>
<tr>
<td>RCT</td>
<td>randomized controlled trial</td>
</tr>
<tr>
<td>RR</td>
<td>relative risk</td>
</tr>
<tr>
<td>SBA</td>
<td>skilled birth attendance</td>
</tr>
<tr>
<td>SMD</td>
<td>standard mean difference</td>
</tr>
<tr>
<td>SMS</td>
<td>Short Message Service</td>
</tr>
<tr>
<td>UNICEF</td>
<td>United Nations Children’s Fund</td>
</tr>
<tr>
<td>WHO</td>
<td>World Health Organization</td>
</tr>
<tr>
<td>WMD</td>
<td>weighted mean difference</td>
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</table>
Chapter 1
Background to Scoping Review

Improving the nutrition of infants and young children through optimal breastfeeding and complementary feeding practices is critical to reducing preventable child mortality and improving developmental outcomes in Low- and Middle-Income Countries (LMIC) [1]. Infant and Young Child Feeding (IYCF) practices occur at the household level, and are strongly influenced by social norms and available resources [2, 3]. Improvements in IYCF practices have been limited [4, 5] despite global evidence-based recommendations and IYCF targets having been incorporated in the national nutrition plans of many countries. To address this gap, a greater investment in contextually-grounded, community-based IYCF interventions is needed, guided by the evidence base from both effectiveness studies and implementation science [6].

1 Current Strategy, Policy and Interventions to Support Infant and Young Child Nutrition

The Global Strategy for Infant and Young Child Feeding, launched by UNICEF and WHO in 2003, defined optimal IYCF practices based on expert reviews of the evidence [7]. Optimal IYCF begins with initiation of breastfeeding within one hour of birth. Breastfeeding should then be exclusive until the infant is around six months of age, when complementary feeding begins. Complementary feeding refers to the introduction and gradual increase in consumption of age-appropriate, nutrient-rich foods, in addition to breastmilk. This stage lasts through the second year of life until breastfeeding is discontinued and the full diet is derived from family foods.

Optimal complementary feeding is complex to define, as it includes multiple elements implemented over a period of significant transition both in terms of feeding practices and broader infant development. The following ten components of the complementary feeding period have been described in best practice guidance: i) duration of exclusive breastfeeding and timing of introducing other foods; ii) continuation of breastfeeding; iii) responsive feeding; iv) safe food preparation and storage; v) quantity of food required; vi) food consistency; vii) feeding frequency and energy density; viii) nutrient content; ix) the use of micronutrient supplements or fortified products; and x) feeding during and after illness [8]. Each of these components relies
on practices at the household level, the specifics of which vary according to the age and developmental stage of the individual child as well as aspects of the local context.

1.1 Strategic Importance of Breastfeeding

Optimal breastfeeding encompasses three practices: early initiation; exclusive breastfeeding (EBF) for six months; and continued breastfeeding through the second year of life [7]. All of these practices have strong associations with child survival [9]. Early initiation is important for establishing EBF and ensuring the infant receives colostrum to begin building a healthy immune system. A systematic review and meta-analysis found that initiation of breastfeeding within the first 24 hours significantly reduced all-cause neonatal mortality (RR=0.56; 95% CI 0.40-0.79), likely by contributing to the protective effect of EBF [10]. EBF for six months is associated with decreased morbidity due to infectious disease, particularly gastrointestinal and respiratory infections [11]. Non-exclusive breastfeeding in infants age 0-5 months in LMIC is associated with a significantly elevated risk of mortality, which increases as the degree of breastfeeding exclusivity declines, up to a Relative Risk (RR) of 14.4 for non-breastfed infants [9]. Sub-optimal breastfeeding, primarily non-EBF in the first six months of life, contributes to over 820,000 child deaths per year in LMIC [12]. The current global target is to increase the prevalence of infants receiving EBF in the first six months of life to 50% by 2025 [13].

Continued breastfeeding is also associated with reduced all-cause mortality risk compared to no breastfeeding in infants age 6-11 months (RR=1.76; 95% CI 1.28-2.41) and age 12-23 months (RR=1.97; 95% CI 1.45-2.67) [9]. Beyond survival, breastfeeding confers benefits to both infants and mothers in several domains, including cognitive development for the infant, with breastfed subjects scoring higher on intelligence quotient tests (mean difference: 3.44 points; 95% CI 2.30-4.58) [14]. Evidence is also emerging of lifelong health benefits of breastfeeding, including reduced risk of type II diabetes and obesity [15]. Ever breastfeeding is associated with a reduced risk for women of both breast and ovarian cancer (OR=0.78; 95% CI 0.74-0.82 and OR=0.70; 95% CI 0.64-0.77, respectively), and both EBF and predominant breastfeeding extend the period of lactational amenorrhoea [16]. To date, no significant associations have been found between breastfeeding and improved child growth, but the data available to assess this are limited to studies of breastfeeding support interventions [17].
Despite the many benefits of breastfeeding for infant survival and lifelong health, practices are sub-optimal across all regions of the world [12]. The highest rates of early initiation, EBF and continued breastfeeding are found in the lowest income countries, but there is still a sizeable gap between recommended and actual practices [12]. In LMIC with the highest burden of mortality, only 50% of infants benefit from early initiation of breastfeeding, despite 65% of births being attended by skilled personnel [5]. The practice of EBF remains stagnated below 40% globally and in LMIC, a figure which has changed little over the past decade [12]. EBF rates are highest in the most vulnerable populations, but still rarely exceed 50%. Breastfeeding at 12 months is near-universal in the lowest income countries, but declines to less than 60% among children 20-23 months, with lower rates for both age groups in middle-income countries [12].

1.2 Effectiveness of Community-Level Breastfeeding Support Interventions

Breastfeeding practices are influenced by determinants at multiple levels, as illustrated by the conceptual model presented in the recent Lancet Breastfeeding Series (Fig. 1) [2]. The remainder of this thesis focuses primarily on interventions to provide counseling, support and lactation management at the family and community level, but with the recognition that these must be situated within a more comprehensive enabling environment for greatest impact.

Implementation of the Global Strategy on Infant and Young Child Feeding [7] is associated with greater increases in national rates of EBF, particularly for countries with low EBF prevalence at baseline [18]. A core component of the Global Strategy is the Baby-Friendly Hospital Initiative (BFHI), which promotes Ten Steps to Successful Breastfeeding, a set of policy and practice recommendations for maternity care facilities [19]. The BFHI has been widely implemented, with an estimated 31% of maternity facilities in LMIC having ever received BFHI certification [20]. A recent narrative systematic review found that adherence to the Ten Steps positively impacts breastfeeding practices, with a dose-response relationship between the number of Steps a mother is exposed to and the likelihood of improved breastfeeding practices [21]. Community-level support (Step 10) was found to be important for sustaining adherence to improved breastfeeding practices.
This accords with other reviews demonstrating that a combination of health facility- and community-based support is most effective for improving breastfeeding practices [22, 23]. Breastfeeding practices are heavily influenced by social norms, cultural knowledge and practical realities [24]. Knowledge of breastfeeding recommendations is insufficient to produce changes in practice, particularly for EBF [25]. Mothers face many barriers to EBF, the most pervasive of which is a lack of confidence in the sufficiency of breastmilk for infant needs [26-28]. This perception is reinforced when mothers experience poor health or food insecurity, and when infants cry excessively [29, 30]. Providing water to young infants is a common practice which compromises EBF, but is considered an essential component of infant care in some cultures [27, 31, 32]. Other significant barriers to optimal breastfeeding include conflicting advice from family or peers, the need to return to paid work, and unresolved breastfeeding difficulties [2, 26, 33]. Fully overcoming these challenges requires action in all three settings described in the conceptual model (Fig. 1), but community-based support is particularly critical for mitigating several of these barriers and establishing EBF as the social norm for infant feeding [2, 34]. Periodic contact with health facilities cannot provide sufficient confidence-building.

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reinforcement and lactation management support to sustain the 24-hour-a-day practice of EBF over six months [35].

Several systematic reviews and meta-analyses have demonstrated the effectiveness of community-based interventions for improving breastfeeding practices. Most recently, a comprehensive systematic review and meta-analysis of randomized controlled trials (RCTs), quasi-experimental trials and observational studies (cohort and case-control) by Sinha et al. examined the effects of breastfeeding support interventions delivered in one or more of five settings: home and family; community; health system; workplace; policy environment [23]. The pooled Odds Ratio (OR) values were greater in LMIC compared with high-income countries for early initiation (OR=1.66; 95% CI 1.44-1.91 and OR=1.13; 95% CI 1.07-1.19, respectively) and for exclusive breastfeeding (OR=1.69; 95% CI 1.54-1.85 and OR=1.35; 95% CI 1.26-1.43, respectively). In contrast, interventions to support continued breastfeeding showed a greater effect in high-income countries (OR=1.76; 95% CI 1.04-3.01) compared with LMIC (OR=1.22; 95% CI 1.09-1.37). Only the health system, home and community settings were included in the combination analysis due to the small number of studies on workplace or policy interventions.

Table 1. Associations between Intervention Settings and Breastfeeding Practices

<table>
<thead>
<tr>
<th>Setting</th>
<th>Early Initiation pooled OR (95% CI)</th>
<th>Exclusive Breastfeeding pooled OR (95% CI)</th>
<th>Continued Breastfeeding pooled OR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health system</td>
<td>1.11 (1.06-1.16) n=29</td>
<td>1.46 (1.37-1.56) n=51</td>
<td>1.18 (1.03-1.35) n=8</td>
</tr>
<tr>
<td>Home &amp; family</td>
<td>1.74 (0.97-3.12)* n=5</td>
<td>1.48 (1.32-1.66) n=43</td>
<td>1.26 (1.05-1.50) n=2</td>
</tr>
<tr>
<td>Community</td>
<td>1.86 (1.33-2.59) n=5</td>
<td>1.20 (1.03-1.39) n=6</td>
<td>no data</td>
</tr>
<tr>
<td>Combined settings</td>
<td>1.57 (1.24-1.97) n=10</td>
<td>1.79 (1.45-2.21) n=26</td>
<td>1.97 (1.74-2.24) n=7</td>
</tr>
<tr>
<td>Health + Community</td>
<td>2.09 (1.64-2.67) n=1</td>
<td>2.52 (1.39-4.59) n=7</td>
<td>10.2 (7.66-13.74) n=1</td>
</tr>
<tr>
<td>Health + Home</td>
<td>1.36 (1.07-1.73) n=6</td>
<td>1.63 (1.27-2.10) n=16</td>
<td>1.34 (1.01-1.81) n=6</td>
</tr>
<tr>
<td>Home + Community</td>
<td>1.85 (1.08-3.17) n=3</td>
<td>1.42 (1.21-1.66) n=3</td>
<td>no data</td>
</tr>
</tbody>
</table>

Note: Data from Sinha et al., 2015 * not statistically significant (p>0.05)
The associations with breastfeeding outcomes of intervention delivery in these three settings either alone or in combination are shown in Table 1. For all three breastfeeding practices, the strongest associations were found with simultaneous delivery of interventions in two settings. Combined delivery in more than two settings was not assessed, and subgroup analysis comparing interventions in LMIC with high-income countries was not performed. This study provides evidence of the importance of community-level interventions, including home-based support, working synergistically with health system interventions. The remainder of this section focuses on the evidence base for community-level breastfeeding support interventions in LMIC.

1.2.1 Early Initiation of Breastfeeding

The evidence base for interventions to increase early initiation of breastfeeding in LMIC is derived from studies of community-based interventions to reduce neonatal mortality. A positive effect of home visit counselling on early initiation of breastfeeding (pooled RR=3.35; 95% CI 1.31-8.59) was reported in a meta-analysis of four RCTs of interventions to reduce neonatal and infant mortality, all conducted in South Asia [36]. A 2010 Cochrane Review of community-based intervention packages for reducing maternal and neonatal mortality and morbidity in LMIC also reported a positive effect on early initiation of breastfeeding (RR=1.94; 95% CI 1.56-2.42) based on data from six RCTs and quasi-experimental trials [37]. This review was updated in 2015 to include eleven trials reporting on early breastfeeding initiation, with a similar positive effect (RR=1.93; 95% CI 1.55-2.39) [38].

1.2.2 Exclusive Breastfeeding

Trials of breastfeeding support interventions have shown positive effects on exclusive breastfeeding, as reported in several systematic reviews. A Cochrane Review of 52 randomized or quasi-randomized controlled trials from 21 countries (primarily high-income) found that all forms of support for breastfeeding mothers reduced the risk of discontinuing EBF before six months (RR=0.86; 95% CI 0.82-0.91)[39]. A systematic review and meta-analysis of community-based interventions in LMIC identified four RCTs which assessed EBF at 4-6 months, all of which reported significant positive results (pooled OR=5.90; 95% CI 1.71-18.59) although intervention strategies varied [40]. Another systematic review and meta-analysis of fifteen RCTs and quasi-experimental trials of breastfeeding promotion interventions (six from LMIC) found significant effects on exclusive breastfeeding at six months, with a six-fold
increase in LMIC (RR=12.14; 95% CI 9.76-15.11) compared with a 1.3-fold increase in high-income countries [41]. Sub-group analysis showed that a combination of individual prenatal and post-natal counseling had the greatest influence on EBF at six months (RR=2.60; 95% CI 1.13-5.96), while group sessions were not effective (RR=2.03; 95% CI 0.85-4.85). This review was updated by Haroon et al. in 2013, whose analysis of 66 RCTs and quasi-experimental studies, 27 from LMIC, concluded that breastfeeding promotion interventions increased exclusive breastfeeding by 43% on the first day of life (RR=1.43; 5% CI 1.09-1.87), by 30% at <1 month (RR=1.30; 95% CI 1.19-1.42), and by 90% from months 1-5 (RR=1.90; 95% CI 1.54-2.34) [22]. Sub-group analyses found that in LMIC, a combination of facility- and community-based counseling produced the greatest increases in EBF on the first day of life (RR=2.57; 95% CI 1.39-4.77), at <1 month (RR=1.35; 95% CI 1.15-1.58) and from months 1-5 (RR=2.88; 95% CI 2.11-3.93).

Three reviews have specifically examined the effects of peer support to improve breastfeeding practices. Chapman et al.’s systematic review of RCTs of peer counselling interventions found a consistent positive effect on breastfeeding practices, including initiation, duration and exclusivity, but a meta-analysis was not conducted [42]. The elements of setting, intensity and timing of peer support interventions were examined for their effects on duration of breastfeeding and exclusive breastfeeding in a subsequent systematic review and meta-analysis by Jolly et al. [43]. Seventeen study sites from fifteen RCTs were included in the meta-analyses; eight study sites were in LMIC. Training for peer counselors varied from a few hours to eight weeks, indicating wide variation in intervention designs. Overall, the relative risk of not practising EBF at the last study follow-up point was 0.82 (95% CI 0.76-0.88) for women allocated to receive peer support compared with usual care. Meta-regression analyses found that the relative risk of discontinuing exclusive breastfeeding was significantly reduced in studies conducted in LMIC (RR=0.63; 95% CI 0.52-0.78) compared with high-income countries (RR=0.90; 95% CI 0.85-0.97) (p=0.01). No significant difference in risk of discontinuing EBF was found between interventions delivering counseling in both the antenatal and postnatal period or only postnatally (p=0.38). No significant difference was found between interventions with lower intensity (<5 planned contacts) compared with higher intensity (≥5 planned contacts) (p=0.73), although individual studies have reported a dose response, with greater improvements in breastfeeding outcomes as the number of counseling contacts increased [44-46].
The systematic review by Sudfield et al. focussed on exploring the influence of formula feeding culture, inclusion of low birth weight infants and infant age at the time of outcome assessment on the effectiveness of peer counseling on EBF duration [47]. Five RCTs with eight study sites were included in the meta-analysis. Based on the community prevalence of formula feeding, three studies were classified as taking place in a low (<10%) and five in a moderate-high (>10%) formula feeding culture. Overall, peer counseling was found to reduce the risk of discontinuing EBF at the last study follow-up point (RR=0.71; 95% CI 0.61-0.82). No significant effect was found when low birth weight infants were included (p=0.367) or by the timing of the end-point assessment (p=0.398). However, the relative risk of discontinuing EBF was significantly greater in settings with a moderate-high level of formula feeding (RR=0.84; 95% CI 0.74-0.95) compared with those with a low prevalence of formula feeding (RR=0.46; 95% 0.36-0.59), suggesting that peer counseling may be most suitable for enhancing adherence to optimal practices in settings where breastfeeding is the social norm.

1.3 Lessons Learned for Breastfeeding Support Interventions

These reviews demonstrate that community-based breastfeeding support interventions delivered through interpersonal communication are effective in increasing early initiation and duration of exclusive breastfeeding in LMIC. The evidence supports a continuum-of-care approach, in which breastfeeding promotion and support begins in pregnancy and continues through infancy, with strong linkages and complementarity between health facility- and community-based services and support [21-23, 41]. Beyond this, the wide variation in study contexts and intervention strategies, inadequate reporting on implementation elements and lack of comparative or cost-effectiveness studies make it difficult to recommend one intervention approach over another [35, 47, 48].

1.4 Strategic Focus on Complementary Feeding

While early infancy carries an elevated risk of mortality due to sub-optimal breastfeeding practices, the complementary feeding period (6-23 months) is a time of great vulnerability to linear growth faltering (stunting) and its multiple negative sequelae [1, 49]. An estimated 165 million children suffer from stunting, with 90% of the global burden concentrated in 34 countries in sub-Saharan Africa and South Asia [1]. Stunting is associated with increased childhood mortality and morbidity, reduced educational achievement and adult income earning potential,
and increased vulnerability to non-communicable diseases in adulthood [50, 51]. In high-burden countries, these individual effects are multiplied across a significant proportion of the population, compromising national development and perpetuating poverty [51, 52]. There is therefore a strong economic rationale for investing in stunting prevention, in addition to the public health imperative [53]. The current global target is to reduce by 40% the number of stunted children, from 2012 levels, by 2025 [13].

