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Development of a mobile application -based breastfeeding program and evaluation of its effectiveness

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ABSTRACT

Background: Breastfeeding has many benefits for maternal and infant health. Mobile health interventions are increasingly used to increase breastfeeding initiation and support breastfeeding continuation.
Purpose: This study aimed to develop a mobile application-based breastfeeding program (MABBP) and to evaluate effectiveness.
Design and methods: This randomized controlled trial study was conducted with 73 mothers on the first postpartum day hospitalized in the postpartum service of a university hospital in Turkey. Mothers in the MABBP group (experimental group) were included in the mobile application-based breastfeeding training program on the first postpartum day. The Participant Information Form, the Infant Breastfeeding Assessment Tool (IBFAT), and the Breastfeeding Experience Scale (BES), Breastfeeding Follow-up Form, and Baby Physical Development Follow-up Form were administered. In the second follow-up, the Mobile Application Evaluation Form was used additionally to collect data from the MABBP group.
Results: There was no significant difference between the postpartum first-day MABBP and control groups in the mean IBFAT scores. In the first and second follow-up, the rate of breastfeeding exclusively was higher and the rate of experiencing breastfeeding problems was lower in the MABBP group compared to the control group. While the mean BES score on the first postpartum day was significantly higher in the MABBP group compared to the control group, it was found to be significantly lower in the second follow-up.
Conclusion: It was determined that the MABBP contributed to the mothers' experiencing fewer breastfeeding problems and feeding the babies exclusively with breast milk at a higher rate.
Practice implications: This study suggests that pediatric nurses can support mothers during breastfeeding with the breastfeeding mobile application.

Introduction

Breastfeeding has many benefits for maternal and infant health (Kaya et al., 2018). World Health Organization (WHO) and United Nations Children's Fund (UNICEF) recommend that infant initiate breastfeeding within the first hour of birth, be exclusively breastfed for the first 6 months of life and continue breastfeeding up to 2 years of age or beyond (WHO, 2022). According to UNICEF global database, 48% infants 0–5 months of age worldwide are exclusively breastfed. This rate is lowest in Middle East and North Africa (32%), West and Central Africa (38%), East Asia and Pacific (42%), Eastern Europe and Central Asia (42%), respectively (UNICEF, 2023). According to the results of the Turkish Population and Health Survey (TDHS), 41% of children younger than 6 months were exclusively breastfed (TDHS, 2018). However, these rates are below WHO's target of "by 2025, the rate of exclusive breastfeeding for the first 6 months up to at least 50%." (WHO, 2021).

Breastfeeding is a natural way of feeding an infant. Most mothers experience difficulties and concerns about breastfeeding in early postpartum (Balaam et al., 2015). Primiparous women have more breastfeeding problems than multiparous women (Demirci et al., 2018). Research indicates that breastfeeding difficulties are associated with early cessation of breastfeeding and introduction of complementary feeding (Lau et al., 2016). For this reason, women should be offered skilled breastfeeding support during pregnancy and postpartum period by health professionals (Cangöl & Şahin, 2017). Most of this support consist of traditional face-to-face education. However, traditional face-to-face education can create time and space limitations (Lau et al., 2016). Technology-based breastfeeding support is easily accessible, offers continuous information support at the desired time and place, and is enriched with different methods (videos, animations, etc.)

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(Lau et al., 2016). These advantages increase the use of mobile health applications in providing breastfeeding support (Lau et al., 2016). In the meta-analysis study by Lau et al. (2016) was found that technology-based breastfeeding support contributed positively to mothers in terms of breastfeeding information, starting breastfeeding, and breastfeeding for the first six months (Lau et al., 2016). In this context, it is predicted that maintaining breastfeeding support with mobile health applications will contribute as a modern way to improve breastfeeding outcomes (Marcucci, 2018). The COVID−19 pandemic, which has affected the whole world, has affected women's breastfeeding experiences (Hull et al., 2020). In Brown and Shenker (2021)'s study, it was found that mothers reported more challenging experiences, worrying about the safety of feeding, feeling isolated and struggling to get support in COVID−19 (Brown & Shenker, 2021). In other study, many mothers reported that they could not access face-to-face professional breastfeeding support due to the pandemic (Hull et al., 2020). Mobile health based breastfeeding support can be an effective method that offers breastfeeding support to mothers "anytime, anywhere".

The aim of this study is to develop a mobile application-based breastfeeding program (MABP) and evaluate the effect on breastfeeding outcomes, such as the rates and duration of exclusive breastfeeding.

Design and methods

This research was designed as a randomized controlled trial and registered at clinicaltrials.gov as NCT05497245. The data of the study were collected at Istanbul University Cerrahpasa Faculty of Medicine postpartum service. The G*Power software was used to calculate the sample size. The sample size calculation was set at $\alpha = 0.05$, Cohen's $d = 0.80$, with a power of 90%. The estimated sample size was 34 for each group. The optimal sample size was 80 primiparous breastfeeding mothers with a 10% loss for withdrawals, missing data, and lost follow-up. Fig. 1 shows the consort flow chart of the study. The inclusion criteria were women aged >18 years, primiparous, vaginal birth at term (>37th gestational week and baby weight >2500 g), planning to breastfeed, having a smartphone, and effective skills of using the smartphone (self-identification by mother). Mothers who were multipara, had undergone a cesarean section, did not have a smartphone or effective use skills (self-identification by mother), or did not volunteer to participate in the study were excluded.

Materials

Participant information form

Participant Information Form was developed by the researcher in line with the literature. This form consisted of 28 questions to collect data about the sociodemographic, obstetric, birth, and breastfeeding histories and the smartphone and mobile application use history of the primiparous (Aksu et al., 2011; Demirci et al., 2018; Dienelt et al., 2020; Feenstra et al., 2018).

