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Evaluating a woman-centred web-based breastfeeding educational intervention in Saudi Arabia: A before-and-after quasi-experimental study ☆

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ABSTRACT

Background: Although digital educational resources are used worldwide to educate new parents, the impact of digital resources tailored specifically to women's needs on breastfeeding practices is not well explored.

Aim: The study aimed to evaluate the effectiveness of using a women-centred Web-Based Breastfeeding Educational Resource (WEBBER) in increasing the rate of exclusive breastfeeding at one month after birth.

Methods: A quasi-experimental study with before and after intervention was conducted in one metropolitan hospital in Saudi Arabia. Participants were primiparous women (n=290) aged 18 or above who intended to breastfeed. The intervention involved introducing the WEBBER to pregnant women and reinforcing its uses as a routine breastfeeding educational resource. Women's characteristics and infant feeding data were collected at one month after birth via an online survey.

Findings: The rate of exclusive breastfeeding at one month postpartum among the women who received the WEBBER intervention was nearly three times higher compared to the women prior to the introduction of the intervention (66 % vs. 26 %, p-*value* <.001). Furthermore, other predictors of exclusive breastfeeding at one month were the mother being unemployed, the baby not receiving infant formula in the hospital, and the mother having postnatal intention to continue breastfeeding for 6 months or more.

Discussion and conclusion: Using WEBBER as a routine breastfeeding educational resource increased the rate of exclusive breastfeeding one month after birth. Embedding woman-centred digital resources into routine breastfeeding education is an effective intervention for women in Saudi Arabia.

Introduction

Breastfeeding initiation within one hour of birth, followed by exclusive breastfeeding for up to six months and continued breastfeeding for up to two years, is highly recommended by the World Health Organization (WHO) [1]. Exclusive breastfeeding is defined by WHO as "Breastfeeding while giving no other food or liquid, not even water, with the exception of drops or syrups consisting of vitamins, mineral supplements or medicines" [2]. Every year, breastfeeding can save more than 820,000 children and prevent 20,000 breast cancer-related deaths [3]. In contrast, the use of infant formula has long been associated with various health risks for both mothers and babies [4]. Mothers who do not breastfeed are at a higher risk of developing metabolic syndrome, including weight gain, type 2 diabetes, and certain cancers such as premenopausal breast cancer and ovarian cancer [5]. Similarly, infants who are not breastfed face an increased risk of developing obesity,

diabetes, and various types of infections, including otitis media, pneumonia, gastroenteritis, and, most significantly, sudden infant death syndrome (SIDS) [5].

Despite the global recommendations, the current rates of breastfeeding initiation and exclusive breastfeeding at six months is less than 50 %, which is below the WHO's target of 70 % by 2023 [6]. In Saudi Arabia, the Holy Quran emphasises encouraging women to breastfeed for up to two years (Surah Al-Baqara, 2: verse 233) [7,8]. However, despite the cultural and religious support, the rate of exclusive breastfeeding to six months in different regions of Saudi Arabia has fallen alarmingly low, with rates between 15.1 % and 28 % [9–11].

In a recent systematic review conducted by Alahmed and colleagues [11], the findings demonstrated that the rates of breastfeeding initiation in Saudi Arabia were approximately 31.5 %, and the rate of exclusive breastfeeding up to six months was even lower at around 15.1 %. The decline in breastfeeding rates can be attributed to several factors, including a lack of breastfeeding education, and support and negative attitudes towards breastfeeding. The perception of insufficient milk supply has been reported as the leading factor among many Saudi mothers to introduce formula to their infants [9,11]. Moreover, returning to work is another influencing factor to early breastfeeding cessation as employed mothers are entitled to only statutory 70 days' maternity leave in Saudi Arabia [11,12].