The etiology of stunting is multi-faceted, as illustrated by the WHO Conceptual Framework on Childhood Stunting (Fig. 2) [54]. Major contributors to stunting include maternal undernutrition, poor sanitation, and sub-optimal IYCF, particularly during the complementary feeding period [54-56]. Achieving the 2025 global stunting reduction target will therefore require increased investment in effective IYCF interventions as part of a broader multi-sectoral package [57, 58].

A core set of IYCF indicators, including three for breastfeeding and five for complementary feeding, was published by WHO in 2008 [59]. The core indicators for complementary feeding assess: i) timely introduction of complementary foods; ii) minimum meal frequency; iii) minimum diet diversity; iv) minimum acceptable diet (combined indicator reflecting diet diversity and meal frequency); and v) consumption of iron-rich or iron-fortified foods. This was the first globally standardized set of indicators for complementary feeding, and the core indicators have since been included in nationally representative cross-sectional surveys in LMIC, including the Demographic and Health Surveys. This has enabled more consistent and comparable assessment and tracking of complementary feeding practices. The first multi-country review of the standardized IYCF indicators included Demographic and Health Survey data from 46 countries, and found consistently sub-optimal complementary feeding practices [4]. Less than one-third of children age 6-23 months received minimum diet diversity, half received minimum meal frequency, and only 21% met the combined criteria for minimum adequate diet.
Figure 2. WHO Conceptual Framework on Childhood Stunting: Context, Causes and Consequences

Several papers have used regression modeling to analyze associations between IYCF indicators and child growth status using data from cross-sectional Demographic and Health Surveys for individual countries [60, 61], while three have examined these associations for multiple countries. The study by Marriott et al. included cross-sectional data from 14 countries, and found that approximately 50% of children received minimum meal frequency but less than 25% received minimum diet diversity and less than 20% met the criteria for minimum acceptable diet [62]. For infants 6-8 months of age, intake of iron-rich foods and meeting the standards for dietary diversity and minimum acceptable diet were associated with a significantly lower risk of stunting (p<0.001). Onyango et al. analyzed cross-sectional data from 21 LMIC and found that Peru was the only in which the majority of the sample received the minimum acceptable diet [63]. Only five countries had at least half the sample receiving minimum diet diversity, the indicator most consistently associated with attained linear growth. A positive effect estimate between minimum diet diversity and attained linear growth was found in 12 of the 21 countries, with effect size ranging from 0.16 to 1.40 z-score. The countries with the smallest proportion of children receiving minimum diet diversity had the greatest declines in height-for-age z-score over the complementary feeding period. The review and synthesis of findings from eight cross-sectional studies by Jones et al. found that minimum acceptable diet was positively associated with height-for-age z-score in four countries, but other relationships between child feeding and child growth were inconsistent [64].

Although findings are mixed, these analyses of cross-sectional studies highlight the inadequacy of complementary feeding practices in LMIC, and suggest the potential for improved practices to benefit child growth. Longitudinal data from a clinical trial in Zambia supports this assertion with the finding that dietary diversity at six months of age was positively associated with height-for-age z-score at 18 months (p<0.001) [65].

1.5 Effects of Complementary Feeding Interventions on Child Growth

The alignment of several practices is required in order to follow optimal complementary feeding practices, including use of responsive feeding techniques, adequate frequency of feeding, and provision of sufficient energy- and nutrient-density of foods according to the child’s age [8]. Interventions may therefore include one or a combination of three broad approaches: provision
of energy- and/or micronutrient-dense complementary foods; provision of micronutrient supplements; and behaviour change communication (BCC) to promote improved complementary feeding practices [57]. All of these interventions must be delivered at the community and household level where complementary feeding practices occur on a day-to-day basis. Many individual studies report improvements in complementary feeding practices following intervention delivery, but effects on child growth are inconsistent [57].

Three systematic reviews have assessed the evidence for effects of complementary feeding interventions on linear growth, and the following discussion focuses on the findings related to BCC interventions. In 2008, Dewey and Adu-Afarwuah identified a modest effect of nutrition education interventions on linear growth (mean effect size 0.20 \( z \)-score, range 0.04-0.64), based on data from six efficacy trials and five effectiveness studies, with the greatest impact reported by two interventions promoting animal source foods as a key BCC message [66]. A more modest effect on linear growth was reported for the eight studies (two efficacy trials and six effectiveness studies) providing complementary food along with some other strategy, usually nutrition education (mean effect size 0.17 \( z \)-score; range 0-0.32) although the two efficacy trials demonstrated a small but significantly greater effect on child growth with food plus education compared with education alone [67, 68].

In 2011, Imdad et al. conducted a systematic review which included 17 RCTs and quasi-randomized trials reporting on child growth outcomes from either complementary food provision (with or without nutrition counseling), or complementary feeding counseling alone [69]. The primary outcomes were the mean changes in weight and height over the study period. Meta-analysis showed that both categories of intervention resulted in significant increases in both weight and length growth compared to controls, using Weighted Mean Difference (WMD). For weight gain, WMD=0.34 SD (95% CI 0.11-0.56) in the food provision group and WMD=0.30 SD (95% CI 0.05-0.54) in the trials of nutrition counseling alone. For length, WMD=0.26 SD (95% CI 0.08-0.43) in the food provision group and WMD=0.21 SD (95% CI 0.01-0.41) in the counseling-only group. These effects translated into additional weight gain of 0.25kg (+0.18) and 0.30kg (+0.26), and additional length gain of 0.54 cm (+0.38) and 0.49 cm (+0.50) from the food provision and counseling-only interventions, respectively. A subsequent systematic review of the same two intervention categories analyzed absolute gains in height and weight, calculated as Standard Mean Difference (SMD) [70]. Inclusion was restricted to interventions of at least six
months duration, but both randomized and non-randomized study designs were included (n=16). Pooled analysis showed a significant effect on growth in length (mean height-for-age z-score) and weight (mean weight-for-age z-score) respectively from interventions delivering either complementary food (SMD 0.39; 95% CI 0.05-0.73 and SMD 0.26; 95% CI 0.04-0.48) or counseling alone (SMD 0.23; 95% CI 0.09-0.36 and SMD 0.16; 95% CI 0.05-0.27). The studies were further stratified into food secure (ten studies) and food insecure populations (six studies) based on average per capita income data. However this sub-group analysis was limited by inadequate data. No studies of complementary food provision were conducted in food secure environments, and only one study of counseling-only in a food insecure population contributed data on linear growth.

Although these studies provide evidence of benefits for child growth from community-based complementary feeding interventions, there is a great need for implementation research to provide guidance on optimal intervention strategies [6]. Childhood linear growth is mediated by many factors; complementary feeding interventions are likely to prove more effective when implemented in combination with measures to promote early child development and to address maternal undernutrition, poor sanitation and infectious disease [54, 57]. Furthermore, complementary feeding includes a multi-dimensional set of practices, only a small number of which are typically addressed in a single intervention. The diversity of focus, designs and outcome measures in the available complementary feeding studies make it difficult to draw comparisons between intervention strategies [71].

### 1.6 Lessons Learned for Complementary Feeding Interventions

Two papers have assessed implementation elements contributing to effective complementary feeding interventions. After reviewing 29 studies of behaviour change interventions related to complementary feeding, Fabrizio et al. concluded that positive outcomes can be achieved through a variety of intervention designs based on community-level interpersonal communication [71]. Two key elements of successful approaches were identified: the use of formative research to guide the intervention design and messaging, and the delineation of the expected program impact pathway. Briscoe and Aboud analyzed the specific behaviour change techniques used by six purposively selected complementary feeding interventions, as part of a study of 24 BCC interventions for improved child care practices in LMIC [72]. All six
interventions included information delivery and demonstrations of improved practices plus at least one other BCC technique. Provision of food and use of small media such as drama and songs were techniques used by four studies each. The authors conclude that the use of multiple techniques may enhance the effectiveness of interventions, by engaging the target audience through multiple domains and attempting to ameliorate barriers to improved practice.

2 Knowledge Translation: Implementing Effective Community-Level IYCF Support Interventions

Despite the importance of IYCF practices to child survival, growth and development, and the proven value of certain types of interventions to improve breastfeeding and complementary feeding, a sizeable gap persists between recommended and actual practices. Achieving high coverage of interventions supporting improved IYCF practices through sustainable community-based systems remains a challenge in many LMIC. There is a shortage of best practice guidance linking the evidence from efficacy and effectiveness studies with implementation experience. Research on delivery systems for IYCF support was ranked highest priority of eight topics for implementation research required to support the scaling-up of efficacious nutrition interventions in LMIC [6].

A recent landscaping study of IYCF BCC practitioners confirmed that community-based delivery is the norm, with messaging most commonly integrated within broader health and nutrition communication programmes [73]. A strong commitment to formative research was evident, but there was a lack of clarity on the processes and practice of translating formative research findings into intervention plans and crafting of BCC messages. The need for guidance on both process and outcome evaluations for IYCF BCC was also identified. Recommendations from this study include the need for compilation of a compendium of existing IYCF BCC guidance tools, development of additional guidelines to cover the full programme process, continued support to effective programmes, and development of innovative delivery channels [74]. The authors conclude that:

‘...the constraints that IYCF practitioners face create serious challenges for effective communication of the complex set of messages that constitute BCC to improve IYCF. There is, we suggest, an urgent need to identify complementary and alternative models for the dissemination of IYCF knowledge and skills to
those who are in a position to support caregivers in meeting the challenge of improving IYCF nutrition. This includes the full programme impact pathway from policy makers to frontline workers and community educators to household members, including especially fathers and grandmothers.’ (p.242)[73]

Scaling up effective IYCF interventions therefore requires strengthening human resources for the delivery of interpersonal BCC at the community level, supported by investments in a comprehensive enabling environment [2, 75]. Interpersonal BCC must engage the whole family and not only the mother, and must include skilled lactation support [2, 21, 76, 77]. Frontline health workers (FLWs) are often relied upon to promote optimal IYCF practices, but studies in different settings have shown FLWs to be inadequately prepared, motivated and supported to perform effectively in this role [78, 79]. In planning for adequate coverage of IYCF support it is vital to consider mechanisms to reach adequate intensity (frequency and quality) of intervention delivery, in order to achieve sustained changes in practice [76]. In addition to structural issues and workforce numbers, intensity is influenced by workload, training and supervision, all of which are known to be common barriers to effective delivery of services by FLWs in LMIC [80-82]. Greater attention must be paid to these issues to increase the effectiveness of community-based IYCF support [6, 73, 83].

Three distinct, contextually-derived models for delivering IYCF support at scale were developed by the Alive & Thrive programmes in Bangladesh, Ethiopia and Vietnam [78]. Guided by a shared socio-ecological theoretical model, each country programme addressed key elements in the theory of change through locally appropriate delivery channels [83]. Interpersonal communication, social mobilization and mass media were the primary strategies for influencing behaviour change (Fig. 3), with interventions targeted to mothers and families, community opinion leaders and health providers [27, 84]. IYCF counseling by trained providers directly addressed specific individual barriers to improved practice, while mass media was used to build social support and create demand for services, and advocacy efforts aimed to shape an enabling environment for improved IYCF practices [85].
The specific delivery approaches for these broader strategies varied by country, and were grounded in extensive formative research, including feasibility trials of improved practices [27]. In Bangladesh, Alive & Thrive partnered with the non-governmental organization (NGO) BRAC to equip and support its existing network of FLWs to deliver interpersonal IYCF counseling through home visits [84]. A performance-based incentive scheme was implemented, with FLWs receiving a cash reward for each mother who applied recommended IYCF practices. In Ethiopia, IYCF support was integrated into routine outreach services delivered by the Ministry of Health’s existing cadre of Health Extension Workers [83]. In Vietnam, a social franchise model was developed to provide IYCF counseling to both individuals and groups through government health care facilities at the community level [85]. A 2013 process evaluation in Vietnam documented an increase in EBF to 62% in intervention areas, from 19% at the 2010 baseline [86]. Programme impact evaluations conducted in 2014 in Bangladesh and Ethiopia showed significant improvements in key IYCF practices in intervention areas, compared to 2010 baseline levels (Table 2) [87, 88]. Challenges remain, however, particularly for complementary feeding practices.

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Table 2. Evaluation Results for Alive & Thrive Programmes

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Bangladesh</th>
<th></th>
<th>Ethiopia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2010</td>
<td>2014</td>
<td>2010</td>
<td>2014</td>
</tr>
<tr>
<td>Early initiation of breastfeeding</td>
<td>64%</td>
<td>94%</td>
<td>67%</td>
<td>82%</td>
</tr>
<tr>
<td>Exclusive breastfeeding</td>
<td>48%</td>
<td>88%</td>
<td>72%</td>
<td>80%</td>
</tr>
<tr>
<td>Minimum diet diversity</td>
<td>32%</td>
<td>64%</td>
<td>6%</td>
<td>12%</td>
</tr>
<tr>
<td>Minimum meal frequency</td>
<td>42%</td>
<td>75%</td>
<td>46%</td>
<td>70%</td>
</tr>
<tr>
<td>Minimum acceptable diet</td>
<td>16%</td>
<td>50%</td>
<td>5%</td>
<td>10%</td>
</tr>
</tbody>
</table>

Note: Data for Bangladesh are from Alive & Thrive, 2015, and for Ethiopia from Alive & Thrive, 2014

3 Summary: Challenge of Increasing Access to Effective IYCF Support Interventions

IYCF practices occur on a daily basis at the household level, in the context of a culture and community, and thus are strongly mediated by social factors [27, 89]. Although significant gaps persist between recommended and actual IYCF practices in LMIC [4], there is a growing evidence base for effective approaches to narrow them. Both breastfeeding and complementary feeding practices have been shown to be amenable to change with contextually-appropriate and sufficiently intense community-level interventions [23, 71]. The benefits of community-level interventions are enhanced through an enabling environment promoting IYCF-friendly policies and social norms [75, 84]. Guiding principles for intervention design include the need to ground designs in formative research; build on existing systems and approaches; ensure adequate skills training and supportive supervision for frontline or peer support workers; and monitor results to inform refinements to the design [35, 75, 78, 90]. The Alive & Thrive programmes in Bangladesh, Ethiopia and Vietnam provide three models of effective, comprehensive interventions targeting priority IYCF behaviours through contextually-appropriate delivery channels [84, 85, 91].
Drawing on the evidence from successful interventions, the challenge now is to make community-level support for IYCF widely accessible to mothers and families. New investments and creative delivery approaches are needed to address this gap [74], supported by implementation research to strengthen guidance on evidence-based approaches [6]. The proliferation of mobile phone technology in LMIC has created new avenues for BCC delivery, which may be able to contribute to the need for new IYCF BCC delivery approaches [73, 92]. This scoping review study examines the potential for mobile phone technology to expand access to timely, quality counseling and supportive community-level BCC for improved IYCF in LMIC.
Chapter 2
Rationale and Methods

4 mHealth for Maternal, Newborn and Child Health

Over the past decade, mobile phones have become widely available in most LMIC, with subscription rates continuing to grow. Globally, there are approximately 7.4 billion mobile phone subscriptions, representing an estimated 5 billion individual subscribers, including 80% of the population in Africa and India [93]. These figures continue to climb, with 3% year-on-year growth. In the first quarter of 2016, four of the five countries with the greatest numbers of new mobile phone subscriptions were LMIC, led by India with 21 million new subscriptions [93]. There is optimism that leveraging mobile phone technology will assist in overcoming barriers to health system functioning and service delivery in LMIC, and many projects are now integrating mobile health (mHealth) components [94-96]. The term “mHealth” is used to refer collectively to the use of mobile technology for health-related functions, including data collection and management, service delivery, health communication and diagnostics [94].

In the field of maternal, newborn and child health (MNCH), mHealth interventions are being used to address a wide variety of barriers to health service delivery [95, 97]. Twelve key functions of mHealth have been identified, each of which requires its own evidence base and best practice guidelines [94]. Community-level support for improved IYCF practices relates primarily to the first key function, client education and behaviour change communication. Mobile phone technology in particular has the potential to enhance the delivery of BCC initiatives, but this has been under-explored for nutrition [73, 92, 98].

Two systematic reviews of mHealth for BCC in LMIC have been published. Gurman et al. searched both the published and grey literature for BCC interventions which included either formative, process or outcome evaluation data, without restriction by study design or health outcome [99]. The sixteen studies which met inclusion criteria were assessed for adherence to best practice guidelines on mHealth intervention design, and a need for more attention to both formative and evaluation research was identified. Higgs et al. identified fifteen studies, primarily RCTs, reporting causal attribution of mHealth interventions to behavioural outcomes relevant to child survival [100]. All selected studies used text messaging as the BCC
intervention. Target behaviours included anti-retroviral medication adherence, HIV testing and counseling, skilled birth attendance, oral hygiene, and compliance with health care appointments; no studies addressed complex, habitual behaviours such as IYCF practices. These two reviews were limited by the small number of available studies and their heterogeneity in terms of context, intervention strategies and target health outcomes. No conclusions regarding effectiveness could be drawn, and the authors of both reviews call for more attention to building the mHealth evidence base. Higgs et al. also highlight the need for implementation research to identify mechanisms of change and contextual factors influencing the success of mHealth interventions [100].