Infant breastfeeding assessment tool

The Infant Breastfeeding Assessment Tool (IBFAT) was developed by Matthews in 1988, and its Turkish validity and reliability study

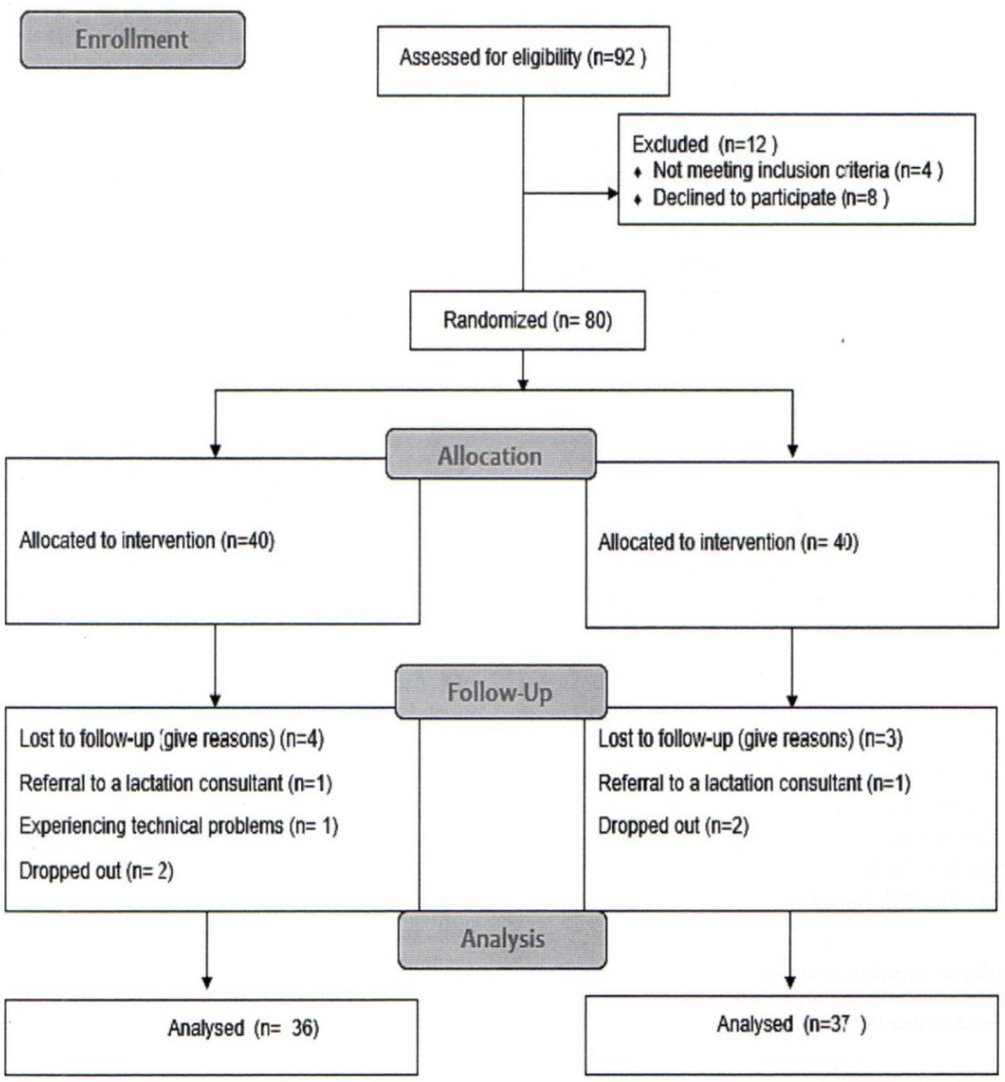

Fig. 1. Consort Flow Diagram.

(Cronbach Alpha coefficient: 0.92) was conducted by Çelik and Demirci in 2017. It was developed to determine the breastfeeding difficulties experienced within the first 4–5 days in healthy and term-born infants. The scale completed by the mother consists of six items. The first (infant's nutritional status) and last items (mothers' feelings during nutrition) are excluded in the scale scoring and are evaluated separately. The other four items include questions about the awakening, search, capture, and sucking behavior of the baby. The questions are evaluated between 0 and 3 points, and the highest score to be obtained is 12 points. The range of 10–12 points represents babies with effective nutrition, the range of 7–9 points indicates babies who suck very well when encouraged, while 0–6 points refer to babies who do not start feeding or searching for the breast without stimulation or who suck for short periods (Çelik & Demirci, 2017; Matthews, 1988).

Breastfeeding experience scale

The Breastfeeding Experience Scale (BES) was developed by Wambach in 1990, and the Turkish validity and reliability study was conducted by Uyanık et al. in 2019 (Cronbach Alpha coefficient: 0.77). The scale, which evaluates the presence and severity of breastfeeding problems in the postpartum period, consists of 18 items and 5 subscales. The scale items are evaluated in the range of 1–5 points (1: not at all, 5: unbearable), and the total score range varies between 18 and 90. The 18 items on the scale were grouped into five subscales as breast concerns (sore nipples, breast infection and cracked nipples), process concerns (baby reluctant to breastfeed due to sleepiness, leaking breasts, baby breastfeeding too frequently, breast engorgement, and feeling very tired), mechanic concerns (baby having difficulty in latching on, baby having sucking difficulty, baby reluctant to breastfeed due to fussiness, difficulty in positioning baby, feeling tense and overwhelmed) and milk insufficiency concerns (worry about not having enough milk, worry about baby's weight gain, and worry that baby was not getting enough milk), and social concerns (feeling embarrassed when breastfeeding and difficulty in combining work and breastfeeding) (Uyanık et al., 2022; Wambach, 1990). In Wambach's study (Wambach, 1997), the Cronbach's α coefficient was found to be 0.60 for mechanic concern subscale, 0.86 for milk insufficiency concerns subscale, 0.68 for breast concerns subscale, 0.48 for social concerns subscale and 0.56 for process concerns subscale of BES (Wambach, 1997).

