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Effectiveness of E-Health Interventions on Breastfeeding Outcomes: A Scoping Review

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ABSTRACT

Background & aim: Protecting, promoting, and supporting breastfeeding is recognized as one of the public health priorities. Electronic health (e-health) interventions have become a widespread and accessible strategy to support breastfeeding. Accordingly, this study aimed to investigate the effectiveness of e-health interventions on breastfeeding outcomes.

Methods: A scoping review of English and Persian articles was conducted via PRISMA for scoping reviews (PRISMA-ScR) checklist by searching English electronic databases including Scopus, PubMed, Web of Science, Cochrane, and Persian databases of SID and Magiran as well as Google Scholar search engine from January 2000 up to February 2025 using electronic technology, mobile technology, cell phones, mobile health, short messaging service, web-based interventions and breastfeeding as keywords. The data were narratively summarized based on the type of e-health interventions.

Results: Out of 423 retrieved articles, 29 studies were eligible, which were grouped into four categories: mobile phone applications (n =12), telephone counseling (n=9), text message (n =4), and web-based education (n=4). Regarding e-health effectiveness on breastfeeding outcomes, findings were inconsistent; as 20 studies reported positive influence of e-health on breastfeeding outcomes including early initiation of breastfeeding, breastfeeding rates, breastfeeding duration, exclusive breastfeeding, maintenance of breastfeeding, breastfeeding self-efficacy, mother's knowledge, attitude and practice towards breastfeeding as well as feasibility of information and communication technologies; whereas nine other studies did not reported any effect on these outcomes.

Conclusion: Given the inconsistent findings about effectiveness of e-health on breastfeeding outcomes, additional research utilizing more robust methodological frameworks are essential to investigate the value of these technologies.

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Introduction

Breastfeeding is considered a key public health policy because of its proven short- and long-term health benefits for both mothers and their infants (1). In recognition of these benefits, both international and regional health organizations actively advocate for initiation and sustained practice of breastfeeding (2).

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The American Academy of Pediatrics (AAP) identifies breast milk as the most appropriate source of nutrition for newborns and healthy infants, while the World Health Organization (WHO) recommends EBF for the first six months of life. However, despite these recommendations, EBF rates remain consistently low (3). EBF rates during the first six months of life have been reported as 36% in the Eastern Mediterranean region, 16% in the United States, 10% in Australia, and 28% in Iran (4). In response to these relatively low figures, the World Health Assembly set a global target in 2012 to increase EBF rates to at least 50% by the year 2025 (5). A range of factors influence both the initiation and continuation of breastfeeding, including medical and psychological elements, environmental conditions such as family and peer support, workplace policies, and healthcare system dynamics, as well as broader sociocultural norms and economic conditions, and the availability of social support (6).

Education and counseling are essential forms of support for breastfeeding mothers, which can be significantly enhanced through information and communication technologies (ICT) (4). E-health refers to healthcare services facilitated by digital ICT processes (7). The primary goals of integrating ICT into healthcare systems include improving the quality and accessibility of medical care, expanding access to health information, services, and skills, and fostering positive health behavior changes. These technologies are designed not only to prevent breastfeeding difficulties but also to promote better adherence to breastfeeding practices and improve overall breastfeeding outcomes (8). Mobile applications represent one of the fastest-growing sectors of ICT in healthcare. The high number of app downloads demonstrates their expanding importance as a valuable resource for accessing medical information and support, serving as a complement to usual breastfeeding assistance methods (9). Additionally, Short Message Service (SMS) interventions have proven effective in enhancing overall health outcomes through educational messaging (10).

Web-based education is another form of e-health intervention that offers continuous informational support at convenient times and locations (11). Although numerous studies have examined the impact of e-health strategies on breastfeeding outcomes, their findings have been varied and sometimes contradictory (12-21). To the best of our knowledge, no comprehensive scoping reviews have specifically investigated the existing gaps regarding the effectiveness of e-health interventions on breastfeeding outcomes The available reviews were often systematic (22-24), focused on specific study design (22), English language (22-24), or a limited number of e-health interventions (22-24), and the included studies were all published before 2018 (22-24) In addition they did not focus on breastfeeding outcomes (22-24). Therefore, this scoping review aimed to provide an extensive summary of existing evidence to highlight research gaps related to the e-health interventions to improve breastfeeding outcomes.

Methods

We selected scoping review because our study aimed to map the key concepts as well as clarify working definition and conceptual boundaries about effectiveness of e-health interventions on breastfeeding outcomes. Also, we aimed to explore the literature, summarize the evidence and inform the future research. This scoping review followed the PRISMA for scoping reviews (PRISMA-ScR) checklist (25). The framework for conducting scoping reviews included: 1. Identifying the research question 2. Categorizing relevant studies 3. Selecting eligible studies 4. Charting the data and 5. Summarizing and reporting the results (25). We included the following databases and search engine: English electronic databases of Scopus, PubMed, Web of Science, Cochrane; Persian electronic databases of SID, Magiran and Google Scholar search engine. These databases and search engine were employed to search for, identify, and select relevant peer-reviewed articles through a search strategy and specific keywords.