Several other reviews of mHealth in LMIC have been published, some broader in scope [96] while others focus on particular health domains [101-103] or geographic areas [104, 105]. Some have included a variety of study types while others restricted inclusion to RCTs. Regardless of approach, a persistent challenge acknowledged in all the reviews is the shortage of published evaluations of mHealth interventions despite the plethora of implemented projects. This limits the possibility for both basic determination of effectiveness and a more granular analysis of the relative merits of different mHealth interventions for different health needs in different contexts [106]. Nonetheless, most mHealth studies report positive effects, so while meta-analysis capabilities are limited, there is a growing agreement that mHealth is an effective tool for extending the reach and quality of a variety of health services [95]. However, the degree to which the successful deployment of mHealth innovations translates to improvements in specific health outcomes, including MNCH or IYCF outcomes, remains undetermined [103, 107]. Much greater understanding of the impact pathway from the design and deployment of specific mHealth designs to achievement of health outcomes is also required [108].

A comprehensive systematic review of the effectiveness of mHealth interventions for MNCH outcomes in LMIC identified only fifteen relevant studies [107]. Three of these studies were explicitly designed to improve IYCF practices [32, 109, 110]. Meta-analysis of these three studies (two RCTs and one quasi-experimental cluster RCT) showed positive effects of the mHealth interventions on early initiation of breastfeeding (OR 2.01; 95% CI 1.27-2.75) and exclusive breastfeeding at three or four months (OR 1.88; 95% CI 1.26-2.50) and at six months (OR 2.57; 95% CI 1.46-3.68). Although this initial evidence of effectiveness is encouraging, the
small number of available studies and the great variation in intervention strategies and contexts limits the guidance for future programme design that can be drawn from these results.

Although the number of published studies is limited, multiple projects utilizing mHealth for MNCH are being designed and implemented within the programming sphere. These initiatives provide a rich basis for learning but are inadequately captured in published studies. A scoping review was therefore designed to identify and map current knowledge on community-level BCC innovations using mobile phone technology, with a focus on relevance to IYCF support. Although the field of mHealth includes a variety of mobile and wireless technologies, mobile phones were chosen as the form of mobile technology most widely available and utilized for health interventions in LMIC.

5 Research Question and Objectives

This scoping review aimed to address the following research question:

*How can mobile phone technology be used to support improved breastfeeding and complementary feeding practices in low- and middle-income countries?*

The scoping review had three specific objectives:

1. To develop a typology of mobile phone-based BCC innovations applied to maternal, newborn and child health in LMIC;

2. To review the evidence for each type of innovation and assess its applicability to community-level IYCF support;

3. To analyze the mHealth innovation landscape for current mobile phone-based IYCF support initiatives in LMIC.

6 Methods

Scoping reviews aim to map the breadth and depth of a field of knowledge through assessment of a broad spectrum of evidence [111]. This approach is particularly relevant for topics with an emergent evidence base, as a scoping review identifies knowledge gaps and provides direction for future research [112]. This review followed the five-stage methodology proposed by Arksey
and O’Malley for scoping reviews in the health sciences [113]. These five stages are: 1) define the research question; 2) identify relevant studies; 3) select studies; 4) chart the data; 5) collate, summarize and report the results. Arksey and O’Malley’s framework includes a consultation exercise as an optional sixth stage, which Levac et al. recommend should be integral to scoping review methodology [112]. A consultation exercise was also included in this study to broaden the data collection and gain insights from project implementers.

6.1 Identification of Relevant Studies

Data were collected through searches of both the published and grey literature, and consultation with researchers and implementers of mHealth projects targeting improved MNCH practices.

6.1.1 Published Literature Search

The published literature search was conducted using three major online databases: PubMed, MedLine and Scopus. These databases were all searched on October 6, 2015, using the key term “mobile phone” with the following search terms: counseling, behavior change, nutrition, infant feeding, and breastfeeding. The full PubMed search terms are provided in Appendix I, and formed the basis of the MedLine and Scopus searches. Searches were filtered for English language papers only, and the Scopus search was also limited to journal articles in the medical and social science fields. There were no restrictions by date. All records were exported to EndNote X7 citation management software and duplicates were removed.

Additional test searches were performed in PubMed using variations in the search terms, but no further relevant articles were identified so these test searches were not repeated in MedLine and Scopus.

6.1.2 Grey Literature Search

An extensive search of the grey literature was also conducted in order to identify unpublished studies, programmatic reports and conference presentations relevant to the scoping review objectives. Several online global databases have been established for the purpose of mHealth knowledge exchange. Twelve online repositories were searched using the terms “behaviour change”, “nutrition” and “counseling” separately and in combination. In addition, the websites of many organizations known to be engaged in mHealth were searched. This was done either
using the website’s internal search function or through screening the documents available for
download under relevant website tabs such as “tools”, “resources” or “publications”.

The grey literature search began in July 2015 with an initial list of known sources. Additional
databases, projects and agency websites were identified from the reference lists of both published
and grey literature papers and through the consultation process, and were added to the search list.
No new sources were added after April 30, 2016, and the final grey literature search list is
provided in Appendix II.

6.1.3 Additional Searches

Additional published studies and grey literature reports were identified through review of the
reference lists of all selected documents, PubMed suggestions for similar articles, and title
review of all nine issues of *JMIR mHealth and uHealth* journal (2013-2015), as well as through
personal contacts and announcements of newly released documents through the Global Digital
Health Working Group email network.

Two online registries of clinical trials, [www.clinicaltrials.gov](http://www.clinicaltrials.gov) and the [WHO International Clinical Trials Registry](https://clinicaltrials.gov), were searched using the terms “mHealth”, “mobile phone” and “mobile
health” combined with “nutrition”, “behavior change” and “counseling” to identify current
research studies related to mHealth BCC interventions for IYCF.

6.1.4 Consultation

Personal contact was also made with key individuals working in the field of mHealth for BCC, to
solicit project examples and implementation experiences. These individuals were initially
identified through personal professional networks or through the grey literature search, and some
provided referrals to additional contacts. Appendix III lists the consultation participants.

6.2 Screening and Selection of Studies and Reports

Records from the literature searches were screened according to pre-determined inclusion
criteria.

Published articles were selected for the scoping review if they reported on feasibility or
intervention studies related to the use of mobile phone technology for BCC addressing MNCH
issues in LMIC. There were no restrictions by publication date or study methodology. Studies reporting on monitoring and evaluation aids, electronic health records, non-MNCH interventions in LMIC and interventions in high-income countries were excluded. Abstracts were reviewed for records that could not be excluded by title alone, and where uncertainty remained, the full text article was reviewed.

All potentially relevant documents identified in the grey literature search were reviewed by title, abstract or executive summary (where available) or full text. Documents were selected for inclusion in the scoping review if they reported on the feasibility, evaluation or implementations lessons from interventions using mobile phone technology for BCC addressing MNCH issues in LMIC. There was no restriction by study methodology, but media articles and project briefs without any evaluation data or reflection on lessons learned were excluded.

6.3 Data Charting

The selected studies were categorized into a typology according to the main mobile phone-based delivery approach used in the intervention. Data were extracted and compiled from each study using charting tables developed for this purpose. The charting tables recorded key details regarding study methodology (design, sample size, location), intervention, and findings. For programme implementation reports that did not include evaluation data, notes were taken of key features of the intervention design and lessons learned.

6.4 Collation and Summary of Findings

A descriptive analysis of the existing evidence related to both effectiveness and implementation was completed for each mobile phone-based delivery approach in the typology. The analysis focused on assessing the applicability of each delivery approach to BCC for improved IYCF practices in LMIC, drawing on examples of projects explicitly targeting IYCF indicators as well as generalizable findings from other projects. The analysis identified both group-specific factors and cross-cutting themes.

The strengths and limitations of the mobile-phone based approaches for BCC delivery were assessed using criteria adapted from Briscoe and Aboud’s analysis of the techniques utilized by twenty-four BCC projects addressing four health behaviours, including complementary feeding, in low resource settings [72]. This framework was chosen because of its derivation from and
therefore direct relevance to BCC interventions for child care practices in low resource settings, which currently lack an adequate guiding theoretical framework [74].

Briscoe and Aboud organized the BCC techniques they identified into six categories: information, performance, problem solving, social support, materials and media (Table 3). This list was adapted for use in this scoping review with the addition of a seventh category: interpersonal communication. Interpersonal communication was the delivery mode in all the studies analyzed by Briscoe and Aboud and is considered a core technique for improving IYCF practices [71, 78] but is not an inherent component of all mobile phone-based interventions. The mobile phone delivery channels identified in the scoping review were therefore assessed for their application of seven categories of behaviour change techniques.

Table 3. Techniques for Behaviour Change Communication

<table>
<thead>
<tr>
<th>Technique</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information</td>
<td>provide knowledge and/or instructions</td>
</tr>
<tr>
<td>Performance</td>
<td>model new practice; opportunity for trial and feedback</td>
</tr>
<tr>
<td>Problem Solving</td>
<td>identify barriers and facilitators of change</td>
</tr>
<tr>
<td>Social Support</td>
<td>shift social norms and build support for improved practice</td>
</tr>
<tr>
<td>Materials</td>
<td>provide an incentive to try or cue to action</td>
</tr>
<tr>
<td>Media</td>
<td>reinforce recommended practices in culturally meaningful ways</td>
</tr>
</tbody>
</table>

Note: Table contents derived from Briscoe & Aboud, 2012
Chapter 3
Results

7 Literature Identified and Included

The flow of decisions on inclusion of articles identified in the literature search is presented in Figure 4. The search of published literature yielded 787 unique articles after removal of duplicates. After title and abstract review, 106 remained for full text review, of which 17 met the inclusion criteria. A further 19 were added from the grey literature, including unpublished research and programmatic case studies, for a total of 36 papers included in the scoping review.

Figure 4. Literature Search Results
8 Typology of Mobile Phone-based BCC Delivery Channels

The interventions described in the selected papers were readily grouped under three primary modes of mHealth delivery:

1) **direct messaging** to clients, primarily mothers, using either brief text or audio messages, and often tailored to stage of pregnancy/infancy;

2) **voice counseling** via mobile phone, either through a hotline accessed at the client’s initiative, or through pro-active contact by a designated counselor; and

3) **job aid applications** for use by frontline health workers, with prompts for key BCC messages; audio or multimedia messages are often embedded as counseling tools.

Several projects utilized both direct messaging and voice counseling, and are presented under this combined category. An additional category, termed **interactive media**, was identified through the consultation process but not the literature search. Interactive media uses internet technology and includes smartphone applications and social media platforms.

Table 4 shows the number of papers identified by delivery channel, and the number reporting on at least one IYCF indicator. The nineteen intervention papers represent thirteen discrete studies. Six of these were RCTs [32, 110, 114-117], one was a quasi-experimental cluster RCT [109], two used quasi-experimental pre-test/post-test designs [118, 119], three were retrospective observational studies [120-122], and one used a simple pre-test/post-test design [123]. The Wired Mothers study in Zanzibar published three papers [116, 124, 125] and the Chipatala Cha Pa Foni (CCPF) project in Malawi produced four published papers [118, 126-128] and one grey literature evaluation report [129].

There were no interactive media projects with documented evaluations or case study reports. The combined category of “messaging + voice” was created to capture seven papers representing three separate studies which included both direct messaging and voice counseling interventions.
Table 4. Literature Search Results by Mobile Phone Delivery Channel

<table>
<thead>
<tr>
<th>Type</th>
<th>Source</th>
<th>Direct Messaging</th>
<th>Voice Counseling</th>
<th>Messaging + Voice</th>
<th>Job Aid Apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intervention (13 studies)</td>
<td>Published</td>
<td>7</td>
<td>3</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grey</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>Formative/Qualitative</td>
<td>Published</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Grey</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Case studies, other reports</td>
<td>Published</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Grey</td>
<td>3</td>
<td></td>
<td></td>
<td>7</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>12</td>
<td>2</td>
<td>7</td>
<td>15</td>
</tr>
</tbody>
</table>

Studies with ≥1 IYCF indicator

<table>
<thead>
<tr>
<th>Source</th>
<th>Direct Messaging</th>
<th>Voice Counseling</th>
<th>Messaging + Voice</th>
<th>Job Aid Apps</th>
</tr>
</thead>
<tbody>
<tr>
<td>Published</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grey</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
</tbody>
</table>

9 Evidence for Mobile Phone-based BCC Delivery Channels

The specific studies and reports are described by delivery channel in the sections below.

9.1 Direct Messaging

Direct messaging delivers brief, standardized messages to clients’ phones using either short-message-service (SMS) for written text, or Interactive Voice Response (IVR) technology for audio content. Nine studies on direct messaging for MNCH BCC were identified, eight from the published literature and one from the grey literature, through the consultation process (Table 5). These studies represent six discrete intervention projects and one feasibility study. Three papers were published from the Wired Mothers intervention in Tanzania. Studies which included voice counseling along with direct messaging are reported in a separate section below. Three project case study reports from the grey literature were also included for their contribution to implementation lessons learned.

Only one published study examined the use of SMS as the sole intervention to support improved IYCF practices. Jiang et al. conducted a quasi-experimental cluster randomized trial in Shanghai, China [109]. Mothers registered with health centres in the intervention group received weekly nutrition-focussed SMS to their personal phones from the third trimester of pregnancy.
until their child’s first birthday. The primary outcome measure was median EBF duration, which was significantly greater in the intervention group at 11.41 weeks (95% CI 10.25-12.57) compared with 8.87 weeks (95% CI 7.84-9.89) for the control (p<0.001). There was no significant difference between the groups for introduction of complementary foods before 6 months nor for the median duration of any breastfeeding at 12 months (7.7 months in both groups).

Direct messaging was also used in a multi-dimensional BCC intervention in Nigeria which aimed to improve breastfeeding practices [32]. All women participating in a micro-credit programme received traditional health education sessions on breastfeeding in a large group format. Those in the intervention group also formed small groups at the community level, and each small group was given a basic mobile phone to receive weekly SMS and IVR messages. The small groups then prepared songs and dramas to illustrate these messages which they presented in the larger group sessions. Interviews conducted with pregnant women at baseline and when their infants were over 6 months of age showed a significantly greater likelihood of timely breastfeeding initiation (OR: 2.6; 95% CI 1.6-4.1) and EBF for six months (OR: 2.4; 95% CI 1.4-4.0) in the intervention group. This study represents a creative blending of traditional BCC approaches with mobile phone technology, but it is not possible to determine the relative contribution of different elements of the intervention.

The Wired Mothers cluster randomized trial in Zanzibar delivered regular SMS messages to mothers in the intervention group, timed to the stage of pregnancy, and also provided participants with a voucher for airtime in order to encourage them to contact health care providers [124]. Mothers in the intervention group were significantly more likely to attend at least four antenatal clinic visits (OR=2.39; 95% CI 1.03-5.55) [116]. Skilled attendance at delivery also increased significantly, but only among urban women (OR= 5.73; 95% CI 1.51-21.81) [124]. Analysis of secondary outcomes found that perinatal mortality was significantly reduced in the intervention group (OR= 0.50; 95% CI 0.27-0.93) [125].
Table 5. Direct Messaging Studies (n=9) and Programmatic Reports (n=3)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Messaging Intervention</th>
<th>Target Outcomes</th>
<th>Key Results</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Intervention Studies – Published Literature</strong></td>
<td></td>
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<tr>
<td>Jiang et al, 2014</td>
<td>Quasi-experimental cluster randomized trial in Shanghai, China. N=582</td>
<td>Weekly SMS on infant feeding from 3rd trimester to 12 months postpartum</td>
<td>Increased EBF duration</td>
<td>Median duration EBF: 11.41 weeks (I.) vs. 8.87 (C.) EBF at 6 mos: 15.1% vs 6.3%</td>
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<tr>
<td></td>
<td>mothers in first trimester recruited from 4 community health clinics, 2</td>
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<tr>
<td></td>
<td>randomized to intervention, 2 to control</td>
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<tr>
<td>Flax et al, 2014</td>
<td>Cluster RCT in Bauchi state Nigeria N=390 mothers pregnant at baseline</td>
<td>Intervention x10 mos.: monthly large group BF education; weekly SMS to small group who</td>
<td>Increase timely BF initiation and duration of EBF</td>
<td>timely BF initiation: OR 2.6 (95% CI: 1.6, 4.1) EBF to 6 mos: OR 2.4 (95% CI: 1.4, 4.0)</td>
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<tr>
<td></td>
<td>&amp; interviewed when infants ≥6 mos.</td>
<td>presented to monthly large group</td>
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<tr>
<td>Lund et al, 2012</td>
<td>Wired Mothers project</td>
<td>Mothers received 1-way SMS targeted tips &amp; reminders 2x/month to 36wks gestation then</td>
<td>Increase in skilled birth attendance (SBA)</td>
<td>SBA: 60% vs 47% overall but non-significant for rural women. Urban OR: 5.73 (95% CI: 1.51-21.81).</td>
</tr>
<tr>
<td>Lund et al, 2014</td>
<td>Cluster RCT via 24 health facilities in Zanzibar, Tanzania</td>
<td>2x/wk to 6 wks postpartum; also received airtime voucher &amp; health worker phone number.</td>
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<tr>
<td>Lund et al, 2014</td>
<td>N=2550 (Intervention: n=1311)</td>
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<tr>
<td>Lund et al, 2014</td>
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<tr>
<td>Study Type</td>
<td>Title</td>
<td>Description</td>
<td>Findings</td>
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<tr>
<td>Intervention Study – Grey Literature</td>
<td>Uddin et al, 2016</td>
<td>Quasi-experimental pre/post evaluation using population level household surveys in Bangladesh N=4,158</td>
<td>Increase vaccination coverage in hard-to-reach groups; Difference-in-differences for full vaccination: +29.5% (rural; p&lt;0.001) &amp; +27.1% (urban; p&lt;0.05). OR for rural: 3.8 (95% CI: 1.5-9.2) OR for urban: 3.0 (95% CI: 1.4-6.4)</td>
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<tr>
<td>Feasibility Study – Published Literature</td>
<td>Crawford et al, 2015</td>
<td>Analysis of electronic monitoring records and quarterly phone-based user surveys in Chipatala Cha Pa Foni project, Malawi</td>
<td>Increase knowledge and coverage of home- and facility-based MNCH care; Message delivery success was greatest for SMS subscribers (30% of users) who were also more likely to report intended or actual behaviour change (p=0.01)</td>
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<tr>
<td>Case Studies – Grey Literature</td>
<td>Chowdhury, 2015</td>
<td>Retrospective observational study of MAMA’s Aponjon project in Bangladesh N=1473 (600 users + 873 non-users matched by propensity score)</td>
<td>Increase care seeking for MNCH 8/19 maternal care practices and 1/12 neonatal care practices significantly associated with Aponjon use (p&lt;0.05). No effect on IYCF indicators.</td>
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<tr>
<td></td>
<td>Datta et al, 2014</td>
<td>Pre/post knowledge test and qualitative assessment in Tamil Nadu, India N=120</td>
<td>Assess feasibility of SMS for improving MNCH knowledge; Knowledge scores improved &amp; qualitative data indicated acceptability of SMS for MNCH message delivery</td>
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<td></td>
<td>MAMA Bangladesh</td>
<td>Narrative report of intervention design process based on formative research findings</td>
<td>Key design elements identified through formative research: options for users with low technology literacy; inclusion of family members; use of female doctor voice; timing of message delivery; record messages in local dialects; adapt message content &amp; frequency for rural vs. urban clients</td>
<td></td>
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<tr>
<td></td>
<td>MOTECH ‘Mobile Midwife’</td>
<td>Narrative report of intervention design process and lessons learned</td>
<td>Message design &amp; delivery guided by formative research. Collaboration with respected partners increased trust, and mHealth initiative integrated with efforts to improve ANC services.</td>
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</table>
SMS was used as part of a larger mHealth intervention to improve vaccination coverage among hard-to-reach groups in Bangladesh [119]. Mothers of registered children received three SMS reminders for each routinely scheduled immunization session. One reminder was sent the day before, one at opening time of the immunization session, and the third two hours before the session closed. During the 12-month intervention period, 8360 children were registered with the service and over 220,000 SMS reminders were sent. The pre/post evaluation compared the “difference-in-differences” from baseline to endline for intervention vs. control areas in both rural and urban settings. In both settings, full vaccination coverage for children over 298 days old increased in the intervention area and decreased in the control area, for a difference-in-differences of +29.5% in the rural areas (p<0.001) and +27.1% in the urban areas (p<0.05).