Additionally, more than two-thirds of mothers in Saudi Arabia receive free infant formula in hospitals, and over 80 % of mothers end up using infant formula after initiating breastfeeding when the hospitals are not accredited by WHO for being Baby-Friendly Hospitals (BFHI) [8,9, 11,13]. The influence of infant formula marketing companies on maternal feeding decisions is an urgent matter that calls for immediate action. Compliance with the WHO Code of Marketing requires the implementation of effective breastfeeding education programs and robust policies to protect and support breastfeeding women and their babies [14]. Breastfeeding educational campaigns, including BFHI accreditation programs [15], have demonstrated successful outcomes in improving breastfeeding rates [14]. However, educating pregnant women with accessible, reliable, and consistent advice is a significant challenge [16–19].

The utilisation of e-technology in health education has gained significant popularity worldwide to capture a large audience with an estimated 6.75 million daily internet health-related queries [20]. Considering that an estimated 94.32 % of the population in Saudi Arabia uses mobile phones to access the internet [21], a web-based intervention has the potential to improve breastfeeding among Saudi women.

To design a website for Saudi women, we adopted a successful and effective intervention called the Milky Way program to develop a Web-Based Breastfeeding Educational Resource named WEBBER. The Milky Way program was an effective face-to-face intervention that involved three antenatal educational sessions and two postnatal follow-up phone calls by a lactation consultant who was also the primary investigator of that study [22]. The main focus was on the perception of low milk supply and linking women to support services [22]. Engaging in the Milky Way program increased rates of breastfeeding by nine times at one month, four times at three months and three times at six months [23]. For the sustainability of the program, the face-to-face intervention was transformed into the Milky Way breastfeeding mobile application, where a persuasive system design (PSD) model was used to transform the human-to-human interaction into a human-to-computer interaction [16].

Persuasive system design model is a model that has been used widely across the world for health behaviour changes [24], including weight loss by improving physical activities [25] and breastfeeding [26].

Additionally, using the Milky Way app demonstrated great success in its accessibility and acceptability by many women [26]. One of the important aspects of using the PSD model is the suitability of an App to be tailored to the users' needs. Therefore, WEBBER adopted the Milky Way app content and structure based on the PSD principles and features,

which was designed for Saudi women's needs [27]. After designing the contents of WEBBER and confirming its cultural appropriateness through a consensus conference [27], the final step was to evaluate the effectiveness of its use through this quasi-experimental study among a group of women in Saudi Arabia to answer the following research question: "What is the effectiveness of using the WEBBER as a routine breastfeeding education resource on the rate of exclusive breastfeeding during the hospital stay and up to one month after birth?" The Hypothesis of this study was that using the WEBBER as a routine breastfeeding education resource can increase the rate of exclusive breastfeeding during the hospital stay and up to one month after birth.

Methodology

Study design

A quasi-experimental study with before-and-after intervention design was employed to evaluate the effectiveness of WEBBER in increasing exclusive breastfeeding rates during the hospital stay and up to one month after birth. Due to the single-site nature of the study, a parallel-arm concurrent study was considered at risk of significant contamination of the intervention among women randomised to usual care. Therefore, a historical control group of women prior to the introduction of WEBBER was chosen as a comparator. Women's feedback about the intervention was collected through the three survey questions and in more detail via semi-structured interviews that will be reported in another paper.

Participants

Participants were primiparous women who intended to breastfeed and would have received care in the study setting.

Inclusion criteria

In this study, the target population consisted of Saudi women, selected to minimise confounding factors and enhance the generalisability of the findings. Eligible participants were required to meet specific criteria, including being at least 18 years old, having experienced a healthy pregnancy, and delivering a healthy full-term baby without any medical conditions that could impact breastfeeding, such as metabolic disorders. Additionally, mothers were required to express the intention to breastfeed at the time of enrollment, demonstrate proficiency in reading and writing Arabic, and have access to the internet via either a computer or a mobile phone.

Only primiparous women (first-time mothers) were included in this study, as previous studies had shown that primiparous mothers had a lower exclusive breastfeeding rate compared to multiparous mothers who had more experience with breastfeeding [28,29]. Furthermore, previous breastfeeding experiences of multiparous mothers would impact subsequent breastfeeding, and this would be a very difficult confounding factor to adjust.

Exclusion criteria

Any woman who could not read and write in Arabic, non-Saudi women, Saudi women under 18 years old, multiparous women, women with multiple births or premature babies, or those with severe medical complications of the baby or mother that could influence breastfeeding practice were excluded from the study.