Breastfeeding follow-up form

This form was created by the researchers with three sections consisting of quantitative and qualitative questions as follows: history of breastfeeding (breastfeeding frequency and duration), history of breastfeeding problems (breastfeeding problems and actions, reason for breastfeeding interruption) and the history of baby formula use (amount, way of use, reason for use).

Baby's physical development follow-up form

The researchers prepared this form to measure the height, weight, and head circumference of the baby.

Mobile application evaluation form

The form developed by the researchers included 10 questions. These included questions about the application's design, functionality, usability, suitability for the purpose aim, information scope, satisfaction, challenges with using it, recommendations for making it better, and the impact on breastfeeding (Demirci et al., 2018; Lewkowitz et al., 2021; Miremberg et al., 2022; Yurtsal & Hasdemir, 2022).

Procedure

The research consisted of two stages: steps involved in developing the mobile app and study procedures used to implement the research study with participants.

1) Steps involved in developing the mobile app

The research consisted of two stages. In the first stage of the research carried out in the pandemic, the content of the mobile application-based breastfeeding program was prepared in line with the current resources of the WHO and the Turkey Ministry of Health by the researchers. After the content was prepared, the mobile application was developed and designed for both Android and iOS devices with a mobile application developer. The created training content was then uploaded to the mobile application.

There were three informative pages for the first use of the application. These pages contained information about the importance of breast milk, WHO breastfeeding recommendations, and instructions on the use of the application. After these informative pages, there was a screen with the mother's name, baby's name, baby's gender, and the baby's weight. The main screen of the application consisted of six screens. These screens were: "Breastfeeding" (breast milk characteristics, the importance of breastfeeding, breastfeeding technique, etc.), "Milking" (milking by hand, milking with a pump, milk storage conditions, etc.), "Unexpected Situations" (breastfeeding problems and solution suggestions), "Frequently Asked Questions", "Breastfeeding Entry," and "Breastfeeding Diary" tabs. The "Breastfeeding Entry" tab allowed mothers to track their breastfeeding status and record the number and length of each breastfeeding period, as well as their milking status, the baby's height, and weight measurements each month, and any breastfeeding-related issues they encountered. Additionally, researchers sent weekly notifications via the mobile application to increase mothers' breastfeeding motivation.

The first notification that mothers get when using the application;

"Dear Mother, your breastfeeding journey has begun. In this process, you can access the information you need through the application, and you can follow the breastfeeding process by keeping a diary on the breastfeeding entry tab."

Some examples of the notifications are presented below:

"Dear Mother, breastfeeding supports both the physical and emotional development of the baby."

"Dear Mother, trust your milk. Your body was created to produce enough milk for the baby."

"Dear Mother, as the baby grows, the amount of breast milk changes to meet the changing nutritional needs of the baby."

After the application was developed, the pilot study was conducted with six primiparous mothers who met the inclusion criteria. The link of the application was sent to Android-operated phones on Google Drive to prevent non-research use. The application invitations were sent to iOS-operated phones, and application records were made through App Store, and the application was accessed through the "Test Flight" application by entering the code. The mothers reported a problem with entering the program and a problem with the progress of the breastfeeding entry page after the first use. These technical problems were resolved by the mobile application developer.

2) Study procedures used to implement the research study with participants

In the second stage of the study, mothers who met the inclusion criteria were informed about the purpose, content, method of the study, and informed consent was obtained from the mothers who agreed to participate. The mothers were randomly assigned to MABBP and control groups using a simple random number table from www.random.org. On the first postpartum day, the Introductory Information

Form, IBFAT, BES were completed by mothers in the MABBP and control groups. The mobile application was installed on the phones of the mothers in the MABBP group on the first postpartum day, and they were informed about the content and use of the application. Their questions about the use of the application were answered. A text on how to use the application was also sent to the mothers digitally. The mothers were free to use the application at any time they wanted and needed throughout the study. The control group received only routine postpartum care. The mothers in the MABBP and control groups were administered the Physical Development Follow-up Form, Breastfeeding Follow-up Form, and Breastfeeding Experience Scale in the fourth week (first follow-up) and eighth week (second follow-up) after birth. Due of the pandemic conditions, the data from the follow-ups for the MABBP and control groups were collected utilizing a Google Forms questionnaire. Additionally, a Mobile Application Evaluation Form was applied to the MABBP group in the second follow-up.

Ethical considerations

This study was approved by the Ethics Committee of Istanbul University-Cerrahpasa Medicine Faculty (08/10/2020–132,875) according to the Declaration of Helsinki. All participants were informed about the aim of the study, and their voluntary written informed consent to participate was obtained.

Data analysis

The IBM® SPSS® version 22 was used to evaluate the data. A descriptive analysis of the sample was carried out using means and standard deviations for quantitative variables and frequencies and percentages for categorical variables. Skewness and kurtosis values and the Shapiro-Wilk test were used to evaluate whether the data showed a normal distribution. Independent group comparisons of the categorical variables were analyzed through the chi-square test. In the comparison of the mean of two independent groups with a normal distribution, the *t*-test was used in independent groups, and the Mann-Whitney *U* test was used in those without normal distribution. For the comparison of repeated measurements within the dependent group, the ANOVA test was used for repeated measurements for normally distributed data, and the Friedman test was used for non-normally distributed data. Two groups were most similar in composition.