The Mobile Alliance for Maternal Action (MAMA) [130], a public-private partnership, collaborated with a global team of advisors to develop a bank of messages covering pregnancy and the first three years of childhood. These messages can be locally adapted and disseminated through either SMS or IVR. The MAMA messages have been used by many different agencies and projects, including three large-scale initiatives led by MAMA in Bangladesh, South Africa and India. In Bangladesh, MAMA’s Aponjon project delivers twice-weekly SMS or IVR messages to mothers with a separate but aligned set of messages delivered to fathers, grandmothers and other influential household figures [131]. Aponjon also hosts a hotline for subscribers to seek support from a female obstetrician/gynecologist. Subscribers use their own phones and airtime to access these services, although the costs are waived for the poorest. A case study report describes the process of defining these and other specific elements of the intervention design through the application of formative research findings [131].

An independent evaluation of the Aponjon project was completed in 2015 and publication of results is forthcoming [132]. The evaluation compared Aponjon users (who reported receiving
Aponjon messages for at least three months) to matched non-users in a retrospective observational study. Use of the hotline was not evaluated. Preliminary findings show that around one-third of users who reported consistently listening to a majority of the messages they received had significantly greater knowledge of both maternal and neonatal care practices, compared with non-users [121]. Aponjon use was significantly associated with 8 of 19 assessed maternal practices but cord care was the only neonatal practice for which a significant effect was seen. There was no effect on breastfeeding or complementary feeding indicators, although the practice of feeding colostrum was high (80%) among both users and non-users, suggesting limited potential for an additional effect of the intervention on early initiation of breastfeeding [M. Chowdhury, personal communication, December 24, 2015].

MOTECH’s ‘mobile midwife’ was the first initiative to implement direct messaging to support improved home-based practices and care-seeking for maternal health. A case study describing the design process highlights several key lessons learned [133]. These relate to the process of developing locally relevant content, including not only the content of messages but the delivery approach. IVR was used to reach largely illiterate, rural populations through the basic phones already owned in the communities. Messages were designed to engage all influential members of the household. Collaboration with partners trusted by the communities increased trust and uptake of the service. Finally, the direct messaging intervention was integrated with a complementary initiative to improve service delivery at antenatal clinics.

The Healthy Pregnancy, Healthy Baby text messaging service in Tanzania leveraged the global messaging bank developed by MAMA to complement existing standardized national public health messages [134]. Subscribers to this service receive 3-4 text messages per week, with separate message tracks for pregnant mothers, their supportive family members, and general-interest users. A case study report describes the project structure and intervention design process [134]. Similar to MOTECH, lessons learned in the content development process include the importance of localizing and rigorously pre-testing content, and integrating fun messages with target biomedical content. Implementation challenges include access issues due to low literacy and mobile phone ownership by females, and the need for a mechanism to respond to incoming questions from subscribers, a service which was not envisioned in the original design [134].
In rural Malawi where mobile phone access is low, the Chipatala Cha Pa Foni (CCPF) project allowed subscribers to a weekly MNCH “tips and reminders” service to choose to receive messages as either SMS sent to their phone, IVR sent to their phone or IVR retrieved through a dial-in number [126]. Although most users registered for retrieved IVR messages, uptake of messages was greatest among SMS users, who were also significantly more likely to report planned or actual changes in health practices. The CCPF project also included a hotline service, and the combined evaluation results are presented below with the studies on Direct Messaging + Voice Counseling.

In a small feasibility study in rural India, Datta et al. found high acceptance of SMS as a delivery channel for MNCH messages, and knowledge improved after participants received one message per day for ten days [135]. The study did not test the service over a longer period of time or evaluate changes in practice.

Although currently limited, the evidence base for the effectiveness of direct messaging for behaviour change communication will continue to be built through the publication of evaluation research from MAMA projects in South Africa and India as well as Bangladesh, and through new large-scale initiatives including two targeted to improving maternal and infant nutrition. The GSMA mNutrition Initiative is led by a global consortium of agencies collaborating to integrate nutrition messages within existing mHealth platforms in ten countries across sub-Saharan Africa, aiming to reach 1 million mothers by 2018 [136]. A rigorous monitoring and evaluation framework is under development for the mNutrition initiative, led by Johns Hopkins University [K. Stockdale, personal communication, June 22, 2015]. The Indian Academy of Pediatrics IAP HealthPhone initiative, launched in 2015, aims to reach over 6 million adolescent girls and women with SMS messages containing links to short mobile phone videos on four key nutrition topics [137].

9.2 Voice Counseling

The use of the mobile phone as a phone, for live, two-way conversations between health providers and clients, is surprisingly under-explored in LMIC. There are two approaches which have been tested to a limited extent: i) health hotline services, in which users access the advice of a health professional through a call centre; and ii) counseling initiatives which link clients with qualified counselors who pro-actively offer support, information and advice over the phone.
Only two papers using voice counseling as the primary channel for MNCH-related communication were identified in this review (Table 6). Other studies using voice counseling also included direct messaging, and these combined interventions are reported in a separate section below.

Huq et al. conducted a qualitative assessment of a mobile phone hotline which was set up to facilitate prompt care for maternal and neonatal emergencies in rural Bangladesh [138]. Families were able to call their local Community Skilled Birth Attendant (CSBA), who in turn could call a higher level medical professional for advice in complicated cases. The main benefit of the intervention was perceived to be the increased access to specialist medical consultations normally unavailable to poor rural women. Although there was no pro-active behaviour change communication component, care seeking was perceived to have improved due to the increased attention being paid to prenatal risk management, and the opportunity to access care without the expense and difficulty of travel to a health facility.

Table 6. Voice Counseling Studies (n=2)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Voice Counseling Intervention</th>
<th>Target Outcomes</th>
<th>Key Results</th>
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<tbody>
<tr>
<td><strong>Qualitative Study – Published Literature</strong></td>
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<tr>
<td>Huq et al, 2014</td>
<td>Qualitative pre/post study in rural Bangladesh</td>
<td>‘mobile pathways’ using toll free numbers: mother/family calls CSBA who provides advice and/or consults with experts</td>
<td>Increase access to prompt, quality care for complications during pregnancy &amp; delivery</td>
<td>Participants perceived improvement in timely access to care, access to specialist care and care seeking.</td>
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<td></td>
<td>Pre: interviews with Community Skilled Birth Attendants (CSBA) (n=12) &amp; mothers (n=14)</td>
<td>Post: in-depth interviews (n= 6 CSBA); semi-structured interviews (n=27 CSBA). 1 FGD with 10 mothers.</td>
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<tr>
<td><strong>Intervention Study – Grey Literature</strong></td>
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<tr>
<td>Sellen et al, 2013</td>
<td>Randomized control trial in Kenya n=752 HIV- mothers randomized to voice counseling (CPS), peer support group (PSG), or standard of care (SOC)</td>
<td>CPS: Proactive bi-weekly call from same counselor to 3 mos post-partum; unlimited access to text &amp; phone support PSG: monthly facilitated peer support group</td>
<td>Increased prevalence of EBF at 3 months postpartum</td>
<td>EBF at 7 d: 94% all groups EBF at 3 mos: 90.9% (CPS), 82.8% (PSG), 78.2% (SOC) [p=0.0017 btwn CPS and other 2 groups, n.s. between PSG &amp; SOC]</td>
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</table>
Sellen et al. conducted the only known trial of pro-active voice counseling as a single intervention to improve IYCF [110]. Mothers were recruited through antenatal care at a BFHI-certified hospital and were randomized to receive breastfeeding support through mobile phone-based counseling, a monthly peer support group or standard of care. In the mobile phone group, each mother was assigned to a specific counselor whom she could contact at any time for IYCF advice, and who would initiate a call at least bi-weekly if the mother had not made contact herself. Participating mothers used their own phones and airtime credits. The primary outcome was exclusive breastfeeding at three months, which was significantly greater in the mobile phone group (91%) compared with either the peer support group (83%) or the control (78%), which were not significantly different from each other.

9.3 Direct Messaging + Voice Counseling

Seven papers relate to the use of direct messaging and voice counseling in combination (Table 7). The Chipatala Cha Pa Foni (CCPF) project in Malawi produced four of these papers, including three published articles and one evaluation report in the grey literature.

The CCPF project included a toll-free hotline staffed by trained district hospital personnel as well as the subscriber-based ‘tips and reminders’ messaging service described earlier as a direct messaging intervention [129]. A mixed-methods study using project monitoring data and qualitative interviews found that over the two years of implementation (2011-2013), the hotline received 12,794 relevant calls from 9,328 unique users [128]. Three-quarters (74%) of these calls came from users who did not have their own phone, demonstrating that community-shared phones could increase access to mHealth services. However, time trend data showed that usage of the hotline by individuals without personal phones declined over time, as did total usage, which peaked 3 months after the intervention began. The motivation of the community volunteers also decreased over time, linked to inadequate incentives and poor quality phones. More than 70% of the phones were broken by the end of the intervention.

The effectiveness of the CCPF project was evaluated using a mixed methods design [129]. The qualitative study found a high level of satisfaction among CCPF users, who cited convenience, respect and improved quality of health services as the major benefits of the intervention. Non-
users faced both socio-cultural and technical barriers to participation, including damaged phones, peer pressure, and a pervasive belief that the hotline was connected with Satanism.

The quantitative study was a two-arm, quasi-experimental pre-post design, with a neighbouring district selected for the control [129]. Changes in MNCH knowledge and use of home- and facility-based services were assessed as aggregate outcomes, each based on a small number of indicators. Findings were disappointing in the “difference-in-differences” analysis, with no treatment effect on aggregate outcomes of MNCH knowledge or maternal care practices, and a significant negative effect on home-based child care practices due to greater improvements in the control area during the project period [118]. The negative effect on the use of facility-based services for child health was driven by a decrease in care-seeking for child fever in the intervention area. Fotso et al. suggest that this finding may reflect improvements in home-based care due to information provided through CCPF, with the mHealth intervention thus alleviating the burden on the health system for cases treatable at home [127]. However the lack of data on home-based care practices for child fever make it impossible to substantiate this argument.

Only 18% of the women in the final survey intervention group had actually used the CCPF services, so a treatment-on-treated effect was also calculated for this sub-sample [118]. In this analysis, a significant positive effect of the project was seen for the uptake of home-based care for both mothers and children, and for facility-based care for mothers. The improvement in home-based child care was driven by the increased uptake of insecticide-treated bed nets, with no changes in exclusive breastfeeding or use of Oral Rehydration Solution for diarrhea [127].

The other studies reported in this section examined either the effectiveness or feasibility of direct messaging in combination with pro-active voice counseling rather than hotlines. A cluster randomized trial in India recruited mothers through hospital antenatal clinics, all of which received BFHI refresher training [117]. Mothers in the intervention group received daily SMS messages and weekly mobile phone calls from auxiliary nurse midwives, who were available for additional support by phone as requested by the mother up to six months postpartum. Mobile phones were provided to participating mothers. There was no difference between the groups for use of pre-lacteal feeds (18%) but infants in the intervention group were significantly more likely to be exclusively breastfed at 14 weeks (96% vs. 69%) and at six months (97% vs. 49%) while bottle feeding at six months was much more prevalent in the control group (17% vs. 1.5%).
Table 7. Studies of Direct Messaging and Voice Counseling in Combination (n=7)

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Intervention</th>
<th>Target Outcomes</th>
<th>Key Results</th>
</tr>
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<tbody>
<tr>
<td>Fotso, Robinson et al, 2015</td>
<td>Two-arm, pre/post quasi-experimental effectiveness evaluation using cross-sectional household surveys n=2810 (baseline); n=3643 (endline)</td>
<td>Chipatala Cha Pa Foni project, Balaka district, Malawi</td>
<td>Increased knowledge and use of home- and facility-based MNCH care</td>
<td>Intention-to-treat analysis: negative effects on child care practices; no effect on knowledge or maternal care. Treatment-on-treated effect analysis: positive effects on home-based (p&lt;0.01) and facility-based (p&lt;0.05) maternal care, and home-based child care (p&lt;0.01).</td>
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<tr>
<td>Fotso, Bellhouse et al, 2015</td>
<td>Mixed-methods study of use of community shared phones; data from monthly usage records and larger program evaluation qualitative data</td>
<td>Community-shared phones hosted by volunteers to increase access</td>
<td></td>
<td>Home-based care for child health improved through increased bed net usage (p&lt;0.01); facility-based care seeking for child fever decreased (p&lt;0.01)</td>
</tr>
<tr>
<td>Larsen-Cooper et al, 2015</td>
<td>Qualitative analysis of 4 in-depth interviews with nurses and 6 FGDs (2 each with HIV+ women, male partners &amp; FLWs) in Nyanza, Kenya N=45, recruited through 2 hospital PMTCT programs</td>
<td>n/a</td>
<td>Assess perceptions of mobile phone communication to support PMTCT service delivery</td>
<td>preferred mHealth platform combines SMS for reminders and basic information with voice counseling for discussion; health workers prefer in-person sessions</td>
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</table>
### Intervention Studies – Grey Literature

<table>
<thead>
<tr>
<th>Study</th>
<th>Description</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Patel et al, 2013</td>
<td>Two-arm cluster randomized trial of mothers (n=1036) recruited through hospital ANC facilities; 2 clusters per arm</td>
<td>Daily SMS, weekly call, additional support as needed to 6 mos postpartum</td>
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<td>Both intervention and control facilities received Baby Friendly Hospital Initiative refresher training.</td>
<td>Improve breastfeeding practices</td>
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<td>EBF at birth: 74% in both groups; at 14 wks: 95.6% vs. 69.4%; at 6 mos: 97.1% vs. 49.3% Pre-lacteal feeds: 19.3% vs 18.3% (NS) Timely BF initiation: 37.2% vs 23.6% (p&lt;0.001) Bottle feeding at 6 mos: 1.5% vs 17.3% Timely intro CF: 94.5% vs. 86.3% (p&lt;0.001)</td>
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<tr>
<td>Watkins et al, 2013</td>
<td>Mixed methods evaluation Quantitative: Two-arm, pre/post quasi-experimental design cross-sectional population-based household surveys n=2810 (baseline); n=3643 (endline) Qualitative: KII (n=47) with health staff, village leaders &amp; project staff; FGDs (n=12 with 10 participants each) with users, non-users and mothers who had not heard of CCPF; in-depth interviews (n=16) with 1 participant/FGD and her husband; hearsay ethnographic journals (n=46)</td>
<td>Chipatala Cha Pa Foni project, Balaka district, Malawi Subscriber-based ‘tips and reminders’ weekly messaging service + case management hotline providing protocol-based advice and referrals Community-shared phones hosted by volunteers to increase access</td>
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<td></td>
<td>Increased knowledge and use of home- and facility-based MNCH care</td>
<td>Intervention reached 19% of eligible mothers, 61% of whom used the community phone to access services. Endline survey: no significant differences in knowledge or home-based care practices; negative effect on uptake of facility-based services for child health. Qualitative: high user satisfaction and perceived improvements in quality of facility-based care. Non-users faced technical and sociocultural barriers.</td>
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</table>

### Formative Study – Grey Literature

<table>
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<tr>
<th>Study</th>
<th>Description</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Napier &amp; Peterson, 2013</td>
<td>Intervention study redesigned to formative study: doer/non-doer analysis of qualitative interviews with adolescent mothers (n=31)</td>
<td>Initial intervention: monthly BF support groups + weekly SMS + additional voice counseling support</td>
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</table>
In Honduras, a study of breastfeeding support for adolescent mothers was launched in an urban area with high access to mobile phones [139]. The intervention plan included bi-weekly mother support groups (breastfeeding clubs) facilitated by trained community health providers, weekly SMS messages and additional support via mobile phone calls as required. However, the study had to be discontinued due to low recruitment, poor participation and security concerns. Instead, a qualitative feasibility study was conducted using doer/non-doer analysis with 31 participants from the intervention group and their family members [139]. This qualitative study identified several technical challenges with using mobile phones to deliver health services, such as frequent switching of SIM cards, phones being switched off or running out of airtime. In addition, the need to engage with the mothers of the adolescent women was identified, and it was recommended that future interventions start with a home visit to establish a relationship before implementing a phone-based service.

