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Breastfeeding Support in Your Pocket: Evaluating the Impact of a Mobile App on Maternal Success

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Abstract

Background: Breastfeeding has well-known benefits for both the nursing infant and the birthing parent. It bolsters the newborn immune system, and reduces the risk of future health conditions in both parties. Due to these advantages, several health organizations internationally recommend exclusive breastfeeding until 6 months of age. However, only a fraction of infants in the United States meet this goal each year. Improved rates and duration of exclusive breastfeeding will lead to better long-term health outcomes for patients. The use of smartphone applications for breastfeeding education and support has not been thoroughly researched. Objective: This thesis explores the feasibility of smartphone apps for breastfeeding education, as well as their effect on parental self-efficacy level, and actual breastfeeding outcomes. The goal of the proposed intervention is to increase exclusive breastfeeding rates and duration through 6 months postpartum. Methods: A literature review will be conducted with current articles that research the use of app-based education and support in breastfeeding. Then, a proposal for further study will detail a randomized controlled trial with an evidence-based educational intervention. The control group will receive standard perinatal care and education, while the experimental group will receive access to a breastfeeding educational app, in addition to standard care and education. The proposed app will include both written and video content, as well as a breastfeeding tracking feature. Data will be collected on infant feeding plans, breastfeeding self-efficacy, and actual breastfeeding outcomes at baseline, 36 weeks gestation, and at 2 days, 3 months, and 6 months postpartum. Statistical analyses will be used to compare the two groups and determine if the study results are statistically significant.

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In 2021, a total of 3,664,292 infants were born across the United States (Osterman et al., 2023). Each of those families, and ones like them every year, are faced with a vital choice regarding infant nutrition: breastfeeding (BF) vs. formula feeding. There are well-documented benefits to BF for both infants and birthing parents. In the infant, breast milk is especially important for immune system development; it possesses a variety of antimicrobial and antiinflammatory properties, and supplies the baby with passive immunity via leukocytes (Goldman, 2012). Additionally, BF can help reduce the risk of adverse health outcomes in both parties, which will be discussed further in this paper (Meek & Noble, 2022). Formula feeding does not offer these same advantages. Due to the benefits of BF, the American Academy of Pediatrics (AAP) recommends BF exclusively for approximately the first 6 months of an infant's life (Meek & Noble, 2022). According to the Centers for Disease Control and Prevention (CDC), exclusive breastfeeding (EBF) is defined as, "feeding your baby only breast milk, not any other foods or liquids (including infant formula or water), except for medications or vitamin and mineral supplements," (Centers for Disease Control and Prevention, 2022b).

Problem Statement

Despite the 6-month recommendation from the AAP, many families do not exclusively breastfeed for this duration of time. In fact, the CDC's Breastfeeding Report Card for 2022 reported that, while 83.2% of infants received some breast milk immediately after birth, only 24.9% were exclusively breastfed until the age of 6 months (Centers for Disease Control and Prevention, 2022a). Healthy People 2030 aims to increase this proportion to 42.4% (US Department of Health and Human Services, n.d.). There are a variety of reasons why a family

might not reach the 6-month goal. However, the decision not to, or to stop BF, can have negative consequences for both the infant and the birthing parent. Infants who are not breastfed exhibit increased rates of health complications later in life. These conditions include ear infections, diarrhea, atopic dermatitis, lower respiratory illness, asthma, obesity, diabetes mellitus, inflammatory bowel disease (IBD), childhood leukemia, and sudden infant death syndrome (SIDS) (Meek & Noble, 2022; Stoody et al., 2019). Additionally, birthing parents who do not breastfeed experience higher risks of hypertension, type two diabetes mellitus, and breast, ovarian, and endometrial cancers (Meek & Noble, 2022; Feltner et al., 2018).

By improving rates of EBF, patients may experience better health outcomes through the duration of their lives, potentially decreasing the load on the healthcare system. There are many strategies in place that attempt to achieve this goal during the perinatal period. However, one strategy that has not been thoroughly studied is the use of smartphone applications for patient education. Smartphones are an accessible resource that have the potential to provide a wealth of information for patients. A free, evidence-based app with information, advice, and support could help more perinatal families choose and succeed with EBF.

Purpose Statement

After reviewing the current literature on perinatal breastfeeding education, this paper will address the gap by implementing an educational app in perinatal families. The purpose of this proposal is to examine the effect of an evidence-based mobile application in the perinatal population, with the goal of improving EBF rates in the first 6 months.

Problem Question

Does a smartphone app-based breastfeeding education program, when compared to standard care and education, increase the rates and length of EBF up to 6 months postpartum?

Hypothesis

People who receive breastfeeding education through an evidence-based smartphone application will express higher rates of breastfeeding knowledge and self-efficacy, and will exhibit increased rates and length of EBF through the first 6 months of the infant's life.