Study setting

The study was conducted in the Obstetrics and Gynecology department of the Maternity and Children Hospital, Eastern Province, Dammam, Saudi Arabia. This hospital is one of the largest tertiary facilities

accredited under the Baby-Friendly Hospital Initiative (BFHI), with a capacity of 400 beds. The labour and birth unit consists of twenty-three beds, including eleven beds for normal vaginal deliveries, two operating rooms for Caesarean Sections, and ten beds for Induction of Labor and high-risk cases. The managers of the Maternal and Child Health Department have indicated that the hospital has a birth rate of approximately 400–500 per month. This hospital is also the main facility offering maternity services to a large population of Saudi women from various geographical locations in Saudi Arabia.

Standard Care

The standard care provided in the hospital comprised routine antenatal care at the antenatal outpatient clinics. Pregnant women had regular visits with their doctors, occurring every four weeks from the first hospital visit until week 28, followed by every two weeks until week 36, and then weekly until week 40.

Furthermore, the hospital Breastfeeding Support Committee Members, including some nurses and midwives who were breastfeeding educators or consultants, offered two types of antenatal parenting education to all pregnant women and their husbands or accompanying relatives. This education included a one-hour session about pregnancy, labour, and birth and four sessions about breastfeeding: a) two antenatal breastfeeding educational sessions, each lasting for 20 minutes; b) one session after birth; and c) one session via a postpartum phone call. In addition, any women who encountered breastfeeding problems could contact the hospital for professional help.

In this study, women in the standard care group were all women who met the inclusion criteria before the WEBBER intervention was introduced (pre-intervention group).

Details of the WEBBER

The WEBBER is a website adopted from the Milky Way app [30], but designed and developed for women in Saudi Arabia to provide them with essential knowledge about breastfeeding. The development of the website's content was tailored for Saudi women by a comprehensive conceptual investigation, achieved through a systematic review that explored Saudi women's breastfeeding knowledge, attitude, and practices [11]. The Baby-Friendly Hospital Initiative 10 steps have been embedded in its content.

Recognising the importance of cultural appropriateness in interventions is crucial for their effectiveness [31]. Henceforth, to ensure the cultural and linguistic appropriateness of the content, images, and layout of WEBBER, the author organised a consensus development conference [27]. The collaborative effort between university researchers, healthcare professionals, and members of the hospital Breastfeeding Support Committee, including service users from the study setting, aimed to ensure the successful implementation of the educational intervention by addressing cultural considerations. For example, using cartoon images with characters dressed appropriately aligns with Saudi culture.

The website contains evidence-based information about breastfeeding, such as the "Benefits of Breastfeeding," "WHO Recommendations about Exclusive Breastfeeding," "Hazards of infant formula," "Normal Baby Behaviour," "Managing Breastfeeding Challenges," "Expressing and Storing Breast Milk," and "Contraception." Furthermore, the website highlights essential points about breastfeeding, including breastfeeding initiation, skin-to-skin contact, attachment, frequency and duration of breastfeeding, colostrum, rooming in, signs of hunger, signs of having enough milk, breastfeeding positions, and the baby's stomach size.

The intervention

Women in the intervention group received the same antenatal parenting education as those in the standard care group, but in addition,