A qualitative study on the feasibility of using mHealth to enhance the delivery of prevention-of-mother-to-child-transmission (PMTCT) services in Kenya also identified a need for linking interpersonal and mobile phone-based support [140]. Participants valued direct messaging for timely delivery of neutral information and reminders, but preferred voice counseling for discussion of more complex or confidential information. A need for gender-tailored messaging was identified; this was also seen as a means to increase male engagement in PMTCT.

9.4 Job Aid Applications for Frontline Health Workers

Frontline workers (FLWs) operating at the community level are vital to the delivery of MNCH services in many countries [81]. Many mobile phone-based tools have been developed to support FLWs during home visits to pregnant women and mothers of young children. In particular, multiple projects have designed and deployed smartphone job aid applications (apps) which combine efficient client registration and data tracking systems with checklists, protocols and reminders of key BCC messages [141-143].

Eight studies of job aid apps for BCC were identified, four from the published literature, and four from the grey literature (Table 8). Five are intervention studies assessing various outcomes, two are formative studies, and one assessed implementers’ perspectives on FLW counseling using job aid apps. In addition, seven grey literature documents presenting programmatic case studies or analyses were included for their contribution to the implementation evidence base.
Thirteen of these papers report evidence related to the use of CommCare or MOTECH suite technology platforms. CommCare is a widely used, customizable open source software platform designed by Dimagi for the development of FLW job aid apps. It provides the front-end data collection system of the MOTECH suite, a package of mobile and cloud-based technologies designed by Dimagi with the Grameen Foundation to provide integrated data management across a broader ecosystem [143].

Only one study attempted to assess health impacts. A retrospective observational study aimed to demonstrate the impact of a mobile phone-based suite of job aid tools on maternal and infant mortality rates in Guatemala [122]. A significant difference between intervention and control communities was reported for the maternal mortality rate, but no evidence was provided to support the claim that this was due to the mHealth intervention.

The other published intervention study identified for this review compared scores for antenatal care delivery before and after implementation of a job aid app to support facility-based health workers in Nigeria [123]. An overall improvement was reported, with frequency of BCC message delivery as the greatest contributor to the change. The effects on health behaviours or outcomes were not assessed.

Three intervention studies reported in the grey literature provide more robust evidence of the potential contribution of job aid apps to changes in health behaviour, although none of them evaluated health outcomes. A major focus was improved care-seeking during pregnancy and delivery. All studies reported positive results, including a cluster randomized control trial in Tanzania which found that mothers served by FLWs using a job aid app were significantly more likely to deliver in a health facility (OR=2.0; 95% CI 1.10-3.48, p=0.02) [115].
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Intervention</th>
<th>Target Outcomes</th>
<th>Key Results</th>
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<tr>
<td><strong>Intervention Studies – Published Literature</strong></td>
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<td>Martinez-Fernandez et al, 2015</td>
<td>Retrospective observational study of population level baseline to endline changes in mortality comparing intervention communities (n=125) with non-intervention areas in rural Guatemala</td>
<td>FLWs equipped with mobile phone-based tools, including job aid app, distance learning modules, and access to supervisors for phone consultation.</td>
<td>Maternal mortality, Infant mortality</td>
<td>MMR decreased in intervention areas (309 to 254) but increased in control areas (338 to 558) with a significant difference between groups (p&lt;0.05). IMR decreased in both groups (25-13; 27-20) with marginal significance between groups (p=0.054).</td>
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<td>McNabb et al, 2015</td>
<td>Pre/post evaluation of pregnant mothers (n=267) in Nigeria; baseline data collection at first ANC visit, endline 12 mos. later</td>
<td>Job aid app to guide facility-based health workers through ANC protocols and track client data in real time; 13 BCC audio files embedded</td>
<td>Improve quality of ANC care and client satisfaction</td>
<td>Quality score increased from 13.33 (baseline) to 17.15 out of 25 (p&lt;0.0001) with greatest improvements in BCC message delivery.</td>
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<td><strong>Formative Studies – Published Literature</strong></td>
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<td>Modi et al, 2015</td>
<td>Descriptive report of design and feasibility testing of ImTeCHo app for FLWs (n=45) in Gujarat, India</td>
<td>Job aid app for ASHAs with work flow scheduling, task monitoring, videos on key BCC messages; link to supervisory support for complex cases &amp; ongoing monitoring</td>
<td>Improve coverage of key MNCH services assigned to ASHAs</td>
<td>Job aid app well accepted &amp; considered feasible but ongoing NGO support required for facilitation &amp; IT support.</td>
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<td>Kaphle et al, 2015</td>
<td>Demographics questionnaire completed by FLWs (n=15); home visit observations (n=14)</td>
<td>Job aid app for home visits</td>
<td>To develop methods to analyze 1) the effects of app adoption on the quality and experience of care; and 2) personal factors influencing app usage by FLWs</td>
<td>Quality scores were 33.4% higher for high users of the app (p=0.04). No significant associations with individual factors were found.</td>
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<td><strong>Intervention Studies – Grey Literature</strong></td>
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<td><strong>Hackett &amp; Sellen, 2015</strong></td>
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<td>Cluster randomized controlled trial in Singida, Tanzania. Outcomes evaluated through household survey of post-natal women (n=572).</td>
<td>CommCare job aid app for FLWs</td>
<td>Increase uptake of maternal health services</td>
<td>Greater likelihood of facility-based delivery in intervention group (OR=2.0; 95% CI 1.10-3.48, p=0.02)</td>
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<td><strong>Borkum et al, 2015</strong></td>
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<td>Cross-sectional survey in Bihar, India comparing mothers of infants &lt;12 mos old (n=1550) in randomly selected intervention and control communities. Qualitative process evaluation: interviews with FLWs (n=23) and project staff (n=4).</td>
<td>Job aid app for home visits during pregnancy and infancy, with multimedia BCC messages embedded</td>
<td>Improve coverage and quality of FLW services</td>
<td>Intervention group more likely to receive home visits prenatally, in first week postnatal, and for complementary feeding (p&lt;0.05), and more likely to report 3+ antenatal care visits, birth preparedness, and timely initiation of both BF and complementary feeding (p&lt;0.05).</td>
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<td><strong>BBC Media Action, 2016</strong></td>
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<td>Observational study in Bihar, India, comparing mothers exposed to the Mobile Kunji intervention (n=2543) vs unexposed (n=956). Qualitative process evaluation: 4 FGD and 28 in-depth interviews with FLWs.</td>
<td>Counseling tool (Mobile Kunji) combining visual aid with IVR messages accessed through FLWs’ own phones</td>
<td>Improve quality and engagement with BCC for key MNCH practices</td>
<td>Exposed mothers more likely to have saved the FLW’s phone number (birth preparedness; OR=2.72) and to have fed infants 6-11 mos old from at least one food group in past 24 hours (OR=1.72) but no effect on family planning practices.</td>
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<th><strong>Qualitative Study – Grey Literature</strong></th>
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<td><strong>Treatman &amp; Lesh, 2012</strong></td>
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<td>Interviews with implementers (n=8) of CommCare app deployments in India.</td>
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<th><strong>Reviews &amp; Case Studies – Grey Literature</strong></th>
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<td><strong>Chamberlain, 2014</strong></td>
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<td>Case study</td>
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<td>Ramachandran, 2013</td>
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<td>Manthan Project, 2013</td>
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<td>Chatfield &amp; Javinski, 2015</td>
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<td>Keisling, 2014</td>
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<td>World Vision, 2015</td>
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<td>MIRA Channel, 2015</td>
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The Ananya programme in Bihar, India, engaged multiple partners to implement a comprehensive package of health system strengthening and BCC interventions for MNCH in eight districts [144]. Extensive capacity building and support was provided to all FLWs. In one district, FLWs were also provided with smartphones equipped with a job aid app with embedded video-based counseling messages. A cluster randomized controlled trial examined the added effect of the app after a 12-18 month implementation period [114]. Mothers in the intervention group received significantly more home visits, including in the first week postnatally (73% vs 60%; p=0.005) and for complementary feeding (45% vs 36%; p=0.022). Significant differences in health practices were also reported for several indicators, with the greatest effect for three or more antenatal clinic visits (50% vs 29%; p<0.001). More mothers in the intervention group reported breastfeeding their infants within one hour of birth (76% vs 62%; p<0.001) but there was no effect on EBF for six months, although EBF knowledge was much higher in the intervention group (74% vs 60%; p<0.001). More infants in the intervention group started complementary feeding by 6 months of age (41% vs 32%; p=0.055) but there was no difference in complementary feeding frequency, quantity or diet diversity between the two groups.

A qualitative process evaluation was also conducted, which found that with significant, ongoing capacity building and support, the FLWs were able to become proficient in using the app [114]. Technical difficulties were common, particularly related to internet connectivity, and hindered the uploading of data forms to the central server. Efficiencies in data management and visit scheduling were identified as the greatest perceived benefits of the app. Use of the counseling videos was limited, with the complementary feeding video among the least used.

A second job aid tool, known as Mobile Kunji, was creatively designed to utilize the basic mobile phones already owned by FLWs, and was deployed throughout the Ananya intervention areas [145]. Mobile Kunji consists of a set of forty hard plastic cards on a ring that can easily be carried by a FLW during home visit rounds. Each card depicts one key BCC message, and includes a unique 7-digit code which the FLW enters into her phone to play a short IVR message on the particular BCC topic. The IVR messages are delivered by a female doctor character, “Dr. Anita”. The cards and IVR messages were combined to deliver BCC through both audio and visual channels, utilizing FLWs’ own phones with minimal requirements for technical competency or literacy. Mobile Kunji is the only identified example of a job aid that uses mobile phones but is not a smartphone app.
An evaluation examined the effects of Mobile Kunji on knowledge, attitudes and practices related to birth preparedness, complementary feeding and family planning [120]. Results showed a greater likelihood of mothers saving the FLW’s phone number (OR=2.72) and feeding their 6-11 month old child at least one food group in previous 24 hours (OR=1.72) if they were exposed to the Mobile Kunji messages. No evidence of improved family planning practices was found. Qualitative data found that the character of Dr. Anita was key to positive perceptions of and engagement with Mobile Kunji by both FLWs and mothers.

In a separate intervention in India, Modi et al. conducted a formative study to guide the design of ImTeCHO, a job aid app for FLWs to use during home visits [146]. Lack of supervision and support for FLWs was first identified as a major barrier to coverage of MNCH services, and the app was designed to address this. A small feasibility trial with 45 FLWs showed that the app was well accepted but that supportive supervision did not increase, and that ongoing technical support and facilitation by the NGO partner would be required for sustained implementation. A cluster randomized trial is currently underway to evaluate the effectiveness of the ImTeCHO intervention [147].

Pilot studies of mSAKHI, a CommCare job aid app deployment in India, found that FLWs using the app scored higher on frequency of full BCC message delivery compared with their counterparts using traditional paper-based tools (p<0.05 for six of nine messages) [148]. FLWs in the intervention group were also more likely to correctly assess newborn health (p<0.05 for five of seven skills). A cluster randomized trial of mSAKHI has been registered but at the last update (May 2015), recruitment had not yet started [149].

Ramachandran led a qualitative study on the theory-driven development of messages for another mobile phone-based counseling tool for FLWs in rural India [150]. Several iterations were required to achieve an effective approach for delivery of targeted, locally relevant and persuasive messages. Recognizing the low capacity of the FLWs both in terms of counseling skills and ability to access other information resources, the final tool used a series of locally filmed videos with built-in discussion questions followed by pauses to encourage conversation between the FLWs and their clients.

Three studies were identified which contribute to the knowledge gap on how FLWs use job aid apps, and how apps can contribute to improved counseling and BCC. Kaphle et al. conducted a
small formative study to develop methods for examining the influence of app usage on quality of care, and the influence of personal characteristics on app usage [151]. Fifteen FLWs were characterized as low, medium and high users of a CommCare job aid app (n=5 in each group), and one home visit per FLW was observed and scored for quality by the researchers. More proficient users of the app scored higher on quality of care (p=0.04). Individual socio-demographic were not significantly associated with app usage but the small sample size may have compromised this analysis.

A small qualitative study of eight CommCare deployments in India reported that embedded audio messages increased FLW credibility by lending external authority to their health communication [152]. The audio recordings were also perceived to ease the discussion of sensitive topics, but the challenge of identifying suitable local individuals for voice recording was noted.

A narrative review of the evidence base for CommCare described findings from 40 references, many of which are programmatic studies or conference presentations [142]. The benefits of job aid apps for increasing data management efficiency and FLW credibility were consistently documented. Preliminary evidence was found for some indicators of increased access, quality, experience and accountability of care, indicating the potential for job aid apps to enhance FLW service delivery. Pre/post programme evaluations report improvements in knowledge and uptake of some health practices, particularly birth preparedness and skilled birth attendance. However, no details of study methods were provided, and in many cases the sources could not be located for verification. A similar challenge exists with the case study of a job aid app intervention in Afghanistan [153] and the summary brief of the MIRA Channel pilot evaluation study in India [154]. In both cases a positive effect was reported for indicators related to antenatal care, birth preparedness and skilled attendance at delivery, but the study methods were not clearly explained and statistical significance was not reported.

Although limited as a source of effectiveness evidence, programmatic reports document valuable implementation lessons learned [142, 153, 155]. Job aid apps have been linked to improved FLW knowledge, timely counseling during community Growth Monitoring sessions [155], and family engagement with BCC messages [142]. Common challenges include technology issues, such as intermittent internet connectivity in remote areas, phone break downs and lack of power.
for charging. The need for in-depth capacity building and on-going support for the use of complex technology, particularly among FLWs with a low education background, has been noted by several projects [114, 155]. Other challenges include the need to ensure that embedded BCC messages are interpreted and discussed with families, not simply played so that a checklist can be completed [114]. The cumulative programmatic experience, particularly the CommCare deployments, has led to recommendations for a FLW-centred job aid app design process, with thorough training in health and nutrition prior to the introduction of innovative technology [156].

In addition to the ImTeCHO and mSAKHI trials, a current pilot study in Islamabad, Pakistan is examining the effectiveness of an integrated mHealth approach on IYCF practices and child growth [H. Mahmood, personal communication, October 15, 2015]. The intervention includes a job aid app to support BCC by FLWs, augmented by an SMS service with separate but aligned messages delivered to mothers and to other significant household members (fathers and mothers-in-law).

### 9.5 Interactive Media

A fourth category was included in the typology of delivery approaches to acknowledge the emergence of more advanced mobile phone technology in LMIC, including smartphones and feature phones with internet capabilities. The term interactive media was chosen to reflect the primary distinctive features of the newer technology, which allow users to interact multilaterally with one another, and to generate and distribute content.

No published studies of interactive media interventions in LMIC were identified, but three project examples of interactive media for IYCF support were found through the grey literature review and consultation process. In Vietnam, the Alive & Thrive programme used interactive media platforms to reach urban mothers, including a website offering online counseling and an interactive forum. Over 26 months, the website received more than 1 million unique visitors [86]. The programme also launched the Mothers’ Diary app, which includes key IYCF messages, a tool for tracking infant development milestones, and links to a social media community to share baby photos and parenting experiences with other mothers [157].

In South Africa, the StartSmart initiative leveraged the growing access to advanced mobile phone technology to promote improved IYCF practices. StartSmart was launched by the Global
Alliance for Improved Nutrition (GAIN) as a two-year pilot from 2013-2015, integrated with the National Department of Health’s national public nutrition campaign “Feeding Smart from the Start” [158]. StartSmart was offered through a variety of mobile channels in order to be accessible to users from across the socio-economic spectrum. The most popular channel was MixT, a social media app to which users could add the StartSmart stream. The pilot project was delivered in partnership with ThumbTribe, a mobile network operator, which provided airtime credits as a reward for engaging with StartSmart content. Within the first year of implementation over 100,000 mothers had subscribed to StartSmart [158]. The two year pilot project was completed in 2015 and an evaluation report is forthcoming.

Nurture Project International is a new NGO developing plans to launch a smartphone app to provide IYCF support to refugee mothers arriving in Greece and migrating across Europe [159]. The project is still in development, but plans to link refugee mothers with trained peer counselors who speak the same first language. The counselors will provide mobile phone-based IYCF counseling, and the app will include links to MNCH services in transit points across Europe.