Results

Characteristics of the participants

In the study, the mean age of the mothers in the MABBP group was 27.73 ± 4.52, and the mean age of the mothers in the control group was 27.00 ± 4.46. There was no statistically significant difference between the groups in terms of the age, education, employment, employment plan in the postpartum period, perceived income (Table 1).

Obstetric features and breastfeeding history

The birth weight, height, and head circumference measurements of the infants in the MABBP and control groups were similar. It was determined that 44.4% of the mothers in the MABBP group and 35.1% of the mothers in the control group gave birth in the 39th gestational week. It was found that 55.6% of the MABBP group.

It was determined that 38.9% of the MABBP group and 35.1% of the control group received breastfeeding training during pregnancy. The results revealed that 61.1% of the mothers in the MABBP group and 62.2% of the mothers in the control group breastfed their babies within the first half hour after birth. There was no statistically significant difference between the groups in terms of the mean scores on the Infant Breastfeeding Assessment Tool. It was found that 13.9% of the mothers in the MABBP group and 24.3% of the control group had problems with the first breastfeeding. The rate of receiving support in the first breastfeeding experience was 52.8% in the MABBP group and 62.2% in the control group. All the mothers intended to breastfeed exclusively, and 86.1% of the MABBP group and 75.7% of the control group planned to continue breastfeeding for at least two years. Of the mothers, 19.4% in the MABBP group and 13.5% in the control group thought that they would have problems breastfeeding due to back to work or worrying about insufficient breast milk supply (Table 2.)

Table 1
Comparison of characteristics of the participants.

Variable	MABBP group		Control group		Test value	p
	Mean ± SD (Min-Max)		Mean ± SD (Min-Max)			
Age	27.73 ± 4.52(20–40)		27.00 ± 4.46 (19–38)		−.852[a]	0.397
	n	%	n	%	Test value	p
Age group						
18–25	13	36.1	11	29.7		
26–30	17	47.2	19	51.4	.341[b]	0.843
31 and above	6	16.7	7	18.9		
Education						
Primary and secondary	8	22.2	6	16.2	1.186[b]	0.553
High school	7	19.4	11	29.7		
University	21	58.3	20	54.1		
Employment						
Employed	13	36.1	16	43.2	.388[b]	0.534
Unemployed	23	63.9	21	56.8		
Employment plan in the postpartum period						
Yes	13	36.1	16	43.2	.143[b]	0.705
No	23	63.9	21	56.8		
Perceived income						
Income = Expense	25	69.4	27	73.0	.111[b]	0.739
Income > Expense	11	30.6	10	27.0		

[a] Independent sample t-test.
[b] Pearson Chi-square test. $p < 0.05$.

Table 2
Comparison of obstetric features and breastfeeding history of participants.

Variable	MABBP group		Control group		Test value	p
	Mean ± SD	Min-Max	Mean ± SD	Min-Max		
Baby birth weight (grams)	3251.11 ± 367.71	2500–4150	3230.14 ± 427.33	2540–4220	.225[a]	0.823
Baby birth length (cm)	49.89 ± 2.32	45–54	49.16 ± 1.97	45–53	−1.610[b]	0.107
Baby birth head circumference (cm)	34.36 ± 1.62	30–36	34.46 ± 1.50	31–36	−.346[b]	0.729
IBFAT scale score	8.55 ± 1.27	6–11	8.48 ± 1.28	6–10	−.154[a]	0.878
	n	%	n	%	Test value	p
Breastfeeding training during pregnancy						
Yes	14	38.9	13	35.1	.110[c]	0.740
No	22	61.1	24	64.9		
Gestational week						
38th weeks	10	27.8	12	32.4		
39th weeks	16	44.4	13	35.1	.660[c]	0.719
40th weeks and above	10	27.7	12	32.4		
Baby's first breastfeeding time						
In the first 30 min	22	61.1	23	62.2	.868[d]	0.767
Within the first hour	10	27.8	12	32.4		
Within the first 2 h	4	11.1	2	5.4		
Problems with the first breastfeeding						
Yes	5	13.9	9	24.3	1.282[c]	0.258
No	31	86.1	28	75.7		
Receiving support in the first breastfeeding						
Yes	19	52.8	23	62.2	.329[c]	0.566
No	17	47.2	14	37.8		
First breastfeeding support person						
Nurse/Midwife	11	30.6	16	43.2	.617[c]	0.432
Companion (mother. Spouse's mother. spouse)	8	22.2	7	18.9		
Intention to breastfeed						
less than two years	5	13.9	9	24.3	1.282[c]	0.258
At least two years	31	86.1	28	75.7		
Worry about having difficulty breastfeeding						
Yes	7	19.4	7	18.8	.003[c]	0.955
No	29	80.6	30	81.1		

IBFAT: Infant Breastfeeding Assessment Tool
[a] Independent sample t-test.
[b] Mann Whitney U test.
[c] Pearson Chi-square test.
[d] Fisher exact-test. $p < 0.05$.

Smartphone and mobile application usage features

The mean duration of smartphone use was similar between the groups (MABBP: 9.03 ± 2.15, Control: 9.00 ± 2.09 years). It was determined that 41.7% of the MABBP group spent 1–2 h a day and 55.5% of the control group spent 3–5 h a day on their phone. Both the MABBP group and the control group were found to use at least one mobile health application (52.8% and 51.4%, respectively). The smartphone use was similar in both groups.