Literature Critique

Introduction

The following literature critique explores the medium of mobile applications for BF patient education. The articles used for this review were retrieved from the following databases: CINAHL Complete and Google Scholar. With each database, the search terms used to find each article included: "breastfeeding or breast-feeding or infant feeding or lactation or lactating," "self-efficacy or self efficacy or confidence or self esteem," "smartphone or mobile application or app or apps or smartphone app," "educational intervention," and "outcomes or effects or impact." The criteria for articles to be included in this literature review were the following: peer-reviewed primary research articles published within the last 10 years (2013 through 2023). A total of six articles were selected for this literature review and are organized under the following subheadings: Feasibility of Mobile App Education for Breastfeeding, Breastfeeding Self-Efficacy, and Breastfeeding Outcomes After Mobile App Education. A Literature Review Table is in Appendix A.

Feasibility of Mobile App Education for Breastfeeding

The following articles investigate the potential of mobile apps as patient education tools for breastfeeding, as it is vital to confirm their general acceptance and promise for use in this context.

Farr et al. (2019) conducted a longitudinal survey study with a nonrandomized block design. The purpose of the study was to evaluate two iPad-based BF interventions for three factors: (a) the effect on intention to exclusively breastfeed; (b) the level of acceptability and satisfaction among participants; and (c) resulting rates of in-hospital EBF. The sample consisted of 243 expectant minority women (predominantly African Americans) who were publicly insured and had completed clinically required BF education. This education aligned with the Baby-Friendly hospital designation, and included information on BF benefits. They were eligible if they were over the age of 18, or 14-17 years old with a consenting adult. Participants were selected via convenience sampling on-site at women's health clinics in Cleveland, Ohio. After recruitment, participants were given a pre-test survey detailing their demographic information, current infant feeding plan, and any prior BF experience. They were subsequently allocated in nonrandom blocks to one of the two test groups, where group one received a module from a free BF app, and group two participated in a positive messaging program presenting information in a question and answer format. The assigned intervention was administered during a scheduled prenatal visit at the clinic. They took less than 10 minutes, and education was reinforced through the teach-back method with written materials provided. After the intervention, participants took a post-test that assessed changes in feeding plans, and their satisfaction with a five-point Likert scale. After the participants delivered their babies, researchers reviewed their charts to obtain data on in-hospital EBF decisions. (Farr et al., 2019).

Farr et al. (2019) found that there was no statistically significant change in EBF intention immediately after the interventions. However, they concluded that both interventions were feasible and accepted by participants; 66.4% of the app intervention, and 54.4% of the positive messaging intervention participants rated the experience as a "5-Very Interesting" on the Likert

scale. Additionally, they observed that both groups had a statistically significant proportion of participants who *did not* intend EBF at the time of the intervention, and then *did* choose EBF in the immediate postpartum period. In the app-based group, 45.3% of the participants who did *not* intend to EBF did in-hospital EBF ($p < 0.0001$). The same was true for 53.7% of the positive messaging participants who did *not* intend to EBF ($p < 0.0001$). The main strength of this study was that the interventions were fast and easy to implement. A noteworthy limitation was that it did not include a control group, so these results cannot be compared with those that had no intervention. Additionally, the study results are difficult to generalize, as the participants were not randomly assigned to the interventions and the sample was small and exclusive to one clinic's patient population. Another notable limitation to the study is that the interventions were only provided at one time, for a very short duration during prenatal care. There may have been more increases observed in EBF intentions and initiation if education took place over a longer period of time. Finally, this study did not follow up on participants' BF decisions after hospital discharge. Therefore, we do not know whether these interventions impacted the length of EBF. (Farr et al., 2019).

Laws et al. (2023) conducted a mixed-methods feasibility study with pre-post design to examine the My Baby Now app. The evaluation was based on the app's feasibility, its impact on BF knowledge and intentions, and whether or not its impact differed based on maternal education level. The researchers recruited 266 expectant Australian women through two rounds of targeted Facebook advertisements to ensure a diverse range of educational levels. Eligible participants were over 18, between 20 and 30 weeks gestation in their first pregnancy, carrying a singleton, and Australian residents with access to a smartphone. Exclusion criteria included any health conditions that contraindicated breastfeeding. Each participant was given access to the app,

which contained evidence-based educational information, and engagement was measured via app analytics. Online surveys were given at three times: baseline (T1), 36-38 weeks gestation (T2), and 8-10 weeks postpartum (T3). These surveys measured participant assessments of the My Baby Now app in terms of quality, acceptability, usefulness, and comprehensiveness. The surveys also measured the participants' BF intentions, confidence, attitudes, and perceived app impact on these factors. Participants who completed the T3 survey were also invited to complete a qualitative phone interview based on their app experience. (Laws et al., 2023).