10 Quality of the Evidence Base

A preliminary assessment of the quality of the evidence base for each mobile phone-based delivery channel can be made by considering the strength of the intervention study designs. Six randomized trials, four of which are currently unpublished, were identified for this scoping review. Direct messaging and job aids each had five intervention studies, two of which were cluster RCTs. Only one RCT was identified for voice counseling, and one for direct messaging combined with voice counseling. This reflects the acknowledged shortage of rigorous trials in the mHealth field [106], with much of the evidence still at the exploratory or pilot stage [160].

Assessment of individual study quality is both contrary to scoping review methodological guidance [113] and complicated by the variety of study designs and grey literature reports included [112]. Accordingly, the papers selected for this scoping review were not individually appraised, but several have been evaluated for risk of bias by the authors of recent systematic reviews. Lee et al. [107] found the voice counseling study by Sellen et al. [110] to have low risk of bias, the direct messaging interventions by Flax et al. [32] and Lund et al. [116, 124, 125] to have moderate risk of bias, and the direct messaging study by Jiang et al. [109] to have high risk of bias. Sondaal et al. [103] found a low risk of bias across eight domains for the direct
messaging studies by Lund et al. [116, 124, 125], but high risk of bias in two domains for the CCPF evaluation by Watkins et al. [129] and in three domains for the formative study of a direct messaging intervention by Datta et al. [135].

The qualitative studies and grey literature documents other than the unpublished studies noted above contribute primarily to evidence on implementation feasibility rather than effectiveness. Detailed case study reports describing the intervention strategy development process and reflections on lessons learned from initial implementation were identified for both direct messaging [131, 133, 134] and job aids [145, 150, 161]. There is no established set of criteria for appraisal of such reports, but they contribute usefully to the understanding of design and implementation issues. Project evaluation data related to job aid apps were found in several case study reports [148, 153-155] and a compilation of evidence on the CommCare app [142]. However, the contribution of these reports to the effectiveness evidence base is severely constrained by inadequate reporting of study methods, and in some cases, failure to report statistical significance for results. Recently published reporting guidelines for mHealth interventions may help strengthen the future contribution of project evaluation data [160].

11 Analysis by BCC Techniques

Each mobile-phone based delivery approach emphasizes one or two of the BCC techniques defined by Briscoe and Aboud [72], as shown in Table 9. Creating a scoring system was not considered feasible with the data available, so the number of “+” in each cell is a subjective assignment intended to reflect the relative emphases within each delivery approach. For example, all four approaches deliver health information, but messages within job aid applications are very brief and limited in number (+), direct messaging services typically deliver a larger number of short messages (++), and extensive information can be provided through voice counseling phone calls and interactive media (+++). None of the mobile phone approaches inherently incorporates materials or performance support, although these could be combined with the use of job aid applications by skilled FLWs.
Table 9. BCC Techniques and Mobile Phone-based Delivery Channels

<table>
<thead>
<tr>
<th></th>
<th>Direct Messaging</th>
<th>Voice Counseling</th>
<th>Job Aid Applications</th>
<th>Interactive Media</th>
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<tbody>
<tr>
<td>Information</td>
<td>++</td>
<td>+++</td>
<td>+</td>
<td>+++</td>
</tr>
<tr>
<td>Performance</td>
<td></td>
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<tr>
<td>Social Support</td>
<td>+</td>
<td>+</td>
<td>++</td>
<td>++</td>
</tr>
<tr>
<td>Problem Solving</td>
<td></td>
<td>+++</td>
<td>++</td>
<td>+/-</td>
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<tr>
<td>Materials</td>
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<tr>
<td>Media</td>
<td>+</td>
<td>+</td>
<td></td>
<td>+++</td>
</tr>
<tr>
<td>Interpersonal Dialogue</td>
<td></td>
<td>+++</td>
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Direct messaging emphasizes information provision almost exclusively, although some services incorporate media features such as short video clips. An example of this is the IAP HealthPhone initiative in India, which was launched in 2015 and aims to reach over 6 million adolescent girls and women with four IYCF videos accessed through links in SMS messages [137].

Voice counseling also emphasizes information provision but equally focuses on problem solving, both mediated through interpersonal dialogue. No additional media is used in voice counseling, and social support is limited to the counselor-client relationship without engagement of the broader family or community network.

Job aid applications include embedded health information messages, often utilizing audio or video media, which are intended to be used for problem solving through interpersonal dialogue between the FLW and mother or family. However these elements are not considered inherently as strong as with voice counseling. Voice counseling interventions must recruit and train counselors specifically for this role, while job aid apps are used by FLWs who are responsible for many health issues and often have limited counseling capacity [73]. However, unlike voice counseling, interpersonal dialogue between families and FLWs within the same community has the potential to build social support for improved health practices.

Interactive media is rich in both information and media but in place of interpersonal dialogue, virtual communities of people from disparate geographic locations can be created. The implications of this for social support related to health communication are not yet understood.
This is particularly a question for societies where trusted relationships are key to acceptance of new information. In LMIC, IYCF practices are heavily influenced by the advice of neighbours and extended family members [26]. Problem solving support provided through interactive media may be a strength or weakness, depending on the reliability of the source.
Chapter 4
Discussion and Recommendations

12 Classifying mHealth Innovations

As the mHealth field matures, there is a growing need as well as increased ability to categorize and examine innovations according to their specific approaches and targeted health outcomes, rather than trying to determine a collective effect [162]. Several frameworks have been proposed, the most frequently cited of which identifies twelve common applications of mHealth in LMIC [94]. Each category within the framework merits its own evidence base, which can be further sub-divided for various health outcomes and intervention contexts. This more granular analysis will allow for much more clarity on what works where for mHealth. This effectiveness evidence must be complemented with implementation science research to complete the picture of how mHealth interventions work in various contexts [106, 108].

This scoping review explored the evidence for the use of mobile phone technology, the most widely employed mHealth tool, from both effectiveness and implementation perspectives with specific application to BCC for improved IYCF practices. BCC is one component of client education and behavior change communication, the first category in the framework of common mHealth applications [94]. Improving IYCF practices is a critical component of global MNCH priorities [56].

13 Mobile Phone-based BCC Delivery Channels

Although mobile technology has not been widely used by the IYCF BCC practitioner community [73, 92] and IYCF has received limited focus from the mHealth community [98], there is an emerging base of relevant evidence and experience as described in this review. Four categories of mobile phone approaches relevant to IYCF BCC were identified: direct messaging, voice counseling, job aid applications for FLWs, and interactive media. Intervention examples were identified for each category. At least one effectiveness evaluation study and at least one study reporting on an IYCF indicator were identified for each of the first three categories and for direct messaging and voice counseling implemented in combination. No published studies were found for any MNCH-related interactive media intervention in LMIC.
13.1 Direct Messaging

Direct messaging, primarily using SMS, is widely used in mHealth interventions. Its main appeal is reach: bulk delivery of messages is a cost-effective means of providing health information to large numbers of people, and even the most basic mobile phones can send and receive SMS [163]. Furthermore, SMS can be tailored to end-user characteristics, such as stage of pregnancy, and can be personalized for services such as appointment reminders, making SMS a promising tool to support health behaviour change [164]. More studies of SMS interventions are available relative to other mHealth delivery modes. Systematic reviews have consistently demonstrated a positive effect of text messaging approaches for health behaviour change, particularly for relatively simple, time-bound health behaviours, such as medication adherence or clinic attendance [164, 165]. However, implementation designs, contexts and health issues of focus vary widely between studies, and most research has been conducted in high-income countries. Furthermore, many studies compare the SMS intervention to a control group receiving no BCC, which makes it difficult to determine whether it is BCC in general or the mHealth approach specifically that is driving the positive outcomes [166].

Several reviewers have examined the effects of key implementation elements such as frequency and targeting of messages, but findings are inconsistent. The meta-analysis by Head et al. analyzed 19 RCTs, 18 of which were conducted in high-income countries [163]. The pooled analysis showed a small-medium positive effect (d=0.329). Among potential effect modifiers, targeted and tailored messaging was found to be most effective, and user-driven tailoring of message frequency was also found to be beneficial. De Leon et al.’s review of 55 health messaging studies identified a preference for tailored messages and for texts over emails, and a benefit of incorporating feedback mechanisms within the messaging [167]. Orr and King pooled data from 38 RCTs comparing SMS as a single intervention to a control group with no messaging [164]. Data from both high-income countries & LMIC and a wide range of target behaviours were included. Effect size was calculated using Hedges g statistic, which includes a correction factor for small sample sizes [168]. The results showed a small but significant weighted average effect size of g=0.291 (95% CI 0.219-0.363; p<0.001). In the subgroup analysis none of the categorical modifiers showed a significant association with the effect size, suggesting that SMS interventions consistently exert a small, positive effect across intervention designs, target populations and health behaviours. Finally, Hall et al.’s systematic review of
reviews synthesized findings from 15 reviews and meta-analyses of text messaging for health promotion and disease prevention [165]. Although a positive effect of SMS interventions was consistently reported, the authors found insufficient evidence to guide the optimization of intervention designs. They recommend that future research should focus on specific health outcomes, settings and intervention characteristics, rather than continuing to attempt to describe the effects of direct messaging in broad terms.

Although the published literature primarily analyzes SMS interventions, Interactive Voice Response (IVR) is often more suitable for MNCH message delivery in LMIC. IVR is accessible to individuals with low literacy and those whose languages do not have a written script compatible with formats available on common mobile phones [133, 161].

Subscriber-based MNCH messaging services deliver health information and reassurance from pregnancy through early childhood. The acceptability of direct messaging as a delivery channel is clearly demonstrated by the high uptake of services such as Aponjon with a reach of 1.2 million in Bangladesh [130]. MomConnect in South Africa enrolled over 500,000 subscribers within the first year and aims for national coverage [169]. The service is available in all 11 national languages. In addition to its SMS service, MomConnect offers users the opportunity to contact a helpdesk via phone or SMS to comment on the quality of care they receive at health facilities. Kilkari is an IVR messaging service implemented in the Ananya programme in India, with over 80,000 subscribers in the first year [170]. The popularity of these services suggests a strong felt need for health information by expectant and new parents, as well as the acceptability of direct messaging as a mode of health information delivery [133]. However, there are challenges to maintaining subscriber engagement [132]. The MAMA evaluation in Bangladesh found that 84% of users in the study sample had received MAMA messages for at least three months, but only 36% of these reported having listened attentively to most of the messages they received [121]. The number of IVR messages successfully played during the CCPF pilot project represented approximately 31% of the total that should have been played, had every subscriber listened to all eligible messages [128].

The primary BCC technique employed by MNCH messaging services is the delivery of health information. Messages are usually targeted to the stage of pregnancy and infancy, but they typically cover a large number of health topics. This is likely to lead to a dilution effect, while
highly focussed interventions may have a greater chance of success of influencing more complex
behaviours [171]. In addition, messages need to be well aligned with outcome measures [172].

Direct messaging services are inherently limited in their ability to provide social and problem
solving support [140, 173]. This relates to the absence of interpersonal interaction as well as the
brevity and lack of personalization of SMS or IVR messages. To help address the need for social
support, some SMS services have incorporated parallel messaging tracks to engage fathers and
grandmothers [131], and IVR messages can be listened to by multiple family members. These
factors increase the potential to engage the mother’s social support and decision making team in
the BCC process [133], but problem solving support remains limited. These deficits can be
mitigated by combining voice counseling services with direct messaging. Among the studies
identified for this review, both the Aponjon and CCPF projects augmented direct messaging
services with hotlines for case management [129, 131]. The study by Patel et al. was the only
one to combine direct messaging with pro-active voice counseling, with significant positive
effects on EBF and other key IYCF practices [117]. No studies to date have compared the
effects of messaging alone and in combination with voice counseling.

It is likely that mobile phone-based messaging interventions will prove more effective when
targeted in focus to a small set of practices addressing local IYCF priorities and integrated with
interpersonal BCC approaches. Messaging interventions may also be well suited to play a role
similar to mass media, by promoting positive social norms and reinforcing best practices which
are communicated and supported through interpersonal interventions in a broader BCC
framework. Both of these potential roles of direct messaging for IYCF support warrant further
research.

13.2 Voice Counseling

Health hotlines and telephone counseling are familiar public health services in high-income
countries, but to date there are limited examples of the transferability of these models to LMIC.

Health hotlines have been implemented by mobile network operators in some LMIC, and
preliminary evidence suggests a beneficial effect on timely access to quality health information
by previously underserved populations [174]. Two studies identified for this review used health
hotlines to support improved care-seeking for MNCH. The CCPF project in Malawi aimed to
increase home-based care practices and thereby reduce the demand on over-stretched health facilities through the combined messaging and hotline intervention [127]. Although these linkages could not be confirmed by the available evaluation data, the hotline service was widely used and clients reported an improved quality of care at the health facility when they were referred after first calling the hotline for advice [129].

The focus of hotlines is on case management of acute illness or pregnancy complications, but they may indirectly facilitate openness to BCC. This was suggested by a qualitative study in rural Bangladesh, in which participants reported a heightened awareness and self-monitoring of risk factors in pregnancy because there was an opportunity to access care through the mobile phone-based hotline service [138].

Pro-active counseling and peer support delivered through telephone communication (not necessarily mobile phones) has also been implemented as a public health intervention strategy in high income countries, including for IYCF support. A Cochrane review of telephone interventions for mothers in pregnancy and the first six weeks postpartum identified 27 RCTs, all but one of which were conducted in high income countries [175]. The authors found the evidence base to be insufficient, but conclude that telephone support may improve breastfeeding duration (based on 7 studies), reduce depression scores (based on 2 studies) and improve overall satisfaction in the perinatal period. Interpersonal communication delivered by mobile phone has been found to be effective for promoting and supporting health behaviours such as smoking cessation and HIV medication adherence among underserved and vulnerable populations in the United States [176-178], but not for delivery of a counseling curriculum intended to delay second pregnancies among adolescent mothers [179].

Voice counseling’s great strength for BCC delivery is its emphasis on personalized problem-solving support. It is limited as a means of providing social support but has been shown to be more effective than peer support groups for improving IYCF practices in a peri-urban setting where mothers have their own phones [110]. Voice counseling in combination with SMS was also found to be effective for improving IYCF practices in India [117], although the relative contribution of each intervention element cannot be determined.

The main challenge of implementing voice counseling for BCC is the need to recruit, train and support human resources to provide this service. However, these costs must be considered
against the relative effectiveness of the delivery channel to influence IYCF or other specific health outcomes. The use of hotlines reduces the human resource requirements compared with a pro-active voice counseling intervention, but may be less effective as it relies on user initiative to seek support. In the CCPF project in Malawi, the combination of direct messaging and a health hotline did not result in a significant change in EBF [118]. However this finding is not comparable with the pro-active voice counseling studies, which were randomized trials focused entirely on IYCF while the CCPF data is from a quasi-experimental pre/post evaluation of an intervention addressing multiple MNCH topics. Further investigation of the relative cost-effectiveness of these two approaches in IYCF-focused interventions is recommended.

13.3 Job Aid Applications

FLWs play a critical role in promoting and supporting key MNCH care practices at the household and community levels in many LMIC, primarily through home visits to pregnant women and mothers of young children [180] [181]. However, FLWs are often inadequately equipped and supported for this work [80, 82]. Barriers to quality care delivery include insufficient training and supportive supervision, lack of appropriate incentives, and heavy workload [146]. The potential for mHealth tools to address some of these barriers is well recognized [95], and a plethora of interventions, particularly job aid apps, have been deployed in the programmatic sphere [143].

A recent systematic review found convincing evidence for the acceptability and feasibility of FLWs adopting mHealth tools, although the need for adequate training was clearly noted [182]. The need for extensive capacity building and support to enable FLWs to master new technology has also been noted in formative research studies [146, 150, 151] and programme reports [114], and is a limitation to the scale up of job aid apps [141].

Job aid apps facilitate greater efficiency in data collection and reporting, so it is widely expected that FLWs using these apps will have more time available for counseling on key BCC messages [142]. This in turn is anticipated to lead to changes in health behaviours and health outcomes, but this pathway is complex and not well delineated or evaluated [108]. Very few studies have examined the effectiveness of job aid apps for improving health outcomes [182, 183]. The study by Martinez-Fernandez et al. of maternal and infant mortality in Guatemala is the only paper identified for this scoping review which assessed health outcomes related to a job aid application.
However, this study suffers from several methodological inadequacies, including the non-random assignment of communities to intervention or control, the non-standard approach to the mortality calculations, and the lack of impact pathway data linking the mHealth intervention to the reported changes in mortality. These limitations compromise the contribution of this study to the knowledge gap on effectiveness of job aid apps [143].

Despite the lack of effectiveness evidence, there is preliminary evidence of increased uptake of some essential maternal and newborn care practices when mothers are supported by FLWs using job aid apps. The strongest effects have been reported for antenatal care attendance and skilled birth attendance [114, 115, 120]. The Ananya evaluations of both the CommCare app and the Mobile Kunji job aid tool are the only known studies to have assessed changes in IYCF practices. The findings from the CommCare app trial point to a small positive effect on early initiation of breastfeeding but no other improvements in IYCF [114]. The Mobile Kunji evaluation found a greater likelihood of infants over 6 months in the intervention group receiving at least one complementary food in the previous 24 hours [120]. However the interpretation of this non-standard indicator is unclear, and complementary practices remained poor in both study groups.

Much remains to be learned about how to optimize the use of job aid apps as counseling tools, but there is evidence of several benefits from the use of embedded audio or video BCC messages. At a minimum, there is a guarantee that if the home visit checklist is used, the basic message(s) will be delivered to the mother and possibly to other family members. Training and support are needed to ensure FLWs have the skills and take the time to move beyond this basic approach and integrate the recorded messages into a counseling discussion [114, 184]. With sufficient FLW capacity, there is consistent evidence that the recorded messages serve as a reminder and confidence-builder for FLWs, and add credibility and authority to the advice they give, increasing clients’ receptivity [120, 152, 184].