Characteristics of breastfeeding and infant feeding at first follow-up and second follow-up

The mean duration of breastfeeding and breastfeeding frequency of the mothers in the MABBP and control groups was similar at the first follow-up and the second follow-up. In the first (MABBP 63.9%, control: 56.8%) and the second follow-up (MABBP: 44.4%, control: 45.9%) of the mothers in both groups, the frequency of breastfeeding their babies was found to be "whenever they wanted/cried." On the other hand, it was found in the first and second follow-ups that mothers in the control group had significantly more breastfeeding problems than MABBP group ($p < 0.05$). When the breastfeeding problems were examined, it was found that the problems the MABBP group experienced the most were frequent pain/crack in the nipple (25%), while the control group experienced insufficient milk production (own perception or real) the most frequently (37.8%) in the first follow-up. In the second follow-up, it was determined that the most frequent problem the MABBP group and control group experienced was inadequate milk production (their own perception or real) at a rate of 13.9% and 32.4%, respectively. In the second follow-up, the pain/cracked nipple rate of the mothers in the control group was found to be significantly higher than in the MABBP ($p < 0.05$).

On the other hand, in the first and second follow-up, the breastfeeding rate of the MABBP group was found to be significantly higher than in the control group ($p < 0.05$). In the first and second follow-ups, the rate of exclusive breastfeeding was statistically significantly higher in the MABBP group (86.1% in the first follow-up and 88.9% in the second follow-up) than in the control group (64.9% in the first and second follow-ups) (Table 3).

Comparison of the physical developmental characteristics of the baby

There was no significant difference between the MABBP group and the control group in terms of infant weight on the first postpartum day and at the first follow-up. Infant weights were found to be significantly higher in the MABBP group at the second follow-up (Fig. 2). There was no significant difference between the infant height and head circumference measurements between the groups ($p < 0.05$).

Comparison of breastfeeding experience scale score

In the MABBP group were found to have significantly higher postpartum BES scores on the first day compared to control group, while they were found to be significantly lower in the second follow-up (Fig. 3) ($p < 0.05$). In the MABBP group, the mean BES scores in the second follow-up were found to be significantly lower than those on the first postpartum day and the first follow-up ($p < 0.05$). The mean BES scores of the mothers in the control group were found to be significantly

Table 3
Comprasion of characteristics of breastfeeding and infant feeding at first and second follow-ups.

Variable	MABBP group		Control group		Test value	p
	Mean ± SD	Min-Max	Mean ± SD	Min-Max		
Mean duration of breastfeeding (minute)						
First follow-up	15.89 ± 5.82	10–40	15.81 ± 6.06	10–40	−1.357[a]	0.175
Second follow-up	21.31 ± 8.15	5–30	23.43 ± 7.73	5–30	−.260[a]	0.795
	n	%	n	%	Test value	p
First follow-up daily breastfeeding frequenc						
<7	1	2.8	2	5.6	.084[b]	1.000
8–10 / every two hours	12	33.3	14	37.6		
Whenever they wanted/cried	23	63.9	21	56.8		
Second follow-up daily breastfeeding frequenc						
<7	6	16.7	6	16.2	0.017 [b]	0.992
8–10 / every two hours	14	38.9	14	37.8		
Whenever they wanted/cried	16	44.4	17	45.9		
Having a breastfeeding problem at the first follow-up						
Yes	16	44.4	27	73.0	−2.460 [b]	0.014**
No	20	55.6	10	27.0		
Breastfeeding problem at first follow-up						
İnsufficient milk production	8	22.2	14	37.8	2.113	0.146
Pain/cracked nipple	9	25.0	10	27.0	0.39	0.844
Breast engorgement	4	11.1	8	21.6	1.467	0.226
Breast pain/plugged ducts	2	5.6	2	5.4	1.000	0.682
Flat/depressed nipple	3	8.3	5	13.5	0.711	0.371
Breast refusal	0	0	1	2.8	1.000	0.507
Having a breastfeeding problem at the second follow-up						
Yes	8	22.2	25	67.6	−3.865 [b]	0.000**
No	28	77.8	12	32.4		
Breastfeeding problem at second follow-up						
İnsufficient milk production	5	13.9	12	32.4	3.512	0.061
Pain/cracked nipple	0	0	5	13.5	0.054	0.029**
Breast engorgement	1	2.8	4	10.8	0.358	0.187
Breast pain/plugged ducts	0	0	2	5.4	0.493	0.253
Flat/depressed nipple	0	0	2	5.4	0.493	0.253
Breast refusal	3	8.3	5	13.5	0.711	0.371
Feeding pattern at first follow-up						
Breast exclusively	31	86.1	24	64.9	4.434[b]	0.035**
Breast milk and formula	5	13.9	13	35.1		
Feeding pattern at second follow-up						
Breast exclusively	32	88.9	24	64.9	5.895[b]	
Breast milk and formula	4	11.1	13	35.1		0.015**

[a] Independent sample t-test.
[b] Pearson Chi-square test. $p < 0.05$.

higher at the first follow-up compared to the scores at the first postpartum day ($p < 0.05$).

When the mean scores of the subscales of the BES were compared to evaluate the breastfeeding problems encountered, no significant difference was found between the MABBP and control groups in the subscale of milk insufficiency concerns. In the MABBP group were found to have significantly higher mean scores from the "breast concerns" subscale of the BES on the first postpartum day compared with the the control group ($p < 0.05$). While the mean scores of the "process concerns" subscale of the BES were found to be higher in the MABBP group in the first follow-up, the mean scores were found to be significantly higher in the control group in the second follow-up ($p < 0.05$). In both groups, the mean scores of the "process concerns" subscale of BES at the first follow-up were found to be significantly higher than the postpartum first-day and second follow-up ($p < 0.05$). The mean scores of the "mechanical concerns" subscale of the BES were found to be significantly higher in the control group compared to the MABBP group at the second follow-up ($p < 0.05$). The mean scores of the social concerns subscale of the BES were found to be significantly higher in the control group compared to the MABBP group at the second follow-up ($p < 0.05$) (Table 4).