Search strategy and keywords used in this scoping review consist of Information and communication technologies OR ICT OR e-health OR electronic health OR mobile technology OR digital technologies OR mobile devices OR cell phones OR smart phones OR tablets OR m-health OR mobile health OR mobile app OR mobile application OR digital health OR short messaging service OR SMS OR web-based OR Internet -based AND Breastfeeding OR Breastfeeding Outcomes AND Intervention OR strategies OR program OR trials

The inclusion criteria comprised peer-reviewed qualitative and quantitative articles focused on breastfeeding, specifically examining its initiation, duration, rate, EBF, as well as maintenance as a consequence. Full-text articles published in English or Persian language. The search covered publications from the year 2000 to February 2025.

Exclusion criteria included commentaries, editorials, books, grey literature reports, and non-peer-reviewed conference abstracts and proceedings.

Breastfeeding outcomes included primary and secondary outcomes. Primary outcomes included early initiation of breastfeeding, breastfeeding rates, breastfeeding duration, EBF for the first six months of life, and maintenance of breastfeeding for two years. Secondary outcomes consisted of mothers' KAP as well as feasibility and acceptability of ICT.

To do the screening procedure a team of five reviewers (NM, NSh, FB, FM, and HPF) conducted the search and selection processes. NM and HPF developed the search strategy. The initial round of literature searches yielded a total of 423 titles. After removing duplicates, 83 articles were screened, and 49 records were excluded by initial screening of titles (not related to breastfeeding=11, theses=21, languages other than English or Persian=14, pilot studies=1, and congress abstracts or proceedings=2). The abstracts of the remaining 34 articles were reviewed for potential inclusion, and five studies were excluded due to irrelevant outcomes. Finally, 29 articles met the criteria. The PRISMA flowchart (2020) is shown in Figure 1 (23).

Data extraction from the included studies was independently performed by FB and FM using a predefined checklist, consisting of: first author, year of publication, location, objectives, design, sample size, methods, follow up duration, and findings values for both intervention group (IG) and control group (CG) differences from the baseline (Table 1). In case of disparities, these were resolved by discussion with a third researcher (NM).

For data synthesis, the numerical and thematic extracted data from relevant studies were analyzed by all authors independently, and a brief description of each study findings for every intervention mode was provided both in the text and table form to showcase the most salient aspects of the review, and finally a summary of the findings was written for each mode.

Results

Out of the 423 full-text articles that were evaluated, just 29 articles met the inclusion criteria.

Characteristics of the included studies:

Overall, the mode of intervention varied across studies. Twelve studies utilized mobile phone applications (9, 11-21), nine studies employed telephone counseling (22-30), four studies used text messaging (10, 31-33), and four studies implemented web-based education (34-37).

Most studies (n =20, 68.9%) used the randomized controlled trial (RCT) study design. Quasi-experimental studies (n = 2), longitudinal study design (n = 2), mixed-method study (n = 2), thematic analysis (n = 1), survey study (n = 1), and a case report (n = 1) were among these 29 articles (9-37).