In the Ananya project, the counseling messages embedded in the CommCare app were underutilized during the study period [114]. This may reflect the enormity of the task of developing proficiency in a multi-functional smartphone application for FLWs who may have limited formal education and no prior experience with digital technology. Exploratory research with low, moderate and high proficiency users of a CommCare job aid in India suggested that
there may be a staged process of capacity acquisition [151]. FLWs must first master the data entry and form completion tasks of the app before advancing to a fuller understanding of the value of the app to enhance the delivery of care, including BCC. The time to progress through these capacity development stages is expected to vary widely between FLWs and is likely mediated by a variety of factors which are not well understood. Kaphle et al. did not find any significant associations between user characteristics and CommCare proficiency, but the very small sample size likely compromised results [151]. A World Vision project in Sierra Leone found that participants with a lower education level or less previous mobile phone experience grasped fewer skills required for use of a job aid app after initial training [155]. Further examination of factors influencing technology skill acquisition is needed, and projects introducing job aid apps need to allow sufficient time for full competency development. In addition, it should not be assumed that mobile phone use by FLWs will be accepted by the community, particularly in rural areas where access to technology is very limited. Suspicion or non-acceptance of new technology may hinder participation in an mHealth intervention, even compromising the entire health promotion process [129, 184].

Many programmes assume that FLWs will readily transmit current biomedical knowledge as taught through training sessions, without considering issues of motivation, counseling skills, or the FLWs’ personal knowledge and experience [73, 185]. The failure to consider FLWs as active agents within the BCC process likely contributes to the sub-optimal results from many interventions, including mobile phone-based supports [73, 183]. The success of mHealth interventions is linked to the capacity of the users and strength of the overall health system [186]. In the ImTecHO pilot study, FLWs were incentivized for using the app and for performing MNCH services not normally compensated through the government system [146]. This likely influenced the positive perceptions of the app but has implications for sustainability. The Mobile Kunji job aid tool is unique in that the mobile component was designed for use on the basic phones already owned by FLWs [145]. This approach leverages the existing technical capacity of FLWs, bypassing the need for extensive technical training and support, and increasing the potential for sustainability.

Further work is needed to understand the pathway from increased engagement with the BCC process to actual changes in practice, particularly for complex, habitual behaviours [108]. FLWs are the primary agents for IYCF BCC delivery in many low resource settings, and interventions
which increase their capacity and effectiveness are vital [83]. Preliminary evidence shows potential for job aid apps, but these must be seen as tools to build on rather than compensate for inadequacies in FLWs’ basic capacities in care delivery and IYCF counseling [156]. In addition, FLWs are usually responsible for a broad range of health issues and receive little recognition or compensation for their work, so expectations for IYCF counseling must be reasonable [85]. Efficiencies created by data management systems in job aid apps should not be assumed to automatically lead to greater investment in BCC delivery by FLWs [142]. Instead, training and support must be provided for the unique skill of integrating interpersonal counseling with standardized pre-recorded BCC messages [C. Pimmer, personal communication, February 12, 2016]. Broader issues related to FLW capacity and motivation must also be considered [73, 84].

In an enabling environment, job aid apps could provide the basic structure for an integrated BCC model, combining standardized health information delivery with interpersonal social and problem solving support for improved IYCF practices.

The issues related to BCC delivery by FLWs are the focus of a qualitative study which the author and colleagues are leading in a rural area of Madhya Pradesh, India, where World Vision is implementing a nutrition project. Interviews have been recorded with eight supervisors of FLWs, some of whom are using a CommCare job aid app with embedded BCC messages. Analysis of the transcripts will explore perceptions of IYCF practices in the local context, FLW capacity for BCC, and the strengths and limitations of the app to enhance BCC delivery.

13.4 Interactive Media

Keeping pace with emerging technology is a continual challenge in the mHealth field, and as more advanced mobile phones become more common in LMIC it is likely that interactive media will play a greater role in health communication. Globally, smartphone subscriptions are expected to outstrip basic mobile phones before the end of 2016, and mobile broadband subscriptions are growing by 20% year-on-year, with significant future growth predicted in Africa and the Middle East [93].

Interactive media stands apart from the other mobile phone delivery channels as its expansion and influence will be driven by forces outside the health system as well as (and more than) those within; this process is inevitable. In contrast, messaging, voice counseling and job aid apps are unlikely to be developed and implemented outside of initiatives by health system or development
actors. They also operate primarily through unilateral or bilateral communication between health service providers and clients, while interactive media operates multilaterally and creates a global community of knowledge-creators and knowledge-users who otherwise would never be connected with one another. In this context, health communication often occurs without any involvement of health professionals. The advent of interactive media thus represents a major new frontier in health communication, which requires different models of engagement and risk management [187, 188].

Guidance is needed for health initiatives seeking to leverage interactive media for health promotion. Concern has been raised regarding the potential negative consequences of widely distributed user-generated content, unmoderated by qualified health professionals, and the loss of connection between health care providers and clients [189, 190]. In interventions designed by health providers, a balance needs to be found between user-generated and system-generated content, in order to leverage the participatory appeal of interactive media but ensure quality control [188].

Ritterband et al. have proposed a conceptual model for internet-delivered health BCC in which effects on behaviour are mediated by characteristics of the user and the website, utilization of the website, and influences from environmental factors and external sources of social support [191]. As interactive media interventions expand in use it will be important to measure and assess these multiple contributing elements in order to determine elements of effective design for particular populations and health topics. This will also require the development of new methods to evaluate the effects of interactive media interventions, which are difficult to assess with current approaches [188, 190, 192].

In high income countries, interactive media is used extensively as a source of pregnancy and parenting information, but there is little research on its use or effectiveness for IYCF support [193]. A cross-sectional study of first-time mothers in Australia found that 53% had used internet searches and 19% had used social media sites to seek information on breastfeeding [194]. In a cross-sectional survey administered to mothers of nine month old infants in Ireland, 46.6% reported using the internet and 9.2% used apps to obtain infant feeding information [195]. The majority of the internet sites and all of the apps used by these mothers were public, with unregulated content. In China, a cross-sectional study of women attending an antenatal clinic in
Guangzhou found that 88.7% had used the internet to access pregnancy-related information [196]. The women reported trusting internet sources if the content agreed with other sources of information and if references were provided. These studies point to the need for health care providers to become familiar with existing interactive media resources for MNCH and IYCF in order to assist mothers in navigating the information superhighway and selecting resources which provide evidence-based guidance and skilled problem solving support [196, 197].

A particular challenge for IYCF is the extensive use of interactive media by the infant formula industry. A study of social media sites popular amongst new parents in the United States found a well-established presence by infant formula manufacturers [198]. The advent of new technology has thus introduced a fresh set of challenges for the protection of breastfeeding and enforcement of the WHO International Code of Marketing of Breast-milk Substitutes [199]. This phenomenon is likely to occur also in LMIC as access to new technology spreads, thereby undermining existing breastfeeding practices [200].

There is a need for research on effective interactive media designs for IYCF support to provide guidance on how to positively leverage new communication technologies [197]. An early systematic review classified 21 breastfeeding interventions (randomized or non-randomized trials with concurrent controls) in high-income countries as either e-based or provider-based and reported a positive effect only for e-based designs (OR=2.2; 95% CI 1.9, 2.7) [201]. A more recent systematic review of the effectiveness of internet-delivered breastfeeding education found only one study which met inclusion criteria but it lacked a methodologically rigorous design [193]. A subsequent systematic review included 16 RCTs or quasi-RCTs of breastfeeding interventions using a variety of e-technology platforms, including internet, SMS, CD-roms, e-learning virtual interactive media and e-prompts, most of which are delivered via computers not mobile phones [202]. The meta-analysis found a significant effect of e-technology on early initiation of exclusive breastfeeding (z=6.90, p<0.00001) and exclusive breastfeeding at six months (z=3.20, p<0.001), but no effect on exclusive breastfeeding at six weeks (z=0.20, p=0.84). However each sub-group analysis included only two or three studies, and implementation designs and contexts varied widely. No studies were conducted in low-income countries, and only three were from middle-income countries, including the SMS study in China by Jiang et al. [109].
Interactive media is an information-rich, media-rich BCC delivery channel. It offers new opportunities for health promotion, by stimulating engagement with health information, allowing self-selection and tailoring of content, and providing access to virtual supportive communities [203]. Initiatives such as StartSmart in South Africa and Alive & Thrive in Vietnam have leveraged these opportunities to share information and promote positive social norms regarding optimal IYCF practices [157].

Problem solving support accessed through online communities may be beneficial, unhelpful or harmful, depending on the source. This presents a dual challenge to health professionals, to develop strategies to mitigate the harmful effects of misguided content and to actively utilize interactive media, particularly social media, to distribute evidence-based MNCH information and provide IYCF services [197]. As mobile internet access increases, social media is also becoming a relevant tool for health communication in LMIC, where social networks and relationships are highly influential [187]. Further research is needed to understand the effects of accessing social support for IYCF via online rather than physical communities. Nurture Project International is designing a Mobile Peer Support app through which refugee mothers in transit across Europe can receive IYCF support from a trained volunteer who speaks the same first language [159]. This approach combines the access and communication features of interactive media with social support and skilled problem solving support delivered through interpersonal communication. Such combinations of interactive media and traditional communication channels are likely to become more common as mobile internet access and usage expands in LMIC. Both implementation and effectiveness studies are needed to evaluate novel, integrated BCC designs. Health systems need to develop technical literacy skills to positively leverage interactive media resources for IYCF support, and to respond to the proliferation of health communication channels with unregulated content.

14 Mobile Phones for IYCF BCC: Theoretical Principles

In their critique of health BCC in developing countries, Aboud and Singla call for intervention designs to be grounded in three elements: i) theories of behaviour change; ii) implementation research evidence of what has worked or not worked previously; and iii) in-depth knowledge of the target audience [173]. Practitioners of BCC for IYCF report a strong commitment to formative research and intervention design sensitive to the socio-cultural context (Aboud and
Singla’s third element) and a need for strengthening of the first two elements, the theoretical foundation and implementation research [74]. In the mHealth field, the importance of in-depth knowledge of the target audience is also recognized as a critical element for success [156, 161, 162]. However, the limited body of implementation research on mobile-phone based BCC delivery channels is a constraint to developing best practice guidance [108]. The field is growing but there is a need for more investment in both process and impact evaluations of mobile phone-based BCC interventions for specific health topics and outcomes [99, 100].

14.1 Theories of Change in mHealth Interventions

Many mHealth interventions do not identify a guiding theoretical framework, but most implicitly embody elements drawn from prominent theories of health behaviour change [204]. Preliminary evidence suggests that mHealth interventions using more rigorous, theoretically-grounded designs produce greater behaviour change results [172]. Two large-scale initiatives which have articulated theoretical frameworks are the global MAMA partnership and the Mobile Kunji job aid tool designed and implemented within the Ananya programme in India.

MAMA’s Theory of Change has three core elements and is based on the Health Belief Model and Theory of Reasoned Action [205]. The pathway to improved preventive and care-seeking behaviours for maternal and neonatal health begins with appropriate local content. Wide distribution of this content is expected to increase access to health information, in turn leading to increased knowledge and engagement. The combination of these three core elements is expected to lead to positive changes in health behavior, ultimately contributing to improvements in health outcomes. The model also recognizes the importance of the policy and socio-cultural context to provide an enabling environment for successful implementation of the initiative.

In the Mobile Kunji Theory of Change, increased engagement is the core intermediate step in the pathway to improved practices, mediated by the application of the job aid tool [120]. The use of Mobile Kunji is expected to increase FLWs’ confidence and skills, leading to greater credibility and therefore trust by community members. These elements together contribute to an increased level of engagement. Through elevated engagement, it is expected that mothers will experience improvements in knowledge, self-efficacy and attitudes towards positive health behaviours, leading to changes in practice.
As these two examples illustrate, the dominant theories of health behaviour change focus on cognitive processes of the individual as the primary drivers of health behavior [206]. This emphasis has infused BCC intervention designs more broadly, including BCC for IYCF [74]. Most BCC designs aim to change attitudes and intentions through improvements in knowledge, attitudes and self-efficacy. In many cases this does lead to successful behaviour change, including the significant improvements in a few specific care-seeking practices reported by the evaluations of MAMA Bangladesh and Mobile Kunji [120, 121].

However, cognitive-based theories have important limitations for addressing complex, habitual practices [206]. This is particularly relevant to BCC targeting maternal and child care practices in resource-constrained contexts, where many cultures are collectivist and mothers are often disempowered [171, 173]. In such settings, social determinants are often stronger drivers of behaviour than individual cognitive factors, leading to less-than-expected results when only cognitively-based BCC techniques are applied [89]. Social determinants include issues such as power inequalities, social norms, and access to quality services.

### 14.2 Addressing Social Determinants of IYCF Practices

BCC for IYCF has historically targeted mothers as the primary caregivers of young children and the ones who breastfeed infants, but mothers face many constraints to implementing recommended practices [27]. Studies examining reasons for low adherence to EBF recommendations in LMIC consistently identify high levels of knowledge but socially-based constraints to practice. These constraints include social norms, the need to return to paid employment, and lack of access to lactation management services [25, 26]. Marketing of infant formula is another significant constraint in middle-income countries [2, 200, 207].

Complementary feeding practices are also affected by social determinants and contextual factors [208]. Both ethnographic and intervention studies have found that cultural knowledge, financial resources and mothers’ workloads are highly influential [3, 209]. For example, mothers in rural Bangladesh who participated in a BCC intervention for improved complementary feeding were distressed by their inability to implement recommended practices due to either their lack of financial resources or to gender-based constraints on their ability to access local markets [210].

Although many IYCF interventions continue to emphasize information delivery to mothers as the primary BCC technique, there is a growing acknowledgement of the complex social
determinants of IYCF practices [74]. This is reflected in calls to broaden the narrow focus on the mother-infant dyad to encompass a wider range of influential figures in the mother’s household and social network [76, 77, 84, 211]. The importance of an enabling socio-cultural and policy environment for improved IYCF is illustrated by the conceptual model recently published in the Lancet Breastfeeding Series (Fig. 1) [2], and the Alive & Thrive framework for behaviour change (Fig. 3) [84]. A comprehensive approach to improving IYCF practices must encompass actions at the individual, community and structural levels [75]. BCC delivered via direct messaging, voice counseling and interactive media operate primarily at the individual level, while job aid apps may also have a broader effect on the family and community if implemented by competent, community-based FLWs. Expectations for the impact of any of these approaches must be realistically assessed in light of the broader enabling environment in a particular context.

The importance of a comprehensive approach to BCC for IYCF has been demonstrated by the Alive & Thrive programmes in Bangladesh, Ethiopia and Vietnam. The intervention package included a mix of advocacy, interpersonal communication and mass communication activities, in order to address IYCF determinants at multiple levels [78]. Improving mothers’ knowledge of best practices was only one component of the strategy. In Vietnam, Alive & Thrive documented a sizeable gap between mothers’ knowledge and practice of IYCF recommendations, with the greatest gap for EBF [25]. The knowledge-practice gap for EBF was smaller among mothers who perceived EBF as a social norm (OR: 0.20; 95% CI: 0.15, 0.27) and who received support from health workers at birth (OR: 0.82; 95% CI: 0.70, 0.95). This study clearly shows that knowledge of best practices is not well linked to behaviour, and interventions must move beyond a focus on increasing mothers’ knowledge of the health benefits of recommended IYCF practices. The Alive & Thrive intervention design in Vietnam included interpersonal IYCF counseling delivered through a social franchising model in intervention communities, as well as a national mass media campaign [85]. The 2013 process evaluation found a 21.0 percentage point difference-in-difference from the 2010 baseline for EBF between mothers who received both mass media and counseling (thus engaging in social support and practical problem-solving activities), and those who received only the mass media messages (p<0.001) [85].

The evidence from Alive & Thrive also reinforces the usefulness of Briscoe and Aboud’s categorization of BCC techniques [72]. None of the twenty-four interventions selected for their study relied on information delivery alone, and the most successful interventions used at least
three or four different techniques. The authors suggest this that use of multiple techniques may be more effective at the individual level because each technique appeals to a different psychosocial domain; by influencing several domains, it may be easier for people to learn, recall and make the recommended changes [72]. The use of multiple techniques also requires that elements of practical support be incorporated into the intervention, either through problem solving, provision of materials or both. Building social support engages the broader family and community in the BCC process. It is noteworthy that all six complementary feeding interventions in Briscoe and Aboud’s analysis included performance as a technique, either through demonstrations or trials of improved meals for young children. This may prove to be a critical element for complementary feeding BCC.

In Briscoe and Aboud’s analysis, all of the BCC techniques were applied through the medium of interpersonal communication, with the exception of mass media [72]. The Alive & Thrive programmes also demonstrate the critical importance of interpersonal communication for IYCF BCC [85], and it was therefore added to the framework as a seventh BCC technique for this scoping review. In fact, as the extent of interpersonal interaction decreases, so does the ability to apply a fuller package of BCC techniques. Mobile phones can be used to deliver health information through direct messaging or interactive media without interpersonal communication, but it remains necessary for social, problem solving and performance support.