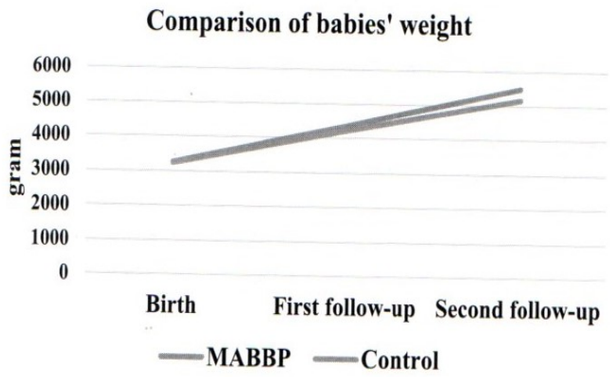

Fig. 2. Comprasion of babies' weight.

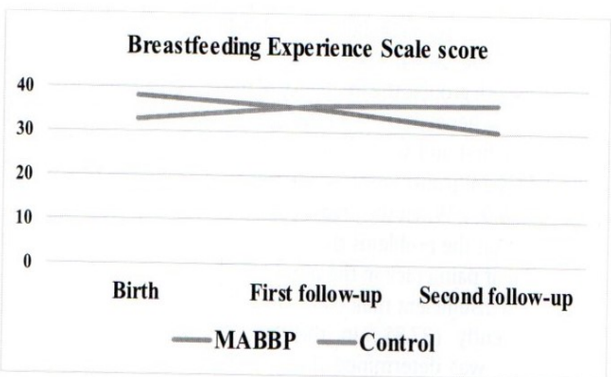

Fig. 3. Comprasion of BES scores.

Table 4
Comparison of the mean BES scores.

Variables	MABBP group		Control group		Test value	p
	Mean ± SD	Min-Max	Mean ± SD	Min-Max		
BES total score						
First postpartum day	38.05 ± 9.69[a]	21–65	32.62 ± 8.82[a]	22–67	−2.799*	0.005
First follow-up	35.22 ± 9.73[b]	22–56	36.00 ± 8.14[b]	23–58	−0.154*	0.878
Second follow-up	30.3 ± 7.44[c]	19–53	36.35 ± 8.58[c]	23–53	−3.038*	0.002
Test/p value	22.237**/ 0.000 c < a, c < b		9.389**/ 0.009	b > a, c > a		
BES subscales						
Milk insufficiency concerns						
First postpartum day	7.66 ± 3.12[a]	3–15	6.83 ± 3.17[a]	3–15	−1.328*	0.184
First follow-up	6.63 ± 2.81[b]	3–12	7.24 ± 3.01[b]	3–12	−0.831*	0.406
Second follow-up	6.13 ± 2.58[c]	3–12	7.37 ± 3.21[c]	3–12	−1.546*	0.122
Test/p value	10.017**/ 0.007	a > b, a > c	0.151**/ 0.927			
Breast concerns						
First postpartum day	5.25 ± 2.24[a]	3–12	4.10 ± 1.64	3–11	−2.542*	0.011
First follow-up	5.13 ± 2.57[b]	3–11	4.43 ± 1.84	3–10	−1.042*	0.298
Second follow-up	3.77 ± 1.14[c]	3–7	3.89 ± 1.36	3–7	−0.013*	0.990
Test/p value	21.868**/ 0.000 a > c, b > c		3.596**/ 0.166			
Process concerns						
First postpartum day	4.52 ± 2.22[a]	2–9	3.78 ± 1.85[a]	2–10	−1.405*	0.160
First follow-up	11.11 ± 2.75[b]	6–16	9.16 ± 1.77[b]	6–14	−3.328*	0.001
Second follow-up	4.33 ± 1.47[c]	2–8	5.29 ± 1.54[c]	2–8	−2.731*	0.006
Test/p value	8.301**/. 016	b > a, b > c	16.357**/0.000	b > c > a		
Mechanic concerns						
First postpartum day	9.50 ± 3.13[a]	5–18	8.72 ± 2.83	5–18	−1.119*	0.263
First follow-up	8.19 ± 2.45[b]	5–14	9.10 ± 2.93	5–19	−1.257*	0.2090
Second follow-up	7.05 ± 1.92[c]	5–13	9.37 ± 3.60	5–19	−3.407*	.001
Test/p value	18.353**/0.000	a > b > c	0.306**/ 0.858			
Social concerns						
First postpartum day	4.52 ± 2.22	2–9	3.78 ± 1.85[a]	2–10	−1.405*	0.160
First follow-up	4.55 ± 1.59	2–8	5.00 ± 1.45[b]	2–8	−1.085*	0.278
Second follow-up	4.33 ± 1.47	2–8	5.29 ± 1.54[c]	2–8	−2.731*	0.006
Test/p value	1.362**/ 0.506		22.786**/ 0.000 b > a, c > a			

BES: Breastfeeding Experience Scale. *Mann Whitney U test. **Friedman test. $p < 0.05$.