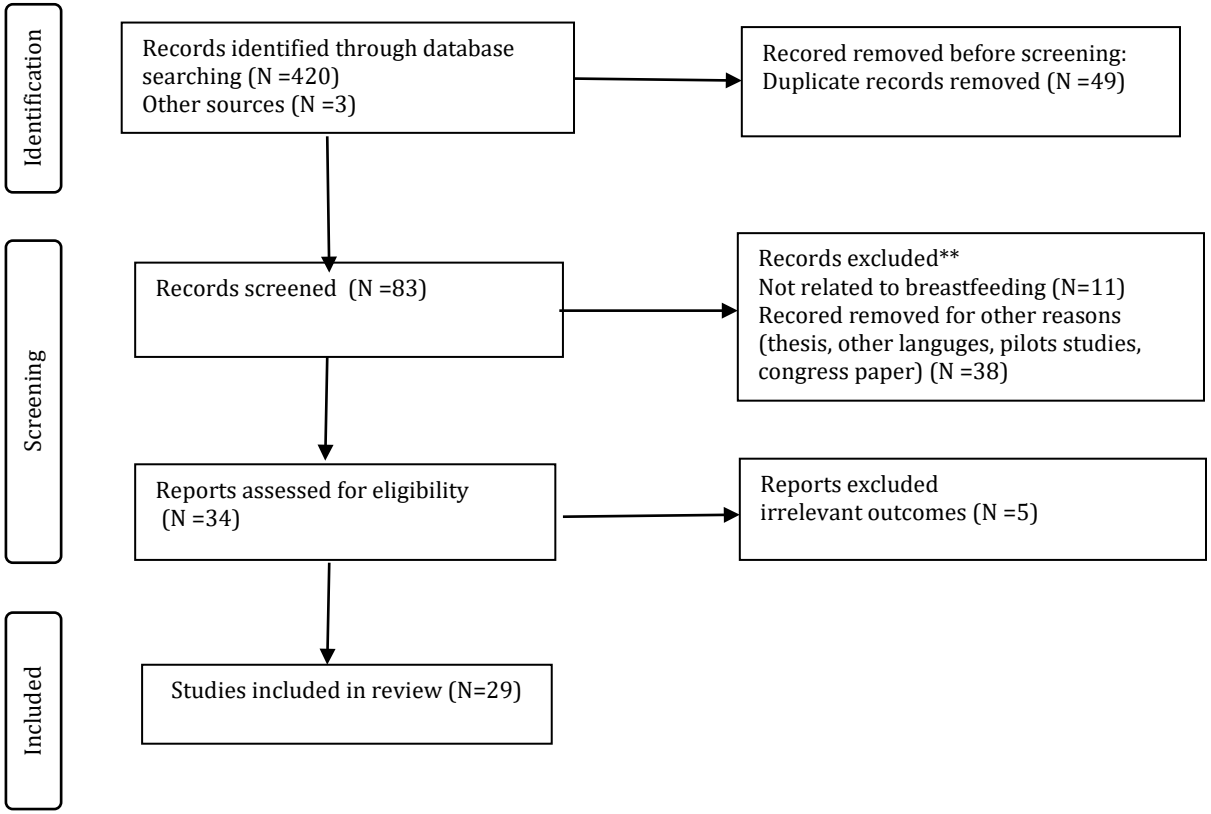

Figure 1. . PRISMA 2020 flowchart illustrating the process of selecting eligible studies

Table 1. Summarizes the publications examined in this review

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Vila-Candel et al, 2024, Spain (9)	RCT	To assess effects of a mobile application (lactapp) compared with standard care on BF rate	270	IG received free access to the mobile application, which provides personalized and convenient support about BF. CG received standard care, which included individual counselling.	During 15 days, 6 weeks, 3 months, and 6 months of postpartum.	Higher BF abandonment at 15 days in the CG vs IG (p = 0.105). LactApp usage did not increase the 6-month postpartum BF rate compared with standard care (CG = 41.6% vs. IG = 43.6 %; p = 0.826).
Mena-Tudela et al, 2023, Spain (26)	RCT	To determine the influence of a free mobile application (LactApp) in maintaining breastfeeding	333	Free mobile application for IG and usual care for CG	During 15 days, at 3 and 6 months of postpartum	LactApp mobile application improved the maintenance of BF at 6 months postpartum versus usual clinical practice.
Doan et al, 2022, Vietnam (16)	RCT	To evaluate the effect of a mobile application on breastfeeding outcomes	568	The mobile application with two separate versions, one for IG, which generated three messages per week and linked with the information in the application's library content to improve breastfeeding practices. and one for CG which sent messages on related general maternal and child health care.	During 3 months, and 6 months of postpartum.	Results support the use of mobile phone application to improve breastfeeding outcomes among mothers who have cesarean sections.
Macchi et al, 2022, Hawaii (10)	RCT	To test the effect of a message (SMS) intervention for improving BF practices	202	Web-based SMS messaging platform about breastfeeding for IG and CG received messages focused on general infant health issues	During 4 months of postpartum	Intervention led to higher intakes of some key nutrients but did not have an overall improvement in the intake of food groups or breastfeeding rates.

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Miremberg et al, 2022, Israel (27)	RCT	To investigate the impact of a smartphone-based counseling on lactation rates and various maternal and neonatal outcomes	197	Daily detailed counseling and feedback on lactation from the team via the application for IG routine lactation counseling and support for CG.	During 6 weeks and 3 months after delivery.	The IG showed higher rates of lactation 6 weeks (96.9% vs 82.0%; P<.001) and 3 months after delivery (81.4% vs 69.0%; P=.049) than the CG.
Griffin et al, 2021, US (17)	RCT	To assess the impact of breastfeeding smartphone applications on breastfeeding rates for low-income women	169	The BFF app for IG was a novel smartphone device App for CG contained digital versions of breastfeeding handouts	During 6 weeks, 3 and 6 months of postpartum	Usage of breastfeeding apps did not improve breastfeeding rates among low-income women.
Farhadi et al, 2021, Iran (28)	Case Report	To assess the efficacy of Smartphone application (WhatsApp) on milk supply, mother-infant bonding and support breastfeeding.	3 cases	Virtual bonding with smartphone application (WhatsApp) for 20 days	In isolation period due to COVID-19 for 20 days	This technology-assisted tele lactation enhanced the mother's capacity to initiate emotional bonding with the infant and was an Adjunct in achieving and maintaining her lactation goals.
Seyyedi et al., 2021 Iran (29)	RCT	To evaluate the impact of an educational program via smartphone app for improving BF in newborns	102	IG had a smartphone app + routine care While CG had standard care	During 6-months at postpartum	Mothers' KAP were considerably higher in IG. Mothers' breastfeeding self-efficacy increased dramatically in IG.

