REVIEW ARTICLE

Impact of a Mobile Health Intervention to Support Exclusive Breastfeeding: A Scoping Review

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ABSTRACT

Nowadays, mobile health (mHealth) intervention has become a popular and convenient strategy to support exclusive breastfeeding (EBF). However, the effectiveness of the mHealth intervention on this topic is still ambiguous. Thus, a scoping review was done to map the available evidence and identify the impact of mHealth interventions to support EBF. A scoping review of English academic journals was conducted using four electronic databases (Scopus, EB-SCOHost, Google Scholar, and Science Direct) from 2016 to 2021. Only 23 articles were eligible. The sample size ranged from 50 to 1,568 participants, aged 18 and above. About 60% of the reviewed articles showed that mHealth interventions had a significant impact on EBF. The intervention group that received the mHealth tools had longer and higher EBF rates and duration compared to the control group. Other articles did not find a significant mHealth intervention impact towards EBF; however, it increased breastfeeding efficacy, mother's knowledge and the child's body weight.

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INTRODUCTION

Exclusive breastfeeding (EBF) is defined as infants who exclusively receive breast milk. Other liquids, including plain water and solids, should not be given except for oral rehydration solutions, drops, vitamin syrups, minerals, or medicines (1). In 2015, WHO suggested exclusively breastfeeding the infants under six months of age and continuing breastfeeding until 2-years-old. EBF was found to have a protective effect against the incidence and prevalence of diarrhoea, hospitalisation, diarrhoea mortality, and overall mortality (2,3). Among babies aged six months or less, who experienced diarrhoea (27.37%), fever (13.24%), and acute respiratory infection (ARI) (8.94%) could have been prevented if EBF was continued. Furthermore, the odds of becoming underweight were 2.16 and 2.01 times higher in infants for which EBF had been discontinued during 0–2 months and 2–4 months, respectively, than in infants with continued EBF. This is due to the nature of breast milk that contains antibodies to fight against common diseases (3). EBF also may provide some prevention for obese and overweight children in the future (4). There are many hormones and biological substances in breast milk that may help shape long-term physiological processes involved in maintaining energy balance (4). It can also benefit the mother, which can help to reduce the risk of ovarian and breast cancer in the future (1).

The prevalence of mothers who practice EBF is still average globally, despite abundance of evidence on the benefits of EBF for infants up to 6-month-old, including improving the child's development and survival (5). The WHO (2021) stated that nearly two out of three infants were not exclusively breastfed for the recommended six months and it had been stagnant for two decades (5). While in the United States, the prevalence of children who were EBF was much lower, which were 46.3% and 25.8% in three months and six months, respectively (6) Several actions had been taken to increase breastfeeding. These included health education programmes and support of mothers throughout pregnancy and beyond, group and individual counselling, family combined intervention, combined facility and community intervention, and workplace policy to give support and protection for working mothers. Furthermore, it covered the implementation of the Baby-Friendly Hospital Initiative, and implementation of and adherence to the International Code of Marketing of Breast-milk Substitutes (5,7,8).

Nowadays, technology has advanced and become a popular strategy and convenient method to support mothers. This includes mobile health (mHealth) which

is defined as component of electronic health that utilises information and communication technology to deliver the healthcare services (9). The primary mHealth technology and most applicable to behaviour change communication interventions are mobile phones (10). Most of the formative studies found that satisfaction, motivation, and psychological support from mHealth aided mothers in making good decisions for their children (9,11,12)

To the best of the author's knowledge, there are several scoping review studies to determine the use of mHealth intervention for a mother and child health behaviour. However, it is a broad topic with several studies, including the formative and feasibility studies (10). There is also another scoping review specifically for one ethnicity, which may not be generalisable to other ethnicities (13). More reviews need to be done to fill the gaps, especially on how mHealth intervention has an impact on the specific Mother, Newborn and Child's Health (MNCH) outcome and to get more quantitative data and behavioural change that can be measured and observed. Other than that, to address the limitations of the older search, more recent literature is also reviewed. Therefore, the objective of this scoping review is to review the impact of mHealth interventions in supporting EBF. The scoping review was conducted to systematically map the research done in the area and identify the new existing gaps in knowledge.

METHODOLOGY

The scoping review was designed to determine the impact of mHealth intervention in supporting EBF amongst mothers. The methodological framework approach was by Arksey and O'Malley (14), which includes five stages: identifying research questions, identifying relevant studies, study selection, charting the data, and last but not least, collating, summarising, and reporting the result. Furthermore, this study has been approved by Unisza Human Research Ethics Committee (UHREC) (UniSZA/UHREC/2022/391).