the head of the Breastfeeding Support Committee gave all the women in the intervention group access to the WEBBER. In collaboration with the head of the Breastfeeding Support Committee, all pregnant women were trained on how to navigate the website to search for information. A poster with two barcodes was created and given to all pregnant women: one barcode linked to the website, and the other linked to a video demonstrating how to navigate the website. The posters about the WEBBER study were displayed in the breastfeeding clinic and in the waiting area of the outpatient antenatal clinic. Furthermore, the head of the Breastfeeding Support Committee encouraged women in the intervention arm of the study to use the website during the routine breastfeeding educational sessions in the hospital. To reinforce the use of WEBBER, reminder messages were sent in collaboration with the head of the Breastfeeding Support Committee through either phone text messages, WhatsApp, or emails to potential participants. The reminder messages were specifically tailored according to women's stage of pregnancy and birth. The main topics for the messages were: a) the importance of exclusive breastfeeding, benefits of breastfeeding, hazards of infant formula (early pregnancy messages), b) skin-to-skin contact, rooming in, attachment, breastfeeding initiation (last trimester and close to birthing date), c) colostrum, normal baby's behaviour, signs of hunger and having enough milk, frequency, and length of breastfeeding (during early postpartum days in the hospitals d) breastfeeding challenges, expressing and storage of breast milk and contraception during breastfeeding (in the first month after being discharged from the hospital). Every week, in collaboration with the head of the Breastfeeding Support Committee, the women were contacted through WhatsApp messaging to ask if they had any breastfeeding questions during the first month after birth and directed them to the specific sections of WEBBER to find guidance or access help. However, if any woman needed professional help, they were asked to contact the Breastfeeding Support Committee Members at the hospital via phone calls and face-to-face visits in their clinic.

Outcomes

The primary outcome was the rate of exclusive breastfeeding at one month after birth. Secondary outcomes were the breastfeeding initiation rate (a) within an hour after birth, (b) after an hour but within 24 hours after birth, and (c) after 24 hours but within 48 hours (delayed initiation). Additionally, data were collected relating to the rate of mixed feeding and predominant feeding at one month, the proportion of babies who received premade infant formula while they were in the hospital, and the proportion of women with the intention to continue breastfeeding for 6 months or more.

Sample size

A sample size of 119 participants in each group was required, based on a Type I error of 0.05 and a power of 0.85, assuming a 17 % absolute increase in the exclusive breastfeeding rate after the intervention. Although the actual exclusive breastfeeding rate at one month after birth was estimated to be between 17.3 % and 18.4 % (Average=18 %) [32], a 17 % increase after using the web-based breastfeeding educational resource for Saudi women was anticipated. Due to an expected attrition rate of approximately 20 %, the overall sample size was planned to be 143 women in each arm of the trial.

Participant recruitment

Participants in the standard care group (pre-intervention) were recruited from October to November 2022 in the post-natal ward after giving birth at the hospital, using a convenience sampling technique. Although this sampling method is associated with multiple biases, it was the most appropriate for a quasi-experimental study where randomisation was not possible as it took place in one hospital [33]. Efforts were

made to minimise bias by controlling and assessing sample representativeness. To minimise bias, all consecutive women who met the inclusion criteria were included in the study. Moreover, participants were recruited in excess of the required number to ensure that both the standard care and intervention groups were not only representative of the Saudi population but also as similar to each other as possible [34]. The head of the Breastfeeding Support Committee distributed participant information sheets, which contained details about the study in both English and Arabic, along with consent forms, by hand to potential participants in the post-natal ward. Once all the women in the standard care group were discharged from the hospital, and the data at one month were collected, access to the website was made available to all pregnant women attending the antenatal clinic in January 2023, regardless of their participation in the study. The participants in the intervention group (post-intervention) were recruited from January to March 2023 in the same manner as those in the standard care group.

Data collection process

One month after the birth, the head of the Breastfeeding Support Committee sent a link for the online survey to the consented participants via WhatsApp or text message on women's mobile phones.

Data collection instruments

The data from each participant were collected through an online survey that included questions about women's demographics, birth data, and breastfeeding practices.

The first part addressed the participant's socio-demographic information, including age, educational level, employment status, and marital status. The second part that addressed the birth data included questions about the type of birth, neonatal health status, and age of the baby at the time of data collection in weeks. The third part of the survey addressed the postnatal breastfeeding practices from birth to one month after birth and their intention to continue breastfeeding for 6 months or more.

Data Analysis

All data management and statistical analysis were undertaken using the R language for statistical computing [35]. The characteristics of study participants have been presented using descriptive statistics, and inferential statistics were used to compare the primary and secondary outcome measures between the pre-intervention group and the WEBBER intervention group. A p-value of <0.05 was considered as being statistically significant, and outcomes of interest are presented as risk differences and associated 95 % Confidence intervals (95 % CI). Potential