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Adam et al, 2021, South Africa (14)	RCT	To measure the efficacy of a mobile video BF Intervention (Philani MOVIE) for Exclusive breastfeeding	1502	Mobile video breastfeeding counseling for IG and standard care for CG	During 5 months of postpartum	Mobile video BF Intervention were as effective as face to face counselling also could be a feasible and practical solution, for supporting BF.
Scott et al, 2021, Australia (20)	RCT	To determine the effectiveness of various father-focused breastfeeding interventions in terms of key infant feeding outcomes	1426 couples	Milk Man, a breastfeeding smartphone app for IG and CG received the usual care	During 26 weeks during postpartum	There were no significant differences between the CG and IG in any of the infant feeding outcomes or level of breastfeeding self-efficacy and postpartum partner support.
Abbass-Dick et al, 2020, Canada (12)	RCT	To assess the efficacy of eHealth resource on breastfeeding rates	113	An online & web based breastfeeding program (including text, video, games, quizzes, and links to additional resources on the internet) for IG and available resources for CG	During 2, 4, 12, 26, 52 weeks, of postpartum	Breastfeeding rates were high in both groups and not statistically significantly different.
Sari&Altay, 2020, Turkey (11)	RCT	To evaluate the effect of a web-based education program on the women' self-efficacy level	88	IG signed in to web based program and CG received routine care	In first week and first, second, and third months of postpartum	In IG, the ratio of exclusive breastfeeding was higher compared to the CG. Self-Efficacy score, were significantly higher in the IG compared to CG ($p < .05$).
Jerin, et al, 2020, Bangladesh (30)	A quasi-experimental study	To find out efficacy of breastfeeding support by mobile phone in improving EBF	129	Support by mobile phone counseling for IG	Every 15 days after discharge up to six months of postpartum	IG had higher rates of EBF. There were no statistically significant differences in nutritional status of infants, and child morbidity in two phases.

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Akber et al, 2020, Pakistan (21)	A quasi-experimental study	To compare the pre and post m-health intervention related KAP of pregnant and lactating mothers regarding IYCF.	135	Android based mobile application for IG	During 6 months of postpartum	M-health intervention raising knowledge, attitude, and practices of mothers regarding IYCF.
Ogaji et al, 2020, Nigeria (31)	RCT	To examine the role of mobile phone-based support on EBR rates and improvement	150	A mobile phone-based advisory support service for IG and usual care for CG	During 6 months of postpartum	Mobile phone-based intervention has positive effects on the growth of infants but no on the rate and duration of EBF.
Wu et al, 2020, China (32)	RCT	To assess the effectiveness of using WeChat to improve breastfeeding practices	344	IG received WeChat breastfeeding education and CG received routine antenatal and postnatal care	During 6 months of postpartum	WeChat breastfeeding education be an effective method of promoting EBF in early life.
Ward et al, 2020, India (33)	Survey	To evaluates the impact of an mHealth on reproductive, maternal, newborn and child health	2741	Mobile *Kunji* tool	During 6 months of postpartum	Significant improvements in reproductive, maternal, newborn and child health related knowledge and behaviors were observed.
Lewkowitz et al, 2020, U.S (18)	RCT	To determine efficacy of a novel smartphone application (*Breastfeeding Friend*) on breastfeeding rate	253	IG received a complimentary Android smartphone and internet service and CG routine care	During 6 months of postpartum	Smartphone application did not improve breastfeeding rates among low-income, first-time mothers.

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Uscher-Pines et al, 2020, U.S (34)	RCT	To evaluate the feasibility and impact of Telelactation via personal electronic devices on breastfeeding duration and EBF	203	IG received Telelactation and CG usual care	During 12 weeks of postpartum	This trial was not detect significant differences in breastfeeding duration and EBF.
Modi et al, 2019, India (35)	RCT	To evaluate the effectiveness of ImTeCHO application, through smart phones in rural areas	22	Mobile-phone-technology–based aid for IG and usual health services for CG	For 12 months	ImTeCHO mobile and web-based application improved coverage and quality of MNCH services in hard-to-reach areas.
Farr et al, 2019, Ohio (36)	Longitudinal survey study	To test efficacy of iPad-based breastfeeding intervention on exclusive breastfeeding	243	A free downloadable app (Coffective) for IG	During 6 months of postpartum	A significant change in the proportion of women who intended EBF was noted.
Unger et al, 2019, Kenya (37)	RCT	To assess the effect of SMS communication on exclusive breastfeeding	300	IG received the Mobile WACh SMS delivery platform and CG received routine clinic-based counselling and care	During 24 weeks of postpartum	SMS improved EBF practices.
Demirci et al, 2018, Pennsylvania (38)	Thematic analysis	To describes the feasibility and acceptability of tele lactation services for rural mothers.	21	Tele lactation services through mobile applications	During 4–6 weeks of postpartum	Tele-lactation was an acceptable delivery model for rural women and appears to be an acceptable method for lactation assistance.