Stage 1: Determining the Research Question
The objective of the study and the research question are formulated prior to the study to guide the literature search. The developed research question was: "What is the impact of mHealth intervention in supporting EBF amongst mothers?" The study population comprised mothers who have children under 2-years-old, and the outcome was EBF. The intervention mentioned in this study was mHealth intervention, whereby WHO (2011) defined as "medical and public health practise assisted by mobile technology, such as cellphones, patient monitoring devices, personal digital assistants, and other wireless devices"(15). It could also include a phone call, voice call, text message, or mobile application intervention

Stage 2: Identifying Relevant Research
To identify the relevant studies and documents, four electronic bibliographic databases were used, namely Scopus, EBSCOHost, Science Direct, and Google Scholar. These databases were used to identify and search for related literature, which linked between mHealth intervention and EBF in the mothers' population. The keywords that were used during the study searching phase and documents are stated in Table I. The Boolean Operators were used as part of the search strategy to find relevant articles by inserting the keywords that were appropriate in the search engine. Some words like 'AND' and 'OR' were used to assist in searching relevant articles, whereas 'AND' were used to combine the keywords, and 'OR' to give more than one option for keywords used. The language was restricted to English only, and for articles published from 2016 to 2021. The search strategy was conducted within two months, which was from October to November 2021.

Table I: Keywords used during the search phase

Databases	Keywords	No. of studies available
Scopus	(Effectiveness*) OR (Effective*) OR (Effect*) OR (Impact*) AND (cell* W/2 phone*) OR (smart W/2 phone*) OR (Mobile W/2 phone*) OR (Mobile W/2 application*) OR (phone W/2 app*) OR (mobile W/2 app*) OR (cell W/2 app*) OR (mobile health) OR (mHealth) AND (breast W/2 feed*) OR (breast W/2 fed)	83 (12)
EBSCOHost	(Cellphone) OR (smartphone) OR (Mobile phone) OR (Mobile application) OR (mHealth) OR (mobile app) OR (mobile health) AND (breastfeed) OR (breastfed)	94 (3)
Science Direct	(Effectiveness) Or (Impact) AND (cellphone) OR (Mobile phone) OR (mobile app) OR (mobile health) AND (breastfeed) OR (breastfed) AND (malnutrition)	424 (1)
Google Scholar	(Effectiveness) Or (Impact) AND (cellphone) OR (Mobile phone) OR (mobile app) OR (mobile health) AND (breastfeed) OR (breastfed) AND (malnutrition)	1870 (7)

Stage 3: Study Selection

Types of study
All types of studies, either randomised or quasi-randomised, including cluster or individual randomisation, non-randomised controlled trials, and cohort were included. The results were specifically in the quantitative data to obtain the objective and accurate results.

Year of publication
From 2016 to 2021 (6 years)

Types of participants
Mothers with children below 2-year-old. Any interventions that included family members as the intervention to aid and support the mother would be

acceptable. However, mothers who have the human immunodeficiency virus (HIV) and other diseases that could be a barrier to breastfeeding and affected the mothers' decisions, would be excluded.

Types of intervention

All mHealth interventions that have an impact on the mother's ability to breastfeed her children exclusively. These did not include the perception, formative, and protocol studies.

Outcome measures (Exclusive breastfeeding)

All the articles that were found after the keyword search would be screened, reviewed, and extracted if they follow the inclusion and exclusion criteria. Firstly, the duplicate articles would be removed and not counted for the upcoming record. Next, one researcher would review all the articles by the titles and abstracts that appeared after the keyword search. Thereafter, the selected articles with full-text would be reviewed and screened again. Lastly, another researcher would review all the selected articles. The study flow followed the PRISMA (2009)(16) guidelines on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses, as shown in Figure 1.

Stage 4: Charting the Data

Summaries of each article were developed related to the author, publication year, country, type, objective, study method and intervention, findings, and also the limitation of studies.

Stage 5: Gathering, Summarising, and Reporting the Findings

Evaluations of the review on the framework were summarised and reported findings were analysed in Table II.
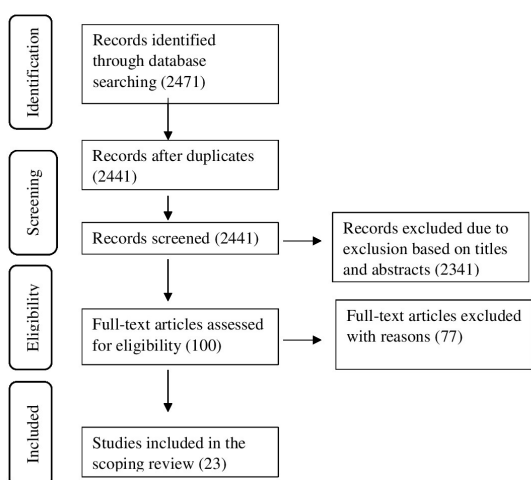

Figure I. Different phases of a scoping review on the flow of information

Figure 1: Different phases of a scoping review on the flow of information

RESULTS

Study demographic

Amongst the 100 full-text articles that were reviewed, only 23 articles met the inclusion and exclusion criteria (17–39). Even though many articles were identified through the research key (2,471 articles), which mostly came from the Google Scholar database, only 100 articles with full text were included. Moreover, twelve articles from Scopus, seven articles from Google Scholar, three articles from EBSCOhost and one article from Science Direct databases were chosen to be included in the study. Next, 40% of the study was conducted in low and middle-income countries such as India (n=3), Pakistan (n=2), Bangladesh (n=1), Kenya (n=1), Nigeria (n=1), and Iran (n=1). Most of the studies (60.8%) used the randomised control trial study design. Experimental studies (n = 17) (3 non-randomised control trials and 14 randomised control trials), longitudinal study design (n = 3), mixed-method study (n = 1), survey study (n=1) and a pilot study (n = 1) were included in these 23 articles. The sample size ranged from 50 to 1,586 participants aged 18 years old and above. These articles summarised the impact of mHealth intervention to support EBF amongst mothers.