One of Laws et al.'s (2023) most important observations was the inverse relationship between maternal education level and satisfaction. While the app was, on average, rated "moderate" in surveys, those with lower educational attainment gave it higher ratings on nearly every subscale. In qualitative interviews, participants expressed that its most valuable qualities were the evidence-based information, the comprehensiveness, and its ease to understand. They also expressed that the app filled a gap in prenatal care; many of their appointments and associated literature were labor and birth-focused. Additionally, there were statistically significant increases in EBF knowledge (59.6% vs. 66.5%, $p < 0.001$) and intentions (76.6% vs. 80.9%, $p < 0.001$) from T1 to T2. The researchers concluded that the My Baby Now app was a feasible source of prenatal BF education, but it may need some improvements in user experience. A notable strength of this study was the range of educational backgrounds among participants. This included parents with a highschool education, to those with postgraduate degrees, improving the generalizability. Additionally, the app's adherence to evidence-based practice made it a strong tool for patient education. However, there were limitations. Technical difficulties reported early in the trial may have contributed to attrition; there were issues with notifications not working, the app being "laggy," and crashing. Researchers noted that app

engagement may increase if it was recommended by a health professional rather than social media advertisements. Furthermore, the participants primarily used English as their first language, and all lived in Australia, which limits the generalizability of these results. Additionally, his study was not a randomized controlled trial (RCT). Finally, because the design lacked a plan to follow up with participants, the researchers were not able to measure actual BF outcomes. (Laws et al., 2023).

These articles affirm that patients readily embrace mobile breastfeeding education when it is credible and functional, with some noting its effective role in addressing gaps in prenatal care. Nonetheless, additional research is essential to quantitatively assess the impact of such mobile apps on EBF rates.

Breastfeeding Self-Efficacy

The following two interventional studies explore the relationship between education, maternal self-efficacy, and EBF outcomes during the postpartum period. Breastfeeding self-efficacy (BSE) can be defined as "a mother's confidence in her capability to breastfeed her infant," (Öztürk et al., 2022).

Shariat et al. (2018) organized an RCT that implemented a self-efficacy-focused educational intervention during the immediate postpartum period. Their study's purpose was to evaluate how increased levels of BSE affect the rate and duration of breastfeeding. The study focused on nulliparous pregnant women in Iran who were 18-35 years old and birthed healthy term or near-term infants. In order to be eligible, the women had to be of similar socioeconomic status, and make the decision to breastfeed. The researchers did not define the socioeconomic status in question. Researchers recruited 129 participants via convenience sampling, and randomly assigned them to the control and intervention groups. Prior to the intervention, all

completed the Self-Efficacy Scale, the Edinburgh Postnatal Depression Scale (EPDS), and Spielberger's State-Trait Anxiety Inventory (STAI). After completion, mothers in the intervention group received a training session on BSE, training pamphlets and CDs on the topic, and a class on parenting methods that included information on postpartum care and infant relationships. Additionally, they were given access to psychological therapy if they reported anxiety, stress, or depression. Then, phone calls were used to follow up participants' feeding methods and BF duration at 6, 12, 18, and 24 months after delivery. (Shariat et al., 2018).

Shariat et al. (2018) observed a statistically significant increase in the rates and duration of EBF in the intervention group. At 6 months postpartum, 41% of the intervention group was still exclusively breastfeeding, compared to 23.5% of the control group ($p = 0.015$). This pattern remained consistent until the 2 year follow up, in which 33.8% of the intervention group reported that they still breastfed occasionally, compared with 7.8% of the control group ($p = 0.001$). These results imply that increased levels of BSE are correlated with increased EBF duration. This study's primary strength is its rigorous randomized controlled trial design. Limitations include potential constraints in generalizing findings due to cultural and healthcare system variations in Iran and within participants' socioeconomic stratum. Additionally, the absence of post-intervention assessments prevents a direct comparison between self-efficacy levels before and after the education session. Finally, response bias among participants may have artificially inflated the reported proportion of EBF. (Shariat et al., 2018).

Öztürk et al. (2022) conducted a two-group quasi-experimental study to evaluate similar variables as Shariat et al (2018). The purpose of this study was to determine if BF education in the prenatal period affects BSE and LATCH scores after birth. The study focused on women in Turkey who were over 18, willing to breastfeed, literate, and had no diseases, pregnancy

complications, or history of drug and alcohol use. A total of 80 participants were selected from obstetrics clinics using convenience sampling. Those in the control group were given standard perinatal care and education. The intervention group was given standard care in addition to an educational course based on Dennis' breastfeeding self-efficacy theory. This education was delivered in two sessions to small groups (four to five people) in-person at the hospital. The classes included verbal education, slides, models, videos, and question and answer methods. During the first week postpartum, researchers followed up with participants using the LATCH breastfeeding assessment tool, and the Breastfeeding Self-Efficacy Scale-Short Form (BSES-SF). At this point, 13 participants were excluded from the study for various reasons. (Öztürk et al., 2022).