Features related to the use of the mobile applications

It was determined that all mothers who used the mobile application thought positively about the application design, that 91.7% of them found it to be simple to use, and that 50% of them used it frequently. Of the mothers, 91.7% stated that the use of the application was beneficial during the breastfeeding. Finding solution to breastfeeding issues, following the breastfeeding process, and having quick access to reliable information were commonly mentioned as advantages of the mobile application. The majority (91.7%) of the mothers stated that the information in the application was sufficient for the breastfeeding. More than half of the mothers (66.7%) stated that keeping a breastfeeding diary had benefits. Only 5.6% of the mothers using the application had problems with entering the application. Most of the mothers (77.8%) stated that they wanted to continue using the application, and 91.7% of them stated that said they would suggest it to other breastfeeding mothers in their environment. It was found that the mothers mostly used the breastfeeding, milking, and unexpected situations tabs of the application. When asked for their recommendations for enhancing the application, they suggested such as "Videos can be added to the content," "The number of notifications can be increased," "A subject search button can be added," and "Content related to childcare can be added" (Table 5).

Discussion

This study was conducted to develop a mobile application-based breastfeeding program in a randomized controlled study and to evaluate its effectiveness. As a result of the research, it was determined that the mobile application-based breastfeeding program positively affected the mothers' breastfeeding experience and contributed to their experiencing fewer breastfeeding problems.

Due to breastfeeding problems experienced by mothers, the time for feeding exclusively with breast milk and the total breastfeeding time can be adversely affected. These breastfeeding problems occur during the first week of breastfeeding. Breast problems are one of these, and they may largely cause prevention or cessation of breastfeeding (Şahin et al., 2013). In a study examining breastfeeding problems in the postpartum three months, it was stated that approximately 70.3% of the mothers experienced breastfeeding difficulties, cracked nipple, pain, insufficient milk perception, fatigue and the difficulties mostly occurred in the first month. Primiparity and an incorrect latching has been reported to be important factors in breastfeeding problems (Gianni et al., 2019). In another study evaluating the early breastfeeding difficulties of mothers, it was determined that 40% of the mothers had breastfeeding problems, the most common problems were the infant's inability to latch on, and sore and cracked nipples. In addition, it has been determined that mothers often fed their infant formula because they are concerned about their milk supply and whether their baby is getting enough milk (Feenstra et al., 2018). In this study, it was found that mothers in the control group had significantly more breastfeeding problems than MABBP group at the first and second follow-up. The results suggest that breastfeeding training and counseling result in decreased breastfeeding problems for mothers (Wong, Mou and Chien, 2021; Giugliani et al., 2015; Lau et al., 2016). Prevention of breastfeeding problems that may occur in the early period and intervention to existing breastfeeding problems are important in terms of maintaining breastfeeding.

Breastfeeding interventions can have a positive effect on the rate of breastfeeding exclusively. Huang et al. (2019) determined that the breastfeeding rate of mothers who received web-based breastfeeding training was 31.7% in the fourth week, while it was 20% in the control group (Huang et al., 2019). In a study where breastfeeding training was given with a home visit on the third postpartum day, it was found

Table 5
Features related to the use of the mobile applications.

Variable	MABBP group	
	N	%
What do you think of the design of the mobile app?		
Positive	36	100
Negative	0	0
What do you think about the ease of use of the mobile application?		
It was so easy	33	91.7
Partly it was easy	3	7.2
How often did you use the mobile application?		
Frequently	18	50.0
Sometimes	15	41.7
Rarely	3	8.3
Do you think the mobile application is beneficial for you and your baby during breastfeeding?		
Yes	33	91.7
I'm undecided	2	5.6
No	1	2.8
If your answer is yes; What are the benefits of using the app?		
Easy access to accurate information	32	88.9
To follow the breastfeeding process	24	66.7
Relieving breastfeeding concerns	20	55.6
Finding solutions to breastfeeding problems	16	44.5
Increasing breastfeeding motivation	14	38.9
Do you think that the information in the mobile application is sufficient for your breastfeeding process?		
Yes	33	91.7
I'm undecided	2	5.6
No	1	2.8
If you evaluate the positive effect of the mobile application on breastfeeding. How many points would you give out of 10? (0: very bad 10: very good)		
0–5	2	5.6
5–7	4	11.1
8–10	30	83.3
Do you plan to continue using the mobile application after work?		
Yes	28	77.8
I'm undecided	5	13.9
No	3	8.3
Would you recommend the mobile application for the use of breastfeeding mothers in your environment?		
Yes	33	91.7
I'm undecided	2	5.6
No	1	2.8
What were the three areas you used most frequently in the mobile application?		
Breast-feeding	34	94.4
Milking	26	72.2
Unexpected situations	22	61.1
Frequently asked questions	20	55.5
Breastfeeding entry	18	50.0

that the breastfeeding rate was significantly higher in the mothers in the experimental group compared with the mothers in the control group at the second week (64% versus 40%), the sixth week (60% versus 33%) and the sixth month (43% versus 23%) (Aksu, Küçük and Düzgün, 2011). In a meta-analysis, it was stated that multicomponent, theory-based breastfeeding interventions of ≥3 sessions through both face-to-face training and telephone follow-up in the prenatal and postnatal period could be effective in improving breastfeeding (Wong et al., 2021). In a study evaluating the effectiveness of the use of "WeChat," one of the largest social networking platforms in China, to support breastfeeding, it was determined that the breastfeeding rate was significantly higher in the experimental group (81.1%) compared to the control group (63.3%) 0–1 month after birth (Wu et al., 2020). A study evaluating the effect of providing smartphone-based daily feedback and counseling platforms on breastfeeding through a postpartum multidisciplinary breastfeeding support team reported that the experimental group had higher breastfeeding rates at six weeks (96.9% versus 82.0%) and three months (81.4% versus 69.0%) after birth compared to the control group (Miremberg et al., 2022). In this study, it was found that the mothers in the MABBP group had significantly higher breastfeeding rates than the mothers in the control group at the first and second follow-up. Similar to the results of other studies, our study results show that breastfeeding support can improve exclusive breastfeeding rates.