Furthermore, amongst the 23 articles, thirteen articles (56.5%) found significant positive impacts of mHealth intervention in supporting EBF. While, a total of ten articles (43.4%) found no significant impact of mHealth intervention towards EBF. However, two out of ten articles did found a significant impacts of mHealth intervention in increasing breastfeeding efficacy and the child's body weight increment and another two articles found a significant impact of mHealth intervention in increasing the timely initiation of breastfeeding and increasing the mother's knowledge, attitude, and practice (KAP) about infant and young child feeding.

Text message

Text messaging was used as one of the components of a mHealth to support EBF in five studies. Three studies found that text messaging was successful in supporting EBF. In a study by Unger et al. (2018), it was found that both intervention groups that received either one-way messaging or two-way messaging had higher rates of EBF through 10 weeks (p=0.0004) and 16 weeks of intervention period (p<0.0001) (22). However, the probability of EBF at 24 weeks was higher in both IGs than in CG, but only statistically significant in the 2-way messaging group (p=0.005). It was also similar to a study by Prieto et al. (2017), whereby significant knowledge increment was found in the IGs and almost all the mothers (89%) that learned the EBF message, still exclusively breastfeed their children at the end of the study compared to 10.7% in the control group (26). This study found that there was a significant correlation between knowledge and self-reported behaviour which was whether the mother still exclusively breastfeed her

Table II: Impact of mHealth intervention to support breastfeeding

Author, Year (Country)	Types of study	Objectives	Methods	Findings	Limitations
Ariff, S. et al., 2020 (Pakistan)	A quasi- experimental study. Subject: 250 mothers aged 18-year-old and above for each group (IG and CG).	1. To evaluate the influence of breastfeeding (BF) promotion package on BF practices during the first 6-month of life. 2. Identify the factors affecting EBF. 3. Evaluate the effect of BF on infant morbidity.	IG received a complete intervention package (educational leaflet, health education session, telephone counselling) with standard counselling, while CG received standard counselling only.	30% of mothers in IG significantly ($P < 0.0001$) provided EBF to their children at 6-month of age compared to only 12.6% in CG. Reduction of infectious diseases was also seen in IG children.	Limited time intervention, time-bound, could not determine which package contributed to positive data.
Ahmed et al., 2016 (United States)	2-arm, RCT. Subject: 49 mother-newborn pairs for IG and 57 for CG.	To see if a web-based interactive breastfeeding monitoring system improved breastfeeding duration, exclusivity, and intensity as primary outcomes, while also reducing postpartum depression symptoms as a secondary outcome.	Mothers in CG received standard care, which include breastfeeding education and support prior to discharge. IG received the same plus additional access to the computer application (Apps) for the interactive BF monitoring system prior to hospital discharge.	IG had greater EBF rates at 1 month, 2 months, and 3 months (63%, 63% and 55%, respectively) compared to CG (40%, 19% and 19%, respectively).	None
Martinez-Brockman et al., 2017 (United States)	RCT (multi-site, single-blind). Subject: 174 women of low income who were enrolled in the women, infants, and children (WIC) breastfeeding peer counselling (BFPC) programme.	To determine the effect of a two-way text messaging intervention on the time it takes for participants and their Breastfeeding Peer Counsellors (BFPCs) to contact each other, as well as on EBF.	Intervention: IG received the usual care of the WIC Loving Support BFPC programme with additional text message intervention, while CG received usual care only.	LATCH (Lactation Advice Through Texting Can Help) had a significant influence on early interaction between participants and BFPCs, but no effect on EBF.	Many were lost on follow-up and self-reported BF. Not generalised to other population.
Seyyedi et al., 2021 (Urmia, Iran)	RCT. Subject: 102 participants (mother and infant pairs). 51 CG + 51 IG	To evaluate the impact of an educational IG based on a smartphone app for improving BF in newborns during their first 6-month of life in Urmia, Iran.	IG had a smartphone app (topic about breastfeeding and complementary feeding) + routine care. While CG had standard care. Duration: Three months	When compared to CG, the mothers' knowledge, attitude, practice, and overall KAP were considerably higher in IG ($p = 0.001$), ($p = 0.010$), ($p = 0.033$), and ($p = 0.001$), respectively. In comparison to CG, the mothers' breastfeeding self-efficacy increased dramatically in IG.	Android users only. Low sample size, which was only 30%, of the original sample size needed.
Ogaji et al., 2021 (Nigeria)	6-month prospective RCT. Subject: 75 mothers and infants pair	To determine if cell phone-based assistance improves EBF rates, duration, and infant growth trends in Nigeria.	IG received mobile phone-based advising support service from the paediatrician concerning BF on the 7th and 14th-day of the first month, and then once every 2–7 days until the infants were 6-month old.	EBF rates were higher in IG (55.2%) than CG (46.8%), but it was not significant. However, IG infants weighed an average of 0.49 kg in the 6th month (95% CI: 0.05, 0.94), which was higher and significant ($p = 0.03$). Significant differences were also observed in the length and weight for age z-scores of these infants ($p = 0.044$) and ($p = 0.022$), respectively.	Small sample size with selection bias.
Wu et al., 2020 (China)	2-arm RCT. Subject: A total of 344 (18-year-old and above, pregnant 11 to 37 weeks) (170 IG:170 CG)	To see the effectiveness of using WeChat application to improve breastfeeding practices of mothers who have children aged 0–5 months.	Women in both groups were asked to follow the Huzhu County Maternal and Child Health Family Planning Service Centre WeChat account on their smartphones. There was a special module named Ke Xue Wei Yang (optimal feeding) within the WeChat official account that could only be accessed by IG.	The study found improvements on EBF on early postpartum period only. The EBF rate at 0-1 month postpartum was significantly higher in the intervention group than that in the control group (81.1% vs 63.3%; odds ratio [OR] 2.75, 95% CI 1.58-4.78; P<.001). However, there was no statistically significant difference for EBF rate 2-3 months (P=0.09) and 4-5 months postpartum (P=0.27)	Several missing data due to the sudden COVID-19 outbreak. Cannot be blind since there are many groups that promote EBF on WeChat. May have been a contamination.
(Ward et al., 2020) (Bihar, India)	Survey-based (Subject: Women who were exposed to the Mobile Kunji and Dr. Anita mHealth tools)	To evaluate the impact of the Mobile Kunji tool. The analyses were done to three separate data sources: Mathematica's Ananya evaluation (2014) [49]; CARE India's Community-based Household Surveys (2012-2017) [50]; and BBC Media Action's own Usage & Engagement Study (2014).	Mobile Kunji was a tool developed using principles of human-centered design as an audiovisual job aid for frontline health worker (FLWs) to improve effective and timely delivery of key health messages during their conversations with individual families. The analyses were done between the women who exposed to the Mobile Kunji and women who did not exposed to the Mobile Kunji with behavior changes.	All of the data sets showed that exposure to the Mobile Kunji mHealth tool implemented by BBC Media Action was associated with significantly give impact to EBF. Mathematica survey were the most strict among the evaluations conducted, and the result shown that the odds of EBF were significantly higher (OR = 1.8, 95% CI = 1.3-2.7) in the exposed group.	All three evaluations were survey-based and relied upon self-reported exposure to the interventions