Öztürk et al.(2022) identified statistically significant differences between the groups' BF plans, self-efficacy levels, and BF success. Overall, the intervention group had higher BSES-SF scores than the control group (61.12 ± 4.06 for intervention, 58.39 ± 5.17 for control; $p = 0.03$). Additionally, the intervention group had higher average LATCH scores (8.38 ± 1.50 for intervention, 7.30 ± 1.51 in control; $p = 0.003$), indicating a higher level of BF success. Finally, the researchers identified a positive correlation between BSES-SF scores and LATCH scores ($p = 0.003$, $r = 0.345$). The study showed that increased BSE is associated with more success in BF initiation for birthing parents. By including a control group, the researchers are able to directly compare intergroup results. While a strength of this study is the provision of evidence-based information to participants, this educational model may not be realistic, as it requires a large commitment of time and money. Another study limitation is that the researchers did not follow up on participants' BF outcomes later in the postpartum period. Therefore, drawing conclusions about the impact of the intervention on EBF duration is not possible. Furthermore, the study took

place in another country, and a power analysis was not described to determine sample size. These factors limit the ability to generalize the results. (Öztürk et al., 2022).

These two study results strongly support the effectiveness of evidence-based education in bolstering self-efficacy among birthing parents. High levels of BSE potentially lead to improved BF outcomes. Notably, the interventions studied were all given in-person, which requires considerable human capital, highlighting the need to explore electronic delivery methods.

Breastfeeding Outcomes After Mobile App Education

The third and final theme of this literature review explores the impact of mobile app education on actual breastfeeding outcomes.

In 2020, Lewkowitz et al. conducted an RCT to assess the impact of a novel app on BF rates. The sample consisted of 169 women in the United States (US) who were at 36 weeks gestation, nulliparous, low-income, and English speaking. Researchers provided a phone and prepaid internet service to all participants before randomizing them to a group. The intervention group was given access to the BreastFeeding Friend (BFF) mobile app for lactation support. The control group was given a skeleton app containing digital forms of generic breastfeeding handouts. Then, participants were assessed on postpartum day 2, 6 weeks, 3 months, and 6 months for BF outcomes. They also asked participants what the best BF resource was, both during their hospital stay and in the postpartum period. (Lewkowitz et al., 2020).

Lewkowitz et al. did not observe any significant differences between the intervention and control groups. BF initiation and duration rates through 6 months postpartum were similar for both. However, users of the BFF app reported that apps offered the best BF support at 6 weeks postpartum. The primary strengths for this study were its RCT design, and its long follow-up. However, the study methodology had several limitations. Participants were not recruited until

they were 36 weeks pregnant. By this point in pregnancy, the parent is considered full-term and likely already has plans for the postpartum period. Given this late recruitment, cognitive bias may have impacted their decisions to breastfeed. Additionally, researchers did not clarify how app usage was monitored or provide a critique of the information provided by the BFF app. Furthermore, researchers focused on low-income women specifically, and their reported rates of EBF were lower than national averages. This limits the generalizability of the results, and introduces possible selection bias. (Lewkowitz et al., 2020).

Bunik et al. (2022) conducted a mixed methods RCT to discern whether the app they developed, Mothers Milk Messaging (MMM), improved BF rates. Researchers recruited a national sample of 467 primiparous mothers through Facebook and radio advertisements, listservs, and local Colorado clinics. To be eligible, participants had to speak English or Spanish, be over 18, and at least 36 weeks gestation with a singleton pregnancy. Participants were stratified according to their language and randomized to one of three arms of the study. The first arm offered participants access to the MMM app along with breastfeeding text messaging. The second arm included MMM app access, breastfeeding text messaging, and a physician-moderated private Facebook group. The third arm, serving as the control group, delivered injury prevention text messages. However, due to limited Facebook engagement, arms one and two were merged. The MMM app provided on-demand educational content and sent daily text messages leading up to the birth of their baby, and up to 3 months postpartum. Then, follow-up data on EBF was obtained at the 3 and 6 month marks. Focused interviews were also conducted to obtain qualitative feedback about the app user experience. (Bunik et al., 2022).

In qualitative interviews, Bunik et al. (2022) discovered that participants found the app useful and dependable. Those in the intervention group also exhibited a significant increase in

BF confidence and perceived support compared to the control group ($p < 0.05$). The study found no differences in breastfeeding rates or exclusivity, because EBF rates in both the intervention and control groups were high (47% and 40% respectively at 6 months). The article contains several strengths and weaknesses. It included a large sample that was similar to recent U.S. Census data. Because the researchers collected outcome measure data at three and six months and employed an RCT design, they could infer a causal relationship between app use and participant outcomes. Finally, it utilized evidence-based, peer-reviewed information for education. This study also has several limitations. Similar to Lewkowitz et al. (2020), parents were not able to enroll unless they were at least 36 weeks gestation. Thus introducing the same opportunity for cognitive bias. Additionally, 26% of the original participants were lost to follow-up. This attrition was higher than expected. The study's power analysis required 450 participants divided between the three experimental groups. Furthermore, confounding variables may have played a role in app engagement. Researchers highlighted that white, married, educated women with higher EBF rates were more likely to engage with the app. Finally, the higher than average EBF rates may be attributed to the Hawthorne effect. (Bunik et al., 2022).