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Patel et al, 2018, India (39)	RCT	To assess effectiveness of cell phones for personalized lactation consultation to improve breastfeeding practices	1036	Cell phone counselling and daily text messages for IG and routine healthcare services for CG	During 6 months of postpartum	Using cell phones can substantially augment optimal BF practices. High rates of EBF were achieved by sustained contact and support.
Wheaton et al, 2018, U.S (40)	Cohort Study	To explore usability of the breastfeeding application and describe participants' infant feeding outcomes	46	IG received the Breastfeeding App	During 6 months of postpartum	The smartphone application was acceptable to breastfeeding women but Further researches needed to evaluate BF outcomes.
Abbass-Dick et al, 2017, Canada (13)	Three-phase explora tory study	To explore the impact of the resource on maternal and paternal infant feeding KAP and self-efficacy, and the co-parenting relationship.	66	Online and web based breastfeeding program (including text, video, games, quizzes, and links to additional resources on the internet) for IG and Available Resources for CG	At 6 weeks, 3 and 6 months of postpartum	E-health resource have a positive effect on increasing parents' infant feeding attitudes, breastfeeding self-efficacy, and breastfeeding knowledge.
Martinez-Brockman et al., 2017 United States (19)	RCT	To determine the effect of a two-way text messaging intervention on the time of EBF	174	IG received two-way text message intervention, while CG received usual care only.	At 2 weeks and 3 months at postpartum	LATCH had no effect on EBF.

Author/ Year/ Country	Design	Objectives	Sample size	Method	Follow up duration	Findings
Prieto et al, 2017, Guatemala (41)	Mixed-methods study	To assess the effects of mHealth intervention (text messaging) on knowledge and BF behavior	100	IG received the text message via mobile phone and CG received a simple mobile phone	During 6 months of postpartum	M-health interventions can play an important role to encourage recommended breastfeeding attitudes along with providing rich information about BF challenges.
Ahmed, et al, 2015, Kuwait (15)	RCT	To determine efficacy of web-based, interactive, breastfeeding monitoring system on breastfeeding duration, exclusivity, and intensity	106	IG given access to an online, interactive, breastfeeding monitoring system and CG followed the standard hospital protocol.	During 1, 2, and 3 months of postpartum	Significant difference in breastfeeding patterns (exclusively breastfeeding, partial, formula) was found between CG and IG.

RCT: Randomized Clinical Trial, BF: Breastfeeding, EBR: Exclusive Breastfeeding, IG: Intervention Group
CG: Control Group, SMS: Short Message Service, App: Application, IYCF: Infant and Young Child Feeding ImTeCHO: Innovative Mobile Phone Technology For Community Health Operations, MNCH: Mother Neonate and Child Health, KAP: Knowledge Attitude Practice, LATCH: Lactation Advice Through Texting Can Help

The sample size ranged from 3 to 2741 participants. Most of the studies (n =10, 34.5%) were carried out in the United States of America (10, 12-14, 18, 23, 29, 31, 34, 35). These articles summarized the effectiveness of e-health interventions on breastfeeding outcomes (Table 1).

Mobile phone breastfeeding applications

Twelve studies that used breastfeeding applications as their intervention mode were included in this category (9, 16-18, 20, 21, 26, 29, 33, 35, 36, 40). Of these, eight studies used the RCT design (9, 16, 17, 18, 20, 26, 29, 35) there was also one study for each of the following designs: quasi-experimental (21), longitudinal (36), cohort (40), and survey (33) study.

A study by Vila-Candel et al. (2024) found that the use of the mobile application (LactApp) did not significantly improve the breastfeeding rate compared to standard care (P = 0.826). However, it was associated with a reduced rate of breastfeeding discontinuation during the first two weeks postpartum (P = 0.015) (9). Lewkowitz et al. (2020) described that the rates of breastfeeding at postpartum were low and similar between the IG that utilized the Breastfeeding Friend (BFF) app and the CG (n=30 [36.6%] vs n=30 [35.7%]; relative risk, 1.02; 95% confidence interval, 0.068–1.53). The rate of EBF was 8.3% (n=5) and 10.4% (n=7) in CG and IG, respectively (relative risk, 0.8; 95% confidence interval, 0.27–2.38) (18).

A cohort study by Wheaton et al. (2018) reported that 79% of participants (n = 23) were breastfed, whereas the local breastfeeding rate at six months was approximately 50%. However, the study did not establish a causal link between the use of the breastfeeding app and the observed difference in breastfeeding rates (40).

Griffin et al. (2021) noted that utilizing the breastfeeding app (BF app) did not increase breastfeeding rates among women from low-income backgrounds (17). Study by Modi et al. (2019) revealed significant improvements in the 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 who utilizing innovative mobile-phone technology for community health operations (ImTeCHO) app (35). Survey by Ward et al, (2020) showed notable advancements in early breastfeeding (OR = 1.64, 95% CI = 1.5-1.78) and EBF (OR = 1.46, 95% CI = 1.33-1.62) in addition there was a positive association between applying Mobile Kunji app and EBF (58% exposed vs 43% unexposed, P < 0.01) (33). Doan et al. (2022) reported that users of mobile breastfeeding applications recorded significant improvements in breastfeeding outcomes. In particular, there was an increased likelihood of initiating breastfeeding within the first two hours postpartum (adjusted odds ratio [aOR] = 1.50, 95% confidence interval [CI]: 1.01–2.24) and of practicing exclusive breastfeeding during the hospital stay (aOR = 1.60, 95% CI: 1.03–2.48), indicating the positive impact of mobile app use on breastfeeding practices (16).