Table II: Impact of mHealth intervention to support breastfeeding (Continued)

Author, Year (Country)	Types of study	Objectives	Methods	Findings	Limitations
Lewkowitz et al., 2020, Washington, United States	The double-blinded randomised trial. Subject: 170 women	To determine whether a novel application BreastFeeding Friend (BFF) will increase breastfeeding rates for low-income first time mothers.	IG had a BFF app that contained an on-demand education video on breastfeeding and newborn behaviour. Whereas CG had an app that contained digital breastfeeding handouts behaviour.	EBF rates on postpartum in day two and BF until six months postpartum were low and similar for both groups (36.6% and 35.7%). Rates of EBF at six months were 8.3% and 10.4%. However, most IG who used the app rated their apps as providing the best breastfeeding support.	Might be a risk of the Hawthorne effect. Unable to track the duration of mothers on the app. Both apps showed breastfeeding content.
Lewkowitz et al., 2021, Washington, United States	A randomised control trial. Subject: 41 in IG and 46 in CG that have the intention to give EBF.	To see how a new smartphone app called BreastFeeding Friend (BFF) affects breastfeeding rates amongst low-income first-time mothers wanting to breastfeed exclusively.	IG had BFF apps that have access to an on-demand education videos on breastfeeding and newborn behaviour. Whereas, CG apps contained digital breastfeeding handouts behaviour.	Nonetheless, EBF rates were comparable on day two (48.7% [n = 19] in the BFF group versus 46.7% [n = 21] in the CG app). Relative risk [RR] = 1.04, (95% confidence interval, CI = 0.67–1.63) until six months after birth. They believed the app provided the best care after six weeks, although they still preferred healthcare professionals.	Hawthorne effect. Unable to track the duration of mothers on the app. Both apps showed breastfeeding content.
Akber, S. et al., 2019according to the National Nutrition Survey (2011 (Islamabad, Pakistan)	A quasi- experimental study. Subject: 135 pregnant and lactating mothers.	To assess the effectiveness of mobile health (mHealth) with regard to an infant and a young child feeding (IYCF) amongst pregnant and lactating women.	Pregnant and lactating women, who have been recruited as well as their mothers in-laws and husbands, received biweekly voice and text messages on proper IYCF practices from LHWs (Lady Health Workers).	Knowledge of 34 pregnant mothers regarding IYCF decreased from 75.6% to 46.7% after the mHealth intervention. However, the overall attitude and practice regarding IYCF before and after intervention were positive. Attitude (43.7% to 63.7%) Practice (16.3% to 65.2%). Practices regarding EBF were 0.0% prior to the intervention (before giving birth) and were significantly raised to 66.7% among these mothers after the intervention.	Data collection through telephonic interviews and quasi-experimental designs might introduce bias.
Jerin et al., 2020 (Savar, Bangladesh)	A quasi- experimental study. Subject: 129 mothers (pre-intervention), 164 mothers (intervention phase).	To determine whether breastfeeding support after hospital delivery via mobile phone at home is effective in enhancing EBF in infants under 6-month of age.	IG received postpartum support for the first hour of breastfeeding, position and attachment correction, and 48-hour of face-to-face counselling in the hospital, followed by mobile phone support once every 15 days after discharge up to 6-month of age from two trained Research Assistants. The pre-intervention phase was treated as usual.	The EBF rates were 58% in the pre-intervention group, while 78% in intervention group (p < 0.001). The rates of EBF remained high in IG from 89% in less than one month to 71% at 5-month of age.	Not randomly selected. Could not determine which intervention was effective. Could have response bias.
Farr et al., 2019 (Cleveland, Ohio)	A longitudinal survey study. Subject: 243 received the champion intervention, and 132 received the positive messaging intervention.	To evaluate: (i) the intervention effect on EBF intention; (ii) the acceptability and satisfaction of the apps; and (iii) the follow-up rates of in-hospital EBF for two iPad-based breastfeeding programmes for expecting minority women.	The champion intervention used one module from a free downloadable application (coeffective) that helped mothers to identify a supportive breastfeeding champion, while the positive message intervention delivered breastfeeding information with picture assistance.	There was a statistically significant difference in the proportion of mothers who chose EBF prenatally (intent) and postpartum (actually in-hospital EBF) for each intervention separately.	There was no control group, the sample size was limited, the follow-up time was brief, and no information on the duration of BF, or exclusivity outside of the hospital stay.
Adam et al., 2021 (Western Cape Province, South Africa)	Stratified, cluster-RCT. Subject: 1,502 women (aged 18+ years) and 84 mothers' mentors.	To assess the impact of the Philani Mobile Video Intervention for EBF (MOVIE), an animated mobile video series provided by a cadre of Community Health Workers (CHWs) ("mentor mothers").	The Philani MOVIE intervention in IG consisted of 13 short (2 to 5 minutes) educational videos in English and isiXhosa with standard care. CG received standard care only.	In terms of EBF rates and other infant feeding habits, there was no statistically significant difference between the video intervention and control arms. However, IG knowledge increased significantly.	At five months, there was a significant loss on follow-up.
Modi et al., 2019 (Gujarat, India)	A cluster RCT. Subject: 11 PHC randomly allocated (280 ASHAs, population: 234,134) and CG (281 ASHAs, population: 242,809)	To evaluate the impact of a mobile phone and web-based apps, Innovative Mobile-Phone Tech for Community Health Operations (ImTeCHO) PHW (Public Health Worker).	IG was given the ImTeCHO mobile phone and web-based programme, which offered several technology-based job aids to help with the PHC. CG received the usual care.	There were also improvements in early initiation of breastfeeding (adjusted effect size 7.8 [95% CI: 4.2, 11.4], p < 0.001), and EBF (adjusted effect size 13.4 [95% CI: 8.9, 17.9], p < 0.001) in IG compared to CG.	Potential risk of inaccuracies in reporting and the intervention was only 12-month long, which may be regarded as insufficient.

Table II: Impact of mHealth intervention to support breastfeeding (Continued)