These studies provided rigorous evaluation of several possible breastfeeding apps. While participants expressed satisfaction with each, there were no changes to breastfeeding outcomes. However, they were both implemented at the 36th week of pregnancy, when many parents have already made decisions regarding their infant's care.

Conclusion

Increasing the rate and duration of EBF in the U.S. is a monumental and important task. The articles reviewed in this literature critique show that mobile applications are a feasible platform for patient education. The literature offers compelling evidence that this form of education may enhance BF intentions and self-efficacy in birthing parents, potentially leading to

improved EBF outcomes. In the past, similar interventions aimed at impacting EBF duration have yielded disappointing results, primarily due to methodological flaws. At the time of this writing, no studies have been published that examine the use of smartphone applications for BF education during the early stages of pregnancy, coupled with comprehensive follow-up to 6 months postpartum. This thesis includes a proposal for further study to address this gap by conducting an RCT aimed at overcoming these limitations and providing valuable insights into this method of education.

Proposal for Further Study

Theoretical Framework

The theoretical framework for the following proposal is based on Albert Bandura's self-efficacy theory (SET). In their article entitled *Bandura's self-efficacy theory of motivation in psychology*, Lopez-Garrido (2023) describes the theory and how it fuels motivation. The term self-efficacy (SE) refers to an individual's belief in their own ability to complete an action, goal, or plan. Bandura theorized that a person's SE is influenced by four main factors: a) mastery experiences, b) vicarious experiences, c) social persuasion, and d) emotional and physiological states. Mastery experiences, or performance outcomes, are made up of an individual's previous attempts at a given task. Prior practice and success will increase SE levels, while perceived failures will decrease SE. Vicarious experiences take place when a person observes a role model's performance at the task. Social persuasion refers to encouragement and positive feedback that an individual receives. Finally, a person's overall physical and psychological well-being can affect their SE level. Those that experience higher levels of SE tend to be more resilient and motivated, and experience higher levels of well-being and personal accomplishment. (Lopez-Garrido, 2023).

Parents who strongly believe in their ability to effectively breastfeed should, according to SET, have increased rates of EBF success. In order to design an intervention that fosters an increased level of BSE through mobile patient education, each factor of SET must be addressed. Providing early education on EBF lays the essential foundation for parents to master this vital skill. Equipping them with the necessary tools and education leads to a positive mastery experience. Vicarious experiences can be provided in a video format that includes visual demonstrations and verbal EBF success stories. Apps can leverage social persuasion by providing guidance from healthcare professionals. Other forms of social persuasion may be possible via video and testimonials, live chats, or push notifications. But these and other forms of encouragement and feedback will likely happen in person, separately from the proposed intervention. Finally, this form of patient education addresses emotional and physiological needs as a source of anticipatory guidance. By offering a breastfeeding app intervention that integrates all aspects of Bandura's SET, we equip parents with the tools to tackle common BF challenges and bolster their self-efficacy. This heightened self-efficacy contributes to a stronger belief in their ability to succeed. As a result, there is a greater likelihood of both initiating and maintaining EBF.

Research Design

The aim of this study is to evaluate the effect of mobile app education on EBF duration through the first 6 months postpartum. A quantitative experimental cohort study design will be used, with 140 participants randomly assigned to either the intervention or control group. The study will be conducted in a virtual format, with baseline and follow-up surveys being completed online.

Ethical Considerations

Before commencing the study, an application will be submitted to the Institutional Review Board (IRB) for approval. Additionally, each participant will receive a written consent form detailing the study's purpose and potential risks or advantages of participation. Furthermore, they will be assured that participation is voluntary, and can be withdrawn at any point without consequence. Before consenting, participants will have time to review the information and seek clarification. Finally, the research team will ensure data confidentiality throughout the study, with access restricted exclusively to the research team.

Sample

Participants will be recruited using targeted Facebook advertisements, radio advertisements, listservs, and in-person recruitment at local clinics in San Rafael. G*Power determined that a sample size of 64 participants per group is needed, considering a two-tailed test, 5% significance level (α), an effect size of 0.5, and a power of 80%. To account for possible attrition, the total sample size will be 140, with 70 participants in each group. To be eligible, potential participants must be US residents who are at least 18 years old, who understand they have an uncomplicated singleton pregnancy, and are within the second trimester of pregnancy (weeks 13-26). They must also have access to a mobile phone and internet. Exclusion criteria will be: prior breastfeeding experience, premature delivery requiring a NICU stay, or any condition of the parent or infant that contraindicates breastfeeding. As an incentive, participants will receive a $20 gift card at each time point if they complete all required surveys. After consenting, participants will provide demographic and other baseline information and be randomized to the control or intervention group. Those in the control group will receive standard perinatal care and education. The intervention group will receive standard perinatal care and education, plus access to the evidence-based BF education app.