14.3 Interpersonal Communication

The number of studies available for consideration in this review is limited, but it is noteworthy that the three interventions which were specifically focused on IYCF and used interpersonal communication as the primary BCC channel all showed positive effects on IYCF practices, despite their varied intervention designs [32, 110, 117]. Both Patel et al. and Sellen et al. implemented voice counseling through mobile phones, in India and Kenya respectively, with an additional SMS component in the Indian study. In the study by Flax et al. in Nigeria, traditional group education was the primary delivery approach, supported by direct messaging to small groups. All of these approaches showed a significant effect on the target outcome of exclusive breastfeeding (Tables 5-7). The Indian study reported improvements in other IYCF indicators as well, which were not assessed in the studies in Kenya and Nigeria.
In contrast, only one of the interventions which used direct messaging as the primary mode of BCC delivery showed an effect on exclusive breastfeeding, but not on other IYCF outcomes [109]. In the study by Jiang et al. in China, mothers in the intervention group were encouraged to respond to SMS messages and interact with the research team, although the extent to which this type of interpersonal interaction occurred was not reported.

The Aponjon and CCPF interventions combined messaging and hotline services, but addressed multiple health behaviours and did not show significant effects on breastfeeding practices [118, 121]. Although hotlines provide an opportunity for interpersonal communication and problem solving support, accessing this support relies on user initiative. A pro-active counseling approach is likely to be more effective for IYCF.

While this is a small evidence base and the heterogeneity between the study designs and contexts limits comparability, other research has shown that message-only interventions (whether delivered through mobile phones or other channels) exert stronger effects on episodic behaviours, such as clinic attendance or medication adherence, rather than habitual behaviours such as exclusive breastfeeding [165, 212].

Qualitative research and project case studies in this review further illustrate the importance of integrating interpersonal communication within mobile phone-based BCC designs. Health workers in Kenya valued SMS for more basic communication such as appointment reminders, but preferred interpersonal communication for more in-depth discussion of complex issues related to PMTCT [140]. Ramachandran proposed six guiding principles for the development of persuasive MNCH messaging, based on her experience designing a mobile phone-based counseling tool for FLWs in rural India [150]. These principles include the need to ‘create opportunities for structured dialogue between humans’ (p.98), which Ramachandran achieved by incorporating guiding questions and pauses for discussion into her video clips. Researchers in Honduras found that although mobile phone access was high among adolescent mothers, participation in a breastfeeding support intervention was poor due to social and contextual factors including security [139]. Qualitative doer/non-doer analysis identified the importance of engaging an adolescent mother’s family support system, leading to the recommendation that future interventions begin with a home visit to establish personal contact and build trust prior to initiating mobile phone-based support. The ‘Healthy Pregnancy, Healthy Baby’ text messaging
initiative in Tanzania was designed as a one-way information service, but found that many users
texted back with questions, indicating a felt need to move beyond receipt of basic information [134].

These examples reinforce the centrality of the social context to health behaviour, and the
importance of interpersonal interaction to facilitate health promotion and behaviour change
communication [171]. It has been argued that mobile phone technology can replace the need for
human resources to deliver BCC [213], but the effectiveness of this approach is likely limited to
a small number of discrete, short-term behaviours that are readily amenable to change with little
additional support [165]. Instead the available evidence points to the importance of integrating
appropriate mHealth innovations within broader BCC and health system strengthening initiatives
[161, 214, 215]. Further research is needed to explore the optimum mix of interpersonal
interaction reinforced and augmented by mHealth tools that is needed to influence sustained
improvements in IYCF practices in various contexts.

15 Implementation Issues

The studies and projects identified in this scoping review provide valuable implementation
lessons regarding the use of mobile phone-based approaches for BCC. These relate to content
development, technology issues, and the timeframe for behaviour change.

15.1 Content Development

For any IYCF intervention, formative assessment of IYCF practices and socio-cultural influences
is essential groundwork to inform the selection of target behaviours, key messages and
intervention approaches [73, 216-218]. When mobile phones will be used to deliver BCC, the
content development process is critical and must be adequately resourced both in terms of time
and expertise [132]. This is particularly true when messages will be delivered without the
presence of a trained health worker to assist with knowledge translation. Globally, very few text
messaging interventions report on message development and pre-testing, but this preparatory
work is vital to effective health communication [219]. Standardized message banks are a
valuable starting point and should be utilized, but all messages must be adapted for the target
audience to ensure effective communication. Messages must not only be scientifically accurate,
but contextualized to specific local IYCF barriers, and presented in language that is clearly
understood and emotionally appealing to end-users [133, 150, 161, 220]. The challenges inherent in this process have been documented by leading actors in this field, including MOTECH [133], MAMA [134], and BBC Media Action, which led the development of BCC materials for the Ananya project in Bihar [161]. Both MOTECH and MAMA implemented direct messaging services targeting mothers and families, while the Ananya initiative included both direct messaging and counseling tools for FLWs to use during home visits.

During the MOTECH design process it became clear that mothers were seeking reassurance as well as health information, and the messages came to be seen as encouraging communication from a trusted advisor, rather than a set of facts and instructions [133]. This aligns with preliminary evidence that motivational rather than informational messages may be more effective in stimulating behaviour change [172]. This principle was also followed in the global MAMA message development process [132]. Mobile phone messaging interventions thus began to incorporate a greater element of social support through the deployment of fictional authority figures. In the Ananya programme, IVR messages were given by the character of “Dr. Anita”, created in response to formative research findings that a female doctor with a warm approach would be most trusted as an advisor to pregnant mothers and their families [161]. Impact evaluation research confirmed that the character of Dr. Anita was key to the positive perceptions of the BCC messages by both FLWs and families [120].

15.2 Technology Issues

Mobile phone-based approaches targeting improved IYCF are subject to the same technological challenges facing all mHealth projects in LMIC. These have been well documented, and include phone breakage, airtime credits expiring, lack of power supply for recharging batteries and poor network coverage [114, 128, 139]. Indeed there is a real risk that technical problems can become the dominant issue in mHealth implementation, detracting from a focus on health and nutrition. This is particularly the case in rural, underserved areas where infrastructure is poor, and where projects have introduced more advanced technology to achieve greater functionality. This requires extensive training and ongoing support for technology use and troubleshooting technical difficulties [114, 146, 155]. There is a strong case to be made for adapting interventions to the technology that is locally available and familiar to users [133, 161]. This position guided the reliance on basic SMS or IVR messaging rather than multimedia functions in the MOTECH and
MAMA projects [131, 133]. It has also led to highly innovative designs such as the Mobile Kunji job aid tool [120].

The ever-growing number of mobile phone subscriptions in LMIC is often used to highlight the potential reach of mHealth, and the assumption has been made that this will lead to more equitable access to health information and services [162]. However, studies have shown that poorer people and women are less likely to have access to mobile phones, and that sharing of phones within households is common [128, 221, 222]. As smart phones and mobile internet become more available and interventions adjust to this new technology, inequities in access based on gender and economic status will persist [187]. This has equity implications and raises questions about the potential for mHealth interventions to reach the most vulnerable. It also impacts implementation designs, particularly for IYCF interventions which typically target mothers. For example, formative research for the Ananya project in Bihar found that males owned the mobile phones and took them outside the home while working during the day [161]. Thus the project designed IVR messages directed to males, who were encouraged to share them with their wives and other household members. Messages were sent in the evening when men were more likely to be home. Formative research to understand patterns of mobile phone access and use in a target population is essential to planning the design of any mHealth intervention [162].

15.3 Timeframe for Behaviour Change

The relatively short timeframe for most project-based funding is a limitation to building a stronger evidence base for mobile phone-based BCC delivery. To date, most reported mHealth outcomes are intermediate steps such as knowledge or antenatal care attendance [98]. It is not yet known to what extent or by what mechanisms mHealth can contribute to improved health outcomes [108]. Acceptance and skill-building with new technology takes time, as does complex behaviour change, and it is likely that projects have shown limited effects on MNCH practices and outcomes partly because of insufficient time [150, 173]. mHealth solutions developed by social enterprises outside of project funding timelines may provide valuable lessons in the timeframe and process involved in taking a mobile phone-based innovation from design to stable implementation at scale.
For example, the Indian social enterprise ZMQ Development is gradually developing and rolling out its award-winning MIRA Channel initiative [154]. MIRA is a multi-faceted mobile phone-based tool which uses iconic pictures to guide illiterate rural women in the self-monitoring of their health. Parallel job aid applications for FLWs and health facilities are designed to increase access to quality services. For the pilot test, a cadre of dedicated MIRA workers was recruited to work concurrently with the existing government-supported FLWs in providing home visits to pregnant mothers [154]. This demonstrated the feasibility and benefits of MIRA and allowed for adjustments to be made to the design. Government-supported FLWs are now being trained in its use, with plans for large scale implementation in Haryana state [S. Quraishi, personal communication, January 22, 2016]. MIRA Channel is also being adapted for implementation in Afghanistan and Uganda.

16 Study Limitations

Extensive searching was conducted for this scoping review, but some eligible interventions may have been missed, particularly from the programming domain. Searching the mHealth evidence base is complicated by the wide dispersal of relevant papers across both the published and grey literature. Research on mHealth interventions may be published in clinical, public health, computer or communication journals. Grey literature reports are spread across the internet, although excellent attempts have been made to consolidate project data into online repositories. Finally, many mHealth programmes are unevaluated or unreported and therefore unavailable to a review such as this.

This scoping review focused on BCC interventions for MNCH delivered via mobile phone to mothers and families. mHealth interventions designed to build FLW capacity, improve adherence to protocols or strengthen communication between health providers were therefore not included, but may contribute to improved quality of BCC delivery. Including interventions targeting health behaviours outside MNCH may also have yielded additional relevant insights.

IYCF messages are likely included within a package of MNCH messages in many job aid apps and subscriber-based messaging services, but this is not always reported in project documentation. Where explicit reference to IYCF messaging as an intervention component was lacking, projects were not included in the discussion of the evidence base. The use of mobile phones for IYCF BCC may therefore be more extensive than reported here.
The shortage of rigorously evaluated mHealth interventions is a persistent challenge noted by many reviewers. This scoping review was similarly constrained by the relatively small number of eligible studies and the wide variation between designs and intervention contexts. However, the aim of a scoping review is to map the existing state of evidence in order to provide direction for future development of the field, and this was achieved. Recommendations for both research and practice are provided below.

17 Recommendations

17.1 Recommendations for Practice

1. **Interpersonal communication is the foundation of BCC for IYCF and should be central to intervention designs.** Investment in skilled frontline workers should be prioritized in community-level IYCF interventions. Mobile phones may be an appropriate delivery channel or aid to interpersonal communication in some contexts, but the evidence to date does not support replacing competent human resources with mHealth approaches.

2. **Formative research should guide the decision to use one or more mobile phone-based delivery channels as part of a larger IYCF BCC strategy.** The key to effective use of mobile phones for BCC is tailoring both the content and the delivery mechanism to the local situation [161]. Formative research should include media audits and data on mobile phone ownership and usage patterns, as well as examining IYCF practices and the factors which influence them.

3. **Document and disseminate formative research methods and findings, including the process of translating findings to intervention designs.** The importance of contextually-appropriate designs is recognized in both the mHealth and IYCF BCC fields, but guidance on how to do this is limited. Many interventions conduct formative research but the process and results are seldom disseminated, hampering collective learning.

4. **Content must be localized and pre-tested prior to deployment.** This is an intensive but essential process. Standardized message banks are a useful starting point but content
must be localized, not merely translated. This ensures that concepts are clearly understood and that the messages are appealing to users.

5. **Content must be aligned with target behaviours and outcomes.** Inclusion of too many health topics likely leads to a dilution effect, which will diminish results. Expectations for behaviour change must be aligned with the intensity and focus of the intervention design.

6. **Ensure adequate capacity building, technical support and time for acceptance and competent use of mobile phone-based services.** This is particularly relevant for job aid apps which introduce new technology (such as smartphones) to FLWs who often have low literacy and limited experience with technology.

7. **Include process evaluation in monitoring and evaluation plans.** The baseline and endline surveys required for project evaluations typically measure changes in knowledge and practices but are inadequate for assessing implementation delivery. Rigorous process evaluations are needed to increase knowledge of implementation realities, in order to strengthen the association between interventions and outcomes and to contribute to best practice guidance.

8. **Build rigorous quality assurance mechanisms for interactive media interventions.** The benefit of knowledge exchange through online forums must be balanced with the risks of inaccurate or harmful information sharing. Interactive media channels need to incorporate mechanisms to moderate online forums and address misinformation while leveraging the advantages of online interaction for social support and problem solving.

### 17.2 Recommendations for Research

1. **Evaluate the effectiveness of each mobile phone-based delivery channel independently or in specified combinations, targeted to specific health practices or outcomes.** This will better contribute to the development of best practice guidance. Determining an aggregate effect of all mHealth interventions is less useful as delivery approaches differ significantly from one another. Contextual factors should also be considered in the interpretation of effectiveness findings.
2. **Compare the cost-effectiveness of direct messaging and voice counseling interventions alone and in combination.** Direct messaging may appear to have cost efficiencies due to its potential for extensive reach with standardized content. However, the costs of quality, localized content development and the limitations of excluding interpersonal communication and problem solving support need to be weighed against the benefits of a large reach.

3. **Compare the cost-effectiveness of voice counseling with health hotlines.** Human resource requirements are lower for hotlines but pro-active social and problem solving support may be more effective for improving IYCF practices.

4. **Define and test theory-based program impact pathways.** Effectiveness evaluations and best practice guidance will both be strengthened by greater understanding of the avenues through which mobile phone-based BCC delivery approaches lead to changes in practices and health outcomes, and the limitations to this.

5. **Examine the elements contributing to successful mHealth deployments.** Implementation science is needed to complement program impact pathway analyses by assessing barriers and enablers of effective implementation. This is particularly important for job aid apps, which are released to FLWs in the community. Implementation research should include qualitative exploration of community and FLW perceptions of job aid apps; identifying patterns of use and characteristics of proficient users; and assessing other implementation elements such as training, supervision, and project timeframes.

6. **Develop novel evaluation methods and tools for interventions using interactive media channels.** The multi-directional interactions and user-driven selection of content in interactive media channels pose challenges for assessing engagement and effectiveness, and new methods of evaluation are needed.

**18 Conclusion**

This scoping review identified four mobile phone-based delivery channels that have been utilized for BCC related to MNCH in LMIC. Each delivery channel was examined for its current
evidence base and potential to contribute to the critical need for expanded access to community-level supportive BCC for improved IYCF practices.

Based on the existing evidence and theoretical principles, it is recommended that interpersonal communication form the core of IYCF BCC intervention designs. Job aid apps may be useful tools to support this in some settings, but FLWs must be adequately skilled and supported in both interpersonal counseling and technology use. In settings where mothers have reliable mobile phone access, are empowered to make IYCF decisions and are comfortable with telephonic communication, voice counseling may be a suitable channel for efficient delivery of IYCF support. Direct messaging may be best suited as an adjunct to interpersonal communication approaches, reinforcing key concepts and building social support for improved IYCF practices.

Interactive media channels lack an evidence base in LMIC but are likely to become a significant vehicle for health communication. Interactive media channels with built-in quality assurance mechanisms have the potential to positively influence MNCH and IYCF practices, but will face competition from the infant formula industry.

The field of mobile phone-based BCC is still nascent and few studies have examined its effects on IYCF practices. Further trials and rigorously evaluated programmes are required in order to establish the relative effectiveness and cost-effectiveness of mobile phone-based approaches delivered singly and in combination. Implementation research is also needed to delineate program impact pathways and elements of effective interventions, contributing to best practice guidance. Strategies to integrate interpersonal communication with mobile phone-based approaches should be prioritized.
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ZMQ. MIRA: Mobile channel on RMNCH+A for rural women.


Appendix I: PubMed Full Search Terms

(((("counselling"[All Fields] OR "counseling"[MeSH Terms] OR "counseling"[All Fields]) OR
("behaviour"[All Fields] OR "behavior"[MeSH Terms] OR "behavior"[All Fields]) AND
("Change"[Journal] OR "change"[All Fields]))) OR ("nutritional status"[MeSH Terms] OR
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"phones"[All Fields]) OR "cell phones"[All Fields] OR ("mobile"[All Fields] AND "phone"[All
Fields]) OR "mobile phone"[All Fields]) AND English[lang]
Appendix II: Sources for Grey Literature Reports and Project Examples

The websites listed alphabetically table below were searched for relevant documents or for project implementation details.

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Appendix III: Consultation Participants

The following individuals contributed to this scoping review by sharing reports, insights and lessons learned from project experiences, and/or providing referrals to others with relevant experience. The consultation process took place through emails and skype calls as well as in-person meetings in Toronto and in Delhi and Narsinghpur, India.

The table is organized alphabetically by organization name, within each category. Individuals who were contacted but did not participate in the consultation process are not included here.

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
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<tr>
<td>Hana Mahmood</td>
<td>Project Director, Maternal, Neonatal &amp; Child Health Research Network</td>
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<tr>
<td>Janneke Hartvig Blomberg</td>
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<td>Mahbub Elahi Chowdhury</td>
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<td>ICDDR,B (Bangladesh)</td>
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<td>Josie Mangxaba</td>
<td>Research Manager</td>
<td>MAMA</td>
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<tr>
<td>Rukhsana Haider</td>
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<td>T.A.H.N. Foundation (Bangladesh)</td>
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<td>Christoph Pimmer</td>
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<td>University of Applied Sciences and Arts (Switzerland)</td>
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<td>Kristy Hackett</td>
<td>PhD candidate</td>
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<td>Silvia Kaufmann</td>
<td>Senior Nutrition Specialist</td>
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<td>Diane Baik</td>
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<td>Miriam Chang</td>
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<tr>
<td>Barbara Main</td>
<td>Public Health Specialist</td>
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### Participation in face-to-face meetings in India

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<td>Sona Sharma</td>
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<td>Rahul Matthew</td>
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<td>Ayushi Singh</td>
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<td>Subhi Quraishi</td>
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