In a study conducted to provide individual advice to mothers on breastfeeding via WhatsApp™, "Midwife Breastfeeding Support Line", it was determined that the height measurement values in the first and second months and the head circumference measurement values in the second month were high in experimental group (Yurtsal & Hasdemir, 2022). In a meta-analysis examining the effect of breastfeeding stimulation interventions on child growth, it was found that interventions did not cause changes in weight or length (Giugliani et al., 2015). A study evaluated the effect of breastfeeding counseling on physical development of the baby, and it was determined that the weight of the babies in the experimental group was significantly higher on the 15th postpartum day compared to the control group (Sehhatie et al., 2020). In this study, while there was no significant difference in height and head circumference measurements between the groups in both follow-ups, it was determined that the weight measurements of the infants were higher in the MABBP group compared to the control group in the second follow-up. The results of the study reveal different outcomes regarding the effect of breastfeeding interventions on the physical development of the baby.

Ko et al. (2015) compared the breastfeeding problems faced by Taiwanese and US mothers in the first three weeks after birth, and they determined that the mean BES score was 32.93 ± 9.56 in Taiwanese women and 29.98 ± 7.37 in US women. The highest mean scores in both groups were found to belong to the sub-dimensions of "process concerns", "mechanical concerns", and "concerns about milk deficiency", respectively (Ko et al., 2015). Öksüz (2021) evaluated the effect of WhatsApp™ assisted breastfeeding support on breastfeeding outcomes and found that the mean BES score was significantly higher in the control group in the first month, and there was no significant difference between the experimental and the control group in the second month.[28] In this study, the mean BES score was found to be higher in the MABBP group compared to the control group on the postpartum first day, while it was found to be significantly lower in the second follow-up. Prevention of breastfeeding problems and early intervention are important in terms of maintaining breastfeeding. With this result, the mobile application-based breastfeeding training program can be said to support mothers to prevent and solve breastfeeding problems by obtaining the right information.

In their study analyzing the content of 65 mobile health applications used to support breastfeeding, it was found that 38 mobile applications have been reported to serve mothers mostly in the postpartum period and focus on breastfeeding duration and solving breastfeeding problems (Schindler-Ruwisch et al., 2018). According to a study conducted by Dienelt et al. (2020) with nine Australian breastfeeding mothers using a mobile application related to infant feeding, it was found that infant feeding applications provide mothers with objective information about breastfeeding and baby care (Dienelt et al., 2020). It was determined that these practices provided mothers with more control and confidence during transition and stress in the early stages of having a baby. Although the mothers were positive about mobile applications related to infant feeding, they expressed concerns about the reliability of the information in the application (Dienelt et al., 2020). Another study reported that 57% of the mothers were found to use a mobile application to monitor infant feeding and mothers who used mobile apps were found to have a higher rate of exclusive breastfeeding (Dinour, 2022). Additionally, it was determined that most mothers used the application to monitor various aspects of infant nutrition, breastfeeding start and stop times, total breastfeeding time, and the daily number and amount of breastfeeding (Dinour, 2022). Lewkowitz et al. (2021) determined that most application users (62.2%) stated that the application provided the best breastfeeding support compared with 39% of the control application (application using digital breastfeeding brochure) users in the sixth week. It was found that mothers in the experimental group had 2.5 times fewer breastfeeding problems than mothers in the control group (16.7% versus 42.9%) (Lewkowitz et al., 2021). Similarly, in this study, most mothers in MABBP group stated that the mobile application was easy to use, was useful in terms of easy access to accurate information and adhering to breastfeeding processes, the users expressed a desire to continue to use the application and stated they wanted to recommend the application to others. In line with all these outcomes, it can be concluded that supporting the use of breastfeeding mobile applications, which are suitable for free, online, and offline use and developed by health professionals based on scientific knowledge, will improve breastfeeding results.

Limitations

Conducting the research in a single center creates a limitation in terms of the generalizability of the research results. Another limitation was that the use of application links caused hesitation in some mothers. The mothers' evaluation of their own breastfeeding ability by themselves due to pandemic measures was another limitation to this study.

Implications to practice

As a result of this study, it was found that mobile application-based breastfeeding support improved mothers' breastfeeding experiences. It is suggested that breastfeeding support should include more innovative methods, and nurses could use technology more actively and effectively in breastfeeding process. Mobile application-based breastfeeding support and counseling services could be integrated with breastfeeding monitoring, especially in primary healthcare services, and they could be organized in a way that they can be continuously delivered to mothers without "time and space obstacles."

Conclusions

In this study, it was found that the mobile application-based breastfeeding program positively affected rate of breast milk exclusively and supported mothers to experience fewer breastfeeding problems. Breastfeeding problems experienced in the early period cause of earlier than desired cessation of breastfeeding. For this reason, it is necessary to detect breastfeeding problems early and to provide appropriate breastfeeding support. Breastfeeding support offered at the hospital and during home visits from pregnancy to until cessation of breastfeeding can be provided through phone calls, SMS, mobile applications, and web-based applications. These practices may provide breastfeeding support to more mothers by eliminating time and space limitations.

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CRediT authorship contribution statement

Zehra Acar: Conceptualization, Methodology, Formal analysis, Investigation, Data curation, Resources, Writing – original draft, Project administration, Funding acquisition. **Nevin Şahin:** Conceptualization, Methodology, Resources, Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no conflict of interest.

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