Intervention

To build the intervention, breastfeeding information from HealthyChildren.org will be converted to a mobile-app format. This is a free, evidence-based resource that has been created by the AAP (American Academy of Pediatrics, n.d.). Resources on the app will include written education, instructional and testimonial videos, and a BF tracking feature to help parents record their feedings. Written education will be offered in both English and Spanish, and will be accompanied by audio narration for the app user. Education topics will include BF preparation during pregnancy, common difficulties/concerns and how to handle them, BF skills and mechanics, physiology, and infant health, growth, and development. Additionally, the app will send users periodic push notifications in order to encourage app use and exposure.

Data Collection

At the time of recruitment, baseline data will be collected. This includes demographic information, initial infant feeding plans and attitudes, and BSE level. These factors will be measured using the following validated tools: the Infant Feeding Intentions scale (IFI), the Iowa Infant Feeding Attitude Scale (IIFAS), and the Breastfeeding Self-Efficacy Scale – Short Form (BSES-SF). Each of these tools will be integrated into the app, and users will self-report their answers. Follow up surveys using the same tools will be completed at 36 weeks gestation, and at 2 days, 3 months, and 6 months postpartum. In addition, participants will report whether or not they are breastfeeding exclusively at each follow-up point. App analytics will also be used to understand participants' exposure to app content.

Analysis

The primary outcome measure of this study will be rates and duration of EBF at 6 months postpartum. Secondary outcomes include differences in EBF intent, BSE, and knowledge

between groups based on pre-post intervention findings. Descriptive statistics will be used to compare the outcomes of the control and intervention groups. Statistical analyses will be performed using t tests and chi-square tests. If the p-value is less than 0.05, then the findings will be considered statistically significant, rejecting the null hypothesis.

Limitations

This study design presents several limitations. There is possible self-selection bias, as those who are more comfortable with smartphone apps and technology may be more inclined to sign up. Social desirability bias and the Hawthorne effect may alter participant responses. Additionally, the study relies on self-reported data. The possibility of participants misreporting their EBF outcomes due to recall bias, or other forms of bias, cannot be eliminated. Furthermore, app usage may vary, and there is no guarantee that participants will use the app consistently or as intended, even with the use of push notifications. Finally, external factors, such as family support, may influence participant outcomes, but are not controlled for in this study.

Conclusion

If the results of this study show a statistically significant increase in EBF rates and duration, it would suggest that implementing a breastfeeding education app in the second trimester of pregnancy, in addition to standard care and education, shows promise for increasing EBF rates on a larger scale. Parents often experience a lack of breastfeeding education during the prenatal period of their healthcare. As nurses, we are frequently responsible for patient education, and we should strive to fill this knowledge deficit. The findings of this study may be applied to future nursing practice to encourage earlier BF education as an upstream approach to health promotion and disease prevention. This may result in improved quality of life, as well as a decreased load on the healthcare system. If an app intervention is proven to be effective, it may

encourage development of similar resources for patients, as well as promotion from healthcare providers. Future research may focus on more widespread use or altered app factors. Depending on the results of the proposed study, changes may be required.

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Appendix A: Literature Review Table

Citation: Bunik, M., Jimenez-Zambrano, A., Solano, M., Beaty, B. L., Juarez-Colunga, E., Zhang, X., Moore, S. L., Bull, S., & Leiferman, J. A. (2022). Mother's Milk Messaging™: trial evaluation of app and texting for breastfeeding support. *BMC Pregnancy & Childbirth*, *22*(1), 1–11. https://doi-org.dominican.idm.oclc.org/10.1186/s12884-022-04976-6 Purpose/Objective of the study: To determine if the Mother's Milk Messaging™ app affects breastfeeding rates and the breastfeeding experience, and to gather qualitative feedback on app usage. Sample: Primiparous, singleton mothers over the age of 18, who spoke English or Spanish, and were at least 36 weeks gestation. n=467 Study Design: Randomized Controlled Trial with Qualitative Feedback Study Methods: App engagement was measured using app analytics. Outcomes measured were EBF rates (primary), and participants' knowledge/attitude, confidence, and perceived social support (secondary). These were measured through qualitative interviews, as well as surveys at baseline, 3 months, and 6 months postpartum. The following assessment tools were used: Iowa Infant Feeding Attitudes Scale, Perceived Barriers to Breastfeeding IFPS II, Breastfeeding Self-Efficacy Scale Long Form, Perceived Social Support Assessment Tool, Depression and Social Support Questionnaires, and Acculturation ICR. Major Findings: Participants found the app useful and dependable. The intervention group exhibited a statistically significant increase in breastfeeding confidence and perceived social support ($p<0.05$). No differences found in breastfeeding rates or exclusivity, because both the intervention and control groups had higher EBF rates than expected. Strengths: Randomized controlled trial with a national sample that is close to recent census data. Measures EBF rates at both 3 and 6 months postpartum. App utilized evidence-based and peer-reviewed information for patients. Limitations: Parents were not able to enroll before 36 weeks gestation. 26% Attrition. Confounding variables at play. Possible selection bias for the qualitative part of the study. Possible Hawthorne Effect, as the control group had much higher rates of EBF at 6 months (40%) than the national average (24.9% according to the CDC for 2022).
Citation: Farr, R. S., Rahman, F., O'Riordan, M. A., & Furman, L. (2019). Assessing the Feasibility and Effectiveness of Two Prenatal Breastfeeding Intervention Apps in Promoting