In a longitudinal study, Farr et al. (2019) found that a prenatal intervention delivered via an iPad-based breastfeeding application was both feasible and associated with a statistically significant increase in the proportion of women intending to EB. Furthermore, participants expressed a preference for breastfeeding apps over in-person care (36). The study conducted by Mena-Tudela et al. (2023) demonstrated that the LactApp mobile application improved the maintenance of breastfeeding at six months after childbirth compared to standard clinical practices (P = 0.05) (26).

Seyyedi et al. (2021) noted that the mothers' KAP had significant differences in the IG (using the breastfeeding app) compared to the CG. In the IG, the changes in knowledge and attitude were higher compared to the CG, with scores of 8.75 ± 1.37 and 5.67 ± 0.94, respectively (P < 0.001, P < 0.001). However, the practice score was recorded at 0.8 ± 0.49, which is viewed as marginally significant (P= 0.063). Throughout the study, the breastfeeding self-efficacy of the mothers in the IG experienced noteworthy improvement (P < 0.001). The score enhancement was 26.85 ± 7.13 for the IG and only 0.40 ± 5.17 for the CG (29). A quasi-experimental study conducted by Akber et al. (2020) demonstrated that general maternal knowledge related to infant and young child feeding (IYCF) nutrition improved among 94 mothers (69.6%) compared to 74 mothers (54.8%) before using the Lady Health app. General attitude on IYCF was deemed favorable by 86 (63.7%) of the mothers, while 88 (65.2%) of the mothers showed good IYCF-related practices (21).

Results of RCT by Scott et al (2021) indicated that a smartphone app (Milk Man app) for mothers and their partners did not prove to be more effective than the standard care provided in routine antenatal classes. Therefore, additional research is needed to assess the effectiveness of this involvement in more socioeconomically diverse population that probably benefits most from additional partner support (20).

In general, the results of the above-mentioned studies were varied. Some studies acknowledged that the mobile phone breastfeeding applications did not increase breastfeeding rates (9, 17, 18, 40), while other studies confirmed the app's effectiveness in early breastfeeding initiation (16, 33, 35) and EBF (26, 36), except one, which explained about the app's lack of impact on EBF (16). Improvements in breastfeeding maintenance, mothers' breastfeeding self-efficacy (19) Mothers' KAP (21, 20), and the feasibility of accessing ICT (11) were observed as well. It seems that due to varied results, more studies are needed to prove these consequences.

Telephone counseling

From the nine studies that used telephone counseling (14, 27, 28, 30-32, 34, 38, 39), six were RCTs (14, 27, 31, 32, 34, 39). The remaining four studies each had a case report (28), qualitative (38), and quasi-experimental (30) designs.

Miremberg et al. (2022) demonstrated that providing lactation support through smartphone-based counseling led to increased postnatal breastfeeding rates and was associated with high levels of patient satisfaction (27). The study by Pines et al. (2019) indicated that participants in the tele-lactation group had higher breastfeeding rates (34). A case report by Farhadi et al. (2021) indicated that educating mothers about infant visual and auditory cues through mobile-assisted technology (WhatsApp) could improve their ability to initiate breastfeeding by promoting early bonding with their newborns. This approach also supported mothers in achieving and sustaining their breastfeeding goals (P < 0.05) (28). Patel et al. (2018) found that the rate of timely initiation of breastfeeding was significantly higher in the IG compared to the CG (37% vs. 24%, P < 0.001). Pre-lacteal feeding rates were low and comparable between both groups (intervention: 19%, control: 18%, P = 0.68) (39). Jerin et al. (2020) in a quasi-experimental study reported that supporting breastfeeding by mobile phone counseling increased the EBF after hospital delivery (P = 0.000), but there was no significant difference in the patterns of morbidity and nutritional status when comparing pre- and post-intervention (P > 0.05) (30). Ogaji et al. (2020) found no statistically significant difference in EBF rates (55.2% vs 46.8%, respectively) at six months between the IG, which received mobile phone-based counseling, and the CG receiving usual care (χ^2 = 0.623; P = 0.430). Likewise, the mean difference of EBF duration between IG and CG was not statistically significant (t = 1.45; P = 0.149) (31). A trial by Wu et al. (2020) indicated that EBF rates were significantly higher in the group receiving online telephone counseling compared to the CG (81.1% vs. 63.3%; odds ratio [OR] = 2.75, 95% confidence interval [CI]: 1.58–4.78; P < .001). Additionally, mothers in the IG were more likely to predominantly feed breast milk (OR = 2.77, 95% CI: 1.55–4.96; P < .001) and less likely to introduce dairy products to their infants (OR = 0.40, 95% CI: 0.21–0.75; P = .005) (32). Adam et al. (2021) found no statistically significant differences between telephone counseling via video call and the CG regarding EBF rates and other infant feeding practices in the last 24 hours at 1 month: RR 0.93 (95% CI 0.86 to 1.01, P = 0.091); EBF in the last 24 hours at 5 months: RR 0.90 (95% CI 0.77 to 1.04, P= 0.152)](14). Patel et al. (2018) mentioned that EBF rates at 24 hours post-delivery were identical (74% in both groups, P = 1.0), and significantly higher EBF rates were observed in the IG at all subsequent follow-ups (control vs. intervention: 6 weeks: 81% vs. 97%; 10 weeks: 78% vs. 98%; 14 weeks: 71% vs. 96%; 6 months: 49% vs. 97%; P < 0.001 for all four follow-up points) (39). Pines et al. (2019) reported that, 51% of mothers in the IG reported EBF, compared to 46% in the CG; however, this difference was not statistically significant (P = 0.47) (34).Adam et al. (2021) observed a small but significant improvement in maternal knowledge at the 1-month follow-up, but this was not evident at the 5-month follow-up (14).