Author, Year (Country)	Types of study	Objectives	Methods	Findings	Limitations
Unger et al., 2018 (Nairobi, Kenya)	3-arm unblended individually RCT. Subject: 300 women (100 each per 3 groups)	The purpose of this study was to see how short message service (SMS) communication affected facility delivery, EBF, and contraceptive use.	Weekly educational and motivational SMS were sent to IG. A nurse sent a two-way SMS to another IG (reply daily on weekdays). CG only received standard care.	Both IG had higher rates of EBF from 10 to 16 weeks (sig: $p < 0.05$). The probability of EBF of 24 weeks was higher in both group interventions than in CG, but only statistical significantly in the two-way messaging group ($p < 0.05$)	Free maternity care increased the facility delivery. Women are not blinded. Performance and self-report biases.
Patel et al., 2018 (Nagpur, India)	2-arm, hospital-based pilot study. Subject: 1,036 pregnant women (519: IG and 518: CG).	To evaluate the effectiveness of mobile phones for providing lactation consultation to improve breastfeeding practices.	CG received standard healthcare services, whereas IG received weekly and daily SMS messages in addition to standard healthcare services.	In IG, rates of timely BF initiation were considerably higher than in CG (37% vs 24% $p = 0.001$). At 24-hour after delivery, the rates of EBF were similar in both groups, but significantly higher in the intervention at all subsequent visits (CG vs IG: 24 h: 74% vs 74%, $p = 1.0$; 6 wk: 81% vs 97%, 10 wk: 78% vs 98%, 14 wk: 71% vs 96%, 6 mos: 49% vs 97%, $p < 0.001$ for the last four visits), and 92.3% satisfied.	An un-blinded pretest study of only four clusters.
Maslowsky et al., 2016 (Quito, Ecuador)	A present prospective evaluation. Subject: Inpatient mothers after delivery 102 IG: 76 CG	To assess the impact of mobile phone-based interventions on maternal postnatal health behaviour and maternal and infant health in middle-income countries.	Mothers in the CG group received standard care, whereas those in the IG group received a two-part intervention. The first half was an instructional session conducted by the nurse over the phone within 48-hour after hospital discharge, and the second part was access to call the nurse on-call during the first 30 days of the infant's life to ask questions regarding newborn care in addition to standard care.	Only three patients called the nurse for additional advice after the 48-hour post-discharge education session. At 3-month follow-up IG reported higher rates of breastfeeding: 65 (86.7%) were EBF compared to 40 (66.7%) CG and it was significant ($p = 0.005$), and low probability to feed formula ($p = 0.016$).	Small sample size. The follow-up was self-reported.
Palacios et al., 2018 (Puerto Rico and Hawaii, United States)	Multi-site RCT. Subject: 170 caregivers, 84 IG: 86 CG	To evaluate the effects of weekly SMS on infants feeding practices and weight.	CG received text messages for four months about common baby health problems, and IG received text messages to improve child feeding practices. A total of 18 SMS was automatically sent via web-based SMS messaging. Both groups received standard care.	Feeding practices, weight status/weight changes and EBF rates did not differ between groups at the end of the study. However, the EBF rates were higher in IG compared to CG.	Short duration (four months).
Prieto et al., 2017 (Rural Guatemala, Central America)	Mixed-methods, 2-phase study. Subject: 23-week intervention with 100 mothers.	To create a descriptive model of mHealth structural characteristics in the context of infant nutrition, and to examine the effects of illustrative interventions using a mixed-methods study that included an impact evaluation and a qualitative assessment.	**Group 1:** text messages (2x/week) on the provided cell phone about infant feeding. **Group 2:** assigned in one of three peer-to-peer groups (10 per group). Can communicate and share information. **Group 3:** They received the same material as Group 2 plus information on breastfeeding practices (as in Group 1) and could communicate with a health professional. **Group 4:** Control. They were given a cell phone and instructed to use it for things concerning their children.	