Postpartum In-Hospital Exclusive Breastfeeding. *Breastfeeding Medicine*, *14*(10), 724–730. https://doi-org.dominican.idm.oclc.org/10.1089/bfm.2019.0053

Purpose/Objective of the study: To assess the effects of two iPad breastfeeding interventions on EBF intention and in-hospital EBF outcomes. To determine if the intervention is acceptable and satisfying to participants.

Sample: Expectant minority women (predominantly African Americans) who were publicly insured, and had completed clinically required breastfeeding education. n = 243.

Study Design: Longitudinal Survey Study with a Nonrandomized Block Design

Study Methods: Participants were assigned to either the champion intervention group, which utilized a free, commercially available app or the the positive messaging intervention, which offered breastfeeding information in a question-answer format. Later, the participants' medical records were obtained to review their in-hospital infant feeding choices. Data analysis included percentages, frequencies, chi-squared analyses, and McNemar's test.

Major Findings: The study found that each of the interventions were feasible. There was a statistically significant increase in the number of participants who did not intend to EBF before the intervention and then chose to EBF in the immediate postpartum period (45.3% in the app group and 53.7% in the messaging group, $p < 0.0001$).

Strengths: Interventions were fast and easy to implement.

Limitations: The study did not have a control group, and was not an RCT. Researchers did not measure breastfeeding outcomes after hospital discharge. Cannot be generalized due to small and exclusive sample size and focus on the African American population. Intervention was only implemented once for less than ten minutes.

Citation: Laws, R. A., Cheng, H., Rossiter, C., Kuswara, K., Markides, B. R., Size, D., Corcoran, P., Ong, K.-L., & Denney-Wilson, E. (2023). Perinatal support for breastfeeding using mHealth: A mixed methods feasibility study of the My Baby Now app. *Maternal & Child Nutrition*, *19*(2), 1–16. https://doi-org.dominican.idm.oclc.org/10.1111/mcn.13482

Purpose/Objective of the study: To assess the My Baby Now app for feasibility in providing BF support, effect on BF knowledge, attitudes, confidence, and intentions, and to analyze differences in participant responses according to maternal education level.

Sample: First-time expectant mothers in Australia over 18 years old, between 20-30 weeks gestation with a singleton pregnancy and smartphone access. n = 266. 24 participated in the qualitative interview process

Study Design: Mixed-Methods Feasibility Study

Study Methods: Participants were given access to the app, and engagement was measured via app analytics. Online surveys were given at baseline (T1), 36-38 weeks gestation (T2), and 8-10 weeks postpartum (T3). Participants who completed the T3 survey were invited to complete a qualitative phone interview. The assessment tools used were Likert scales, surveys, the Breastfeeding Attrition Prediction Tool, and Iowa Infant Feeding Attitudes Scale.

Major Findings: Significant increases in breastfeeding knowledge (59.6% vs. 66.5%, $p<0.001$) and intentions to exclusively breastfeed (76.6% vs. 80.9%, $p<0.001$). In participants without university education, app engagement significantly predicted changes in breastfeeding attitudes ($\beta = 0.13$, 95% confidence interval [CI] 0.01–0.26, $F = 4.79$, $p = 0.037$).

Strengths: Recruited parents with a wide range of educational backgrounds. Mixed-methods design allowed for a more complete grasp of the app's feasibility and acceptability. Included an evidence-based educational intervention for the participants.

Limitations: Participants were recruited via social media. Participants generally used English as their first language, limiting generalizability. Technical difficulties early in the study may have negatively impacted participation. Not an RCT, and was not able to measure actual breastfeeding outcomes.