A qualitative research study conducted by Demirci et al. (2018) emphasized that Tele-lactation is a convenient and effective service essential for rural regions that have limited access to in-person care. Additionally, it provides breastfeeding support and enhances maternal breastfeeding confidence. Telephone counseling was noted to have several advantages, such as providing feasible, accessible, and acceptable breastfeeding services. Barriers to utilizing Tele-lactation services include: maternal reluctance to conduct video calls with an unknown provider, a desire for community-based breastfeeding resources, and technical challenges, including limited Wi-Fi connectivity in rural regions (22,25,27,38).

Altogether, studies have indicated that telephone counseling improved the early initiation of breastfeeding (27, 34), breastfeeding rates (28, 29), mothers' KAP (14), mothers' breastfeeding self-efficacy (38), and feasibility of ICT (38). Concerning EBF, the results of studies were contradictory, some studies describing an enhancement (25, 28, 30).

Text message

Text messaging was employed as one of the e-health components to promote EBF in four studies (10, 19, 37, 41). From these studies, three used the RCT design (10, 19, 37), and one was a mixed-method study (41).

Study by Unger et al. (2019) showed that IG who received SMS compared to the CG, had a higher EBF rate (P<0·005) (37). Research by Martinez-Brockman et al. (2017) reported that while providing lactation guidance through text messaging did not have a statistically significant effect on EBF (odds ratio = 1.26; 95% confidence interval: 0.54–2.66), it did significantly enhance the quality of initial engagement between participants and breastfeeding counselors (odds ratio = 2.93; 95% CI: 1.35–6.37) (19). A study by Macchi et al., (2022) found that participants in the SMS IG had significantly higher intakes of total grains (0.28 oz; 95% CI: 0.00–0.60; P = 0.033), protein (13.5 g; 95% CI: 10.5–18.3; P = 0.022), calcium (472 mg; 95% CI: 418–667; P = 0.012), and zinc (4.39 mg; 95% CI: 2.61–6.51; P = 0.028). However, no significant differences were observed in the duration of breastfeeding between groups (10).

Mixed-method study by Prieto et al. (2017) found a significant relationship between receiving health-promoting text messages and changes in breastfeeding knowledge (P<.001), breastfeeding behavior and practices (P=.010) (41).

On the whole, study results regarding the effect of texting/SMS on EBF were contradictory; one study showed an improvement (37) And one other report, no change (19). Also, one study acknowledged the impact of text messaging on mothers' KAP about breastfeeding (41). Breastfeeding duration did not change with texting technology (10).

Web-based education

According to the findings, four studies implemented web-based interventions to assist mothers with breastfeeding (11-13, 15). From these studies, three used the RCT design (11, 12, 15), and one used an exploratory study design (13).

In a randomized clinical trial, Abbass-Dick et al. (2020) reported that the IG, which had access to a breastfeeding web page, exhibited significantly higher breastfeeding rates (78%) compared to the CG (63%). These elevated rates were attributed to the strong motivation of participating mothers and co-parents who responded to recruitment efforts (12). Ahmed et al. (2015) in an RCT found that there were no significant differences in breastfeeding outcomes between the groups at the time of discharge (P= 0.707). A significant difference in breastfeeding outcomes was observed among the groups at 1, 2, and 3 months (P= 0.027, P= 0.000, and P= 0.002). Participants in the IG who engaged with an interactive web-based breastfeeding program exhibited higher rates of EBF at 1, 2, and 3 months. This suggests that the intervention could be an effective approach to enhancing breastfeeding exclusivity, intensity, and duration (15). Abbass-Dick et al. (2017) conducted an exploratory study which showed that a web-based program had a positive impact on parents' attitudes toward infant feeding, as well as their breastfeeding self-efficacy and knowledge—key factors known to improve breastfeeding outcomes (13).

Research by Sari and Altay (2020) revealed that the women engaged in the web-based program exhibited higher self-efficacy, and their infants achieved superior outcomes in assessments of growth, development, and health compared to those in the CG (11).

Studies declared that web-based education has positive effects on mothers' KAP (13), mothers' breastfeeding self-efficacy (11), breastfeeding rate (34, 37), and EBF (12, 15) for the six months.

Discussion

This study assessed the effectiveness of e-health interventions on breastfeeding outcomes. The results demonstrated that intervention modes varied across studies, and four modes of e-health interventions were identified, which consist of: mobile phone applications, telephone counseling, text messages, and web-based education. Regarding the effect of e-health on breastfeeding outcomes, the findings were contradictory; twenty studies (9-11, 14, 15, 18-20, 22-25, 27, 29, 31-36) reported positive influences of e-health on breastfeeding outcomes such as; early initiation of breastfeeding, breastfeeding rates, breastfeeding duration, EBF, maintenance of breastfeeding, breastfeeding self-efficacy, mother's KAP and feasibility of ICT and nine

other studies (8, 12, 13, 16, 17, 21, 26, 28, 30) did not identify an effect on these outcomes. So, it seems that due to contradictory results, more studies are needed to clarify the effectiveness of these technologies. Recently, results are likely due to multiple reasons, including key differences in study design, study populations, follow-up duration, and the type of applied technologies.

Technology-based breastfeeding support provided during the postpartum period may help women overcome common breastfeeding challenges and improve rates of sustained breastfeeding, since maternal literacy plays an important role in breastfeeding outcomes; in this context, the utilization of technology-driven education can enhance healthcare services (37).

Relating to mobile phone applications the overview by Nazli Khatib et al (2023) mentioned that breastfeeding interventions via mobile devices showed no improvements in breastfeeding knowledge and practices, which was in contrast with our findings. This contradiction can be due to the different methodologies of these two studies, in which they assessed systematic reviews (42). Regarding to telephone counseling a Cochrane review (2016) indicated that offering breastfeeding support by telephone might enhance breastfeeding early initiation and rate. This review observed that providing telephone support for breastfeeding mothers increased EBF at six months postpartum. Although similar results were found in our review, due to the existence of studies that did not report significant impacts on these mentioned outcomes and so contradictory findings, further studies are needed for accurate interpretation (43).

In relation to text messaging our review found that mobile breastfeeding apps were the most commonly used e-health interventions to provide support for breastfeeding mothers. In contrast, Marcolino et al. (2018) in their umbrella review on systematic reviews aimed to evaluate the effects of m-health interventions in the processes of health care services, found that the most effective and widely adopted interventions were modification approaches utilizing text messaging due to the low cost and low broadband requirements. Nonetheless, the authors recommended that additional research be carried out using more rigorous methodologies to validate the effectiveness of m-health interventions. The reason for this inconsistency is the difference in the inclusion criteria in terms of e-health technology type, in which they applied text messaging technology (3).

In addition, about web-based education the present research noted that E-health interventions were an acceptable (17, 22), feasible, and practical solution for supporting lactation (21), which provides rich information about breastfeeding challenges (27) and improved coverage and quality of breastfeeding counseling services (15). In contrast to our research findings, a study conducted in Sri Lanka indicated that women favored engaging with healthcare professionals about their breastfeeding informational needs rather than using technology-based breastfeeding informational support (43).

Our study offers several strengths. Initially, this study was the first scoping review of technology-based interventions related to breastfeeding and provided a large amount of data about their efficacy on breastfeeding outcomes. Our comprehensive report of the study findings can act as a guideline for future researchers intending to create their own reviews. Nevertheless, limitations should be considered. Firstly, this review included only studies published in English and Persian, Therefore, the results may not be applicable to other languages in some regions Secondly, even though we performed a thorough search for the scoping review, since e-health interventions are still emerging in the research area, some are currently in the process of being implemented, and only the study protocol has been published; therefore, these were excluded. So, it is possible that some eligible studies were overlooked.

Additionally, e-health interventions itself is a wide range topic, so it is recommended to conduct a more focused examination of each intervention through systematic reviews or meta-analyses. Since this was a scoping review, it did not assess the cost-effectiveness of the interventions. Even if an intervention proves to be effective, it may be difficult to implement on a broad scale if the cost for the mother is

expensive; therefore, it is suggested that future studies perform a cost analysis to assess the effectiveness of these procedures.

Some of the included participants were from low to high-income countries, since geographical location is a parameter that may affect the success or failure of the e-health intervention in breastfeeding outcomes, this factor should be taken into account in future research.

Likewise, a further review could be conducted to compare these programs with the in-person methods. Finally, it is hoped that this research will have a great impact on supporting breastfeeding by applying e-health methods along with routine care.

Conclusion

In the present review, e-health interventions were grouped into four modes: mobile phone application, telephone counseling, text message, and web-based education, with mobile phone applications accounting for a greater portion of the employed e-health interventions. Regarding the effect of e-health on breastfeeding outcomes, the findings were contradictory; some studies reported positive influences of e-health on breastfeeding outcomes, and some other studies did not identify an effect on these outcomes. Therefore, further research employing more rigorous methodological designs is required to definitively determine the effectiveness of these technologies.

Declarations

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Conflicts of interest

Authors declared no conflicts of interest.

Ethical considerations

The authors acknowledge that they have observed ethical issues, including the principle of honesty, in extracting and inferring data from primary sources, and there has been no plagiarism.

Code of Ethics

Not applicable.

Use of Artificial Intelligence (AI)

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Authors' contribution

HFP, NSh, FB, FM, and NM conducted the literature searches, collected data, prepared tables and figures, performed data synthesis and drafted the manuscript. NM and HFP contributed to the manuscript review and revision. NM supervised the overall design, coordination, and review of the manuscript. All authors read and approved the final version of the manuscript.

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