Changes in knowledge were significantly different in all groups ($p < 0.001$). In terms of increasing knowledge, this is the most effective intervention (1>3>4>2). Individuals in Group 1 and 95% in Group 3 were aware of the EBF messages and the scores were lower in Group 2 and Group 4. Moreover, 89% reported exclusively breastfeeding at the end of the study in groups who learnt about EBF. A significant association ($P = 0.010$) between changes in knowledge and changes in self-reported behaviour was found.	A pilot study is required to be conducted to further investigate the effectiveness.
Wheaton et al., 2018 (Southwest Victoria, Australia)	Prospective longitudinal self-report survey design. Subject: 50 women who want to breastfeed.	To explore the usefulness of the application in breastfeeding women in rural Australia. (b) To describe participants' infant feeding outcomes compared to the general population.	The participants downloaded the Breastfeeding Solutions app (Mohrbacher, 2014) to their mobile phones and were instructed to use the app as needed. The 3- and 6-month follow-ups were done via link (survey online).	Two-thirds of the 46 participants completed the surveys at three and six months. At six months, 96.8% rated the apps were favourable and 79% of the participants were still breastfeeding.	No control group. Over-representation of women who already want to breastfeed.

Table II: Impact of mHealth intervention to support breastfeeding (Continued)

Author, Year (Country)	Types of study	Objectives	Methods	Findings	Limitations
Sari and Altay, 2020 (Turkey)	RCT with a post-test design. Subject: 71 primiparous women-infants pair (IG: 35; CG: 36).	To assess the impact of a web-based programme given to primiparous women on the growth and development of infants, infants' health, and the women's self-efficacy level.	The study had four stages: (a) developing educational content for the web-based education programme; (b) designing and testing the web-based education programme; (c) delivering the web-based education programme to primiparous women; and (d) assessing the results.	The percentage of IG who EBF (80.6% during 1st week, 88.6% in the 3rd month and higher compared to the CG (27.8% in the 1st week, 33.3% in the 3rd month). The mean scores Parental Self-Efficacy Scale, were significantly higher in IG, a contrast to CG ($p < 0.05$). In the 3rd month, the bodyweight z-score average (-0.36 ± 0.724) for CG infants was significantly lower ($p = 0.001$) than IG (0.07 ± 0.587).	Self-reports. Not double-blind.
Uscher-Pines et al., 2020 (Pennsylvania, United States)	Single-site, RCT with parallel groups. Subject: Recruited 203 women, IG (n=102) and CG (n=101).	To assess the feasibility and effectiveness of telelactation via personal electronic devices on breastfeeding duration and exclusivity amongst rural women.	The telelactation arm (IG) provided an introduction to Pacify Health's telelactation programme ('app'), which allowed them to make limitless, on-demand video conversations for as long as they wanted. CG received the usual care.	In all follow-ups, the telelactation group EBF was higher than control, but not significant. At 12 weeks, 51% of participants in the telelactation arm were EBF vs 46% of CG participants.	Not generalisable to other population. Short study time.
Scott et al., 2021 (Perth, Australia)	4-arm, factorial, RCT. Subject: 1,426 couples.	To assess the effectiveness of various father-focused BF interventions in terms of key infant feeding outcomes.	CG and three IGs, consisting of a face-to-face father-focused antenatal breastfeeding class guided by a male peer facilitator; Milk Man, a breastfeeding smartphone app designed exclusively for fathers; and a combination of both interventions.	Between CG and IG, there were no significant differences in infant feeding results included EBF, nursing self-efficacy, or postpartum partner support reported by mothers.	Self-selected and could not be generalised.

children at the end of the intervention. Similarly, a quasi-experimental study by Akber et al. (2019) also found the same result. There was a steady finding in terms of the knowledge of mothers regarding the understanding about EBF where the percentage of mothers giving the correct response towards the question were 80.2% during the pre-intervention and 79.3% during the post intervention (32). Furthermore, practice regarding EBF was 0.0% prior to the intervention (before giving birth) and was significantly raised to 66.7% among these mothers after the intervention. In this study, they combined text messages with voice messages to be given biweekly to the pregnant and lactating women for 6 months.

Mobile phone call

Based on the results, five studies used mobile phone call interventions in supporting the mothers to EBF. Three articles found significant differences in EBF rates between IG and CG. All of these articles found the rates of EBF were still high at three months (p = 0.005), five months (p < or = 0.001), and six months (p < or = 0.0001), respectively, in IG compared to CG (17,24,39). On the other hand, the mobile phone call intervention was not a stand-alone intervention. It was accompanied by other traditional interventions, such as face-to-face dietary counselling and physical education materials, which were provided before the participants received a weekly phone call. Moreover, other study that combined mobile phone calls with daily text messages also found a significant difference in rates of mothers that still continued EBF in IG and CG after each subsequent follow-up from the first week until six months (control vs. intervention: 24 hours: 74% vs 74%, p = 1.0; 6 weeks.:

81% vs 97%, 10 weeks.: 78% vs 98%, 14 weeks.: 71% vs 96%, 6 months: 49% vs 97%, p < 0.001 for the last 4 visits) (23). Contradictively, one study that used the mobile phone call as a stand-alone intervention did not find a statistically significant difference mean between IG and CG at 6 months of child's age in terms of EBF rate even though the IG showed a slow decline in the practice of EBF. However, the child's weight gain was statistically different after the 6-month intervention and the children in IG (μ=4.68) had a higher weight gain than in the CG (μ=4.27) (p = 0.044) (34).

Mobile phone application

Moreover, most of the mobile phone interventions that were used in this review were through the mobile phone application (n = 9). Two articles found a significant results in which higher EBF rates was found (adjusted effect size of 13.4 (95% CI: 8.9, 17.9), p < 0.001) in IG compared with CG (21) and the significantly higher odds of EBF (OR = 1.8, 95% CI = 1.3-2.7) was found in the group that was exposed to the Mhealth tools (36). Both of these applications were used to assist the healthcare workers in their jobs to properly schedule home visits and most of the teaching materials were available in this application. Another study found improvements on EBF rate on early postpartum period only. The EBF rate at 0-1 month postpartum was significantly higher in the intervention group than that in the control group (81.1% vs 63.3%; odds ratio [OR] 2.75, 95% CI 1.58-4.78; P<.001). However, there was no statistically significant difference for EBF rate 2-3 months (P=0.09) and 4-5 months postpartum (P=0.27)(35). Last but not least, longitudinal study by Farr et. al. 2019 found that

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an Ipad-based breastfeeding interventions (Champion intervention and positive messaging intervention) had a positive impact towards EBF. There was a statistically significant difference in the proportion of mothers who chose EBF prenatally (intent) and postpartum (actually in-hospital EBF) for each intervention separately (P<0.0001, P<0.0001).

Others

Last but not least, there were four articles that used other methods of mHealth intervention, such as video messaging, and video education through phone and web pages(18,20,28,40). Two articles found that the mHealth strategies had a positive impact towards EBF. In one article, The IG had greater EBF rates at 1 month, 2 months, and 3 months (63%, 63%, and 55%, respectively) compared with the control group (40%, 19%, and 19%, respectively) and it was significant (18). Other study found that the number of EBF infants in the IG (80.6% in the first postnatal week, 88.6% in the third postnatal month) were significantly higher compared to the control group (27.8% in the first postnatal week, 33.3% in the third postnatal month) (28).

Most of the mHealth interventions that showed significant results were the mobile phones that were combined with traditional methods, mobile phone calls with daily text messages, text message interventions only and mobile applications. There were mostly from the mHealth tools that provide the two way communication between the mothers and the healthcare professional.

DISCUSSION

In this scoping review we summarized the impact of mHealth intervention to support exclusive breastfeeding. Text message, mobile phone call, and mobile phone application were the most commonly used as the mHealth tools in the current study. The intervention to support EBF appear most successful when the mHealth tools were combined with the traditional method or other mHealth tools and when it provided a two-way communication between the mothers and the healthcare professional.

About 60% of the mHealth interventions included in this review showed positive results. The interventions were effective in supporting EBF amongst mothers. Three articles that used text messages only as the medium to deliver education about breastfeeding were able to have the higher and longer rates of EBF amongst mothers. One of them also allowed a two way messaging between the mothers and healthcare practitioner (22). The interventions were done during the important period for establishing and sustaining EBF which was during the pregnancy and first 6 month postpartum. It was found that periodic prompts and reminders, especially using theory-based content, were able to encourage and strengthen good behaviour (41–43). Furthermore,

support tools that can provide reassurance and opportunity to respond to questions may also increase duration of the EBF. They would felt their voice was being heard and they could use the mobile phone as an aid tools when they find the difficulties or problems during the EBF when their husbands were not around or clinics were closed (22,26).

Other than that, four articles that used the mobile phone call as the intervention also showed positive results. However, most of these interventions were combined with traditional methods. Therefore, it could not be concluded which method significantly contributed to the positive result of the intervention. Nonetheless, evidence from other review studies suggested that mobile phone calls that provided useful and trusted information, assisted in problem-solving and provided social support that was effective in changing the behaviour of parents in feeding infants and young children (44). Next, in this review also found that if mother was not provided immediate assistance within few days, she was likely to switch to inappropriate feeding practices (23). Thus, proper planning and implementation of the mobile phone call as mHealth strategies should be done to avoid any delay and disturbance during the process.

Besides, four mobile phone applications were found to be effective in supporting mothers to EBF. A mobile phone applications were able to aid the health care worker and hospital staff to provide a systematic deliverance of nutrition education and information. Other than that, the key benefit of these mobile phone applications included the capacity to successfully enable two-way communication between mothers and health consultants, allowing them to ask questions and increase their knowledge (18). Moreover, mobile phone application as one of the mHealth strategies was found to be able to increase the coverage of the mother and child health service especially in hard-to-reach populations (21).

Furthermore, it was found that combining weekly phone calls with daily text messages and traditional method such as face to face counselling before the discharge from hospital was effective to support the EBF of mothers. The initial EBF rate was similar for both groups during the first 24-hour after delivery, however the number of mothers who continued practising EBF with their infants after subsequent visits until six months remained high and significant in IG only. This could provide a new insight, whereby combining the methods for mHealth intervention may be more effective than using only one method. Therefore, more research can be conducted to further evaluate these promising interventions.

Next, one third (40%) of the articles that have been reviewed showed that mHealth intervention was not significant and did not show the positive impact of supporting EBF amongst the mothers. It mostly came

from the intervention that used the mobile phone application as the intervention (n = 5), a text message (n=2), a video (n=1), a phone call (n=1) and voice messaging (n=1). The reason for this could be due to a limitation in these studies, in which the majority of study samples were lost to follow-up, and thus may have affected the result of the study. Besides that, the mHealth application intervention was mostly unsuccessful in getting a positive result. It was similar to a study, which found that most of the quality of smartphone applications on infant feeding and activity was moderate in terms of engagement and functionality, whereas low in terms of information from trusted sources and low coverage of topics (45). Therefore, mobile phone applications should be checked for quality, validated, and pre-tested to know the feasibility and acceptability of the apps to generate good results.

This review assesses the impact of mHealth interventions when compared with the control group, or when compared during pre and post-intervention. Consequently, it is crucial to note that this review did not assess how much the effectiveness of these interventions affected the mother and child's health, and how they can be a protective factor for the mother and child. A cost-effectiveness analysis was also not conducted as this was a scoping review. Although an intervention may be effective, it may be difficult to implement on a broad scale if the cost per child is quite expensive. Other limitations of the study is although we conducted the extensive search for the scoping review but some of the eligible study may have been missed due to the programming domain. Searching for the mHealth intervention were challenging due to the wide dispersal of the pertinent articles scattered throughout the published and grey literature. As the mHealth intervention is still new to the research field, some of them still in the ongoing intervention process and only the protocol study being published and were excluded. Moreover, this review was conducted to specifically review the mHealth intervention to support EBF, which is one of the components of feeding infants and young children. Nevertheless, mHealth intervention itself is a broad topic. Therefore, it is suggested to give a more specific review of each mHealth intervention using this current data. It is hoped that it will have a greater impact on supporting exclusive breastfeeding. It is also recommended for future studies to conduct a cost analysis to evaluate the effectiveness of this programme.

CONCLUSION

In conclusion, this review found that 60% of studies that used mobile phone interventions were able to find significant results on how the mHealth interventions give positive impact towards EBF. The main reason could be from the constant and prompt reminders and two way communication between mother and healthcare practitioner, which were able to affect the mother's

decision to exclusively breastfeed their children. The decision also could be made upon without having the need go for hospital visits and face to face counselling. It is also relevant in the current situation whereby the use of cell phones in every households is nearly universal. This review also provide insight that combining the methods for mHealth intervention may be more effective than using only one method. Therefore, more research can be conducted to further evaluate these promising interventions. Last but not least, a further review should be conducted on the cost-effectiveness of this programme compared to the traditional method to make mHealth intervention superior to other intervention methods.

ACKNOWLEDGEMENTS

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