Citation: Lewkowitz, A. K., Lopez, J. D., Carter, E. B., Duckham, H., Strickland, T., Macones, G. A., & Cahill, A. G. (2020). 45: Impact of a novel smartphone application on low-income women's breastfeeding rates: a randomized controlled trial. *American Journal of Obstetrics & Gynecology*, *222*(1), S38–S39. https://doi-org.dominican.idm.oclc.org/10.1016/j.ajog.2019.11.061

Purpose/ Objective of the study: To determine whether the BreastFeeding Friend (*BFF*) app affects BF rates in low-income women.

Sample: Nulliparous, low-income, English-speaking women at 36 weeks gestation. n = 169.

Study Design: Randomized Controlled Trial

Study Methods: Participants were randomized to either the BFF app or a skeleton app. EBF outcomes were measured on postpartum day 2, 6 weeks, 3 months, and 6 months. Researchers also asked participants what the best breastfeeding resource was during their hospital stay and in the postpartum period.

Major Findings: Intervention participants were more likely to report apps as the best form of BF support at 6 weeks postpartum (n = 34 (52.3%) vs n = 20 (31.3%); p = 0.03). No significant impact on EBF rates or duration.

Strengths: RCT. Measures breastfeeding outcomes through 6 months postpartum.

Limitations: Participants not recruited until 36 weeks of gestation. Study focused on low-income women specifically. Limited information provided on what the BFF app included for participants, and it is unclear how app usage was monitored. EBF rates for both groups in this study were much lower than the national average according to the CDC, indicating possible error in the recruitment process.

Citation: Öztürk, R., Ergün, S., & Özyazıcıoğlu, N. (2022). Effect of antenatal educational intervention on maternal breastfeeding self-efficacy and breastfeeding success: A quasi-experimental study. *Revista Da Escola de Enfermagem Da USP*, *56*. https://doi.org/10.1590/1980-220x-reeusp-2021-0428

Purpose/ Objective of the study: To analyze the effect of an antenatal BF educational intervention on LATCH and breastfeeding self-efficacy scores.

Sample: Literate pregnant women in Turkey over the age of 18 who were willing to breastfeed, and had none of the following: physical or mental illness, medication for a particular disease, structural defect in the breast, history of smoking, alcohol or drugs, or pregnancy complications. n=80.

Study Design: Two-group quasi-experimental study

Study Methods: The control group received routine perinatal care and the intervention group was given BF education based on Dennis's Breastfeeding Self-Efficacy Theory. Education was delivered in groups of four to five at the hospital and included verbal education, slides, models, video, and question and answer methods. During week one postpartum, researchers followed up and assessed with the LATCH breastfeeding assessment tool, and the Breastfeeding Self-Efficacy Scale-Short Form.

Major Findings: Participants in the intervention group had statistically significant increases in their self-efficacy levels (61.12 ± 4.06 for intervention, 58.39 ± 5.17 for control; p = 0.03) and mean LATCH scores (8.38 ± 1.50 for intervention, 7.30 ± 1.51 in control; p = 0.003). Positive correlation between self-efficacy and breastfeeding success (p = 0.003, r = 0.345)., and the educational intervention increased both of these factors.

Strengths: Method of educational intervention guarantees that all participants were presented with factual, evidence-based information. Included a control group for direct comparison.

Limitations: Method of education delivery was time consuming and expensive. Did not follow up on BF outcomes further into the postpartum period. Sample was small, with no power analysis described. Took place in another country, limiting generalizability.

Citation: Shariat, M., Abedinia, N., Noorbala, A. A., Zebardast, J., Moradi, S., Shahmohammadian, N., Karimi, A., & Abbasi, M. (2018). Breastfeeding self-efficacy as a predictor of exclusive breastfeeding: A clinical trial. *Iranian Journal of Neonatology*. https://doi.org/10.22038/ijn.2018.24694.1316

Purpose/ Objective of the study: To examine how an educational intervention leading to increased awareness, knowledge, and self-efficacy impacts EBF initiation and duration.

Sample: Nulliparous pregnant women ages 18-35 in Iran who birthed healthy term or near-term infants. n=129.

Study Design: Randomized Controlled Trial

Study Methods: These surveys were administered prior to the intervention: Self- Efficacy Scale, the Edinburgh Postnatal Depression Scale (EPDS), and Spielberger's State-Trait Anxiety Inventory (STAI) . The intervention group received breastfeeding self-efficacy training and materials and took a class on parenting methods, postpartum care, and the parent-infant relationship. Participants who reported anxiety, stress, or depression were offered therapy. Phone follow-up was conducted 6, 12, 18, and 24 months after delivery to assess EBF status.

Major Findings: Rates of EBF at 6 months were significantly higher in the intervention group (40.9%) than the control group (23.5%) (p = 0.015). At 24 months, 33.8% of the intervention group reported they still breastfed occasionally, vs. 7.8% of the control group (p = 0.001).

Strengths: The study is a randomized controlled trial.

Limitations: Small sample size. Differences in culture and healthcare systems may limit generalizability of these results. BSE levels could not be directly compared because survey tools were not repeated after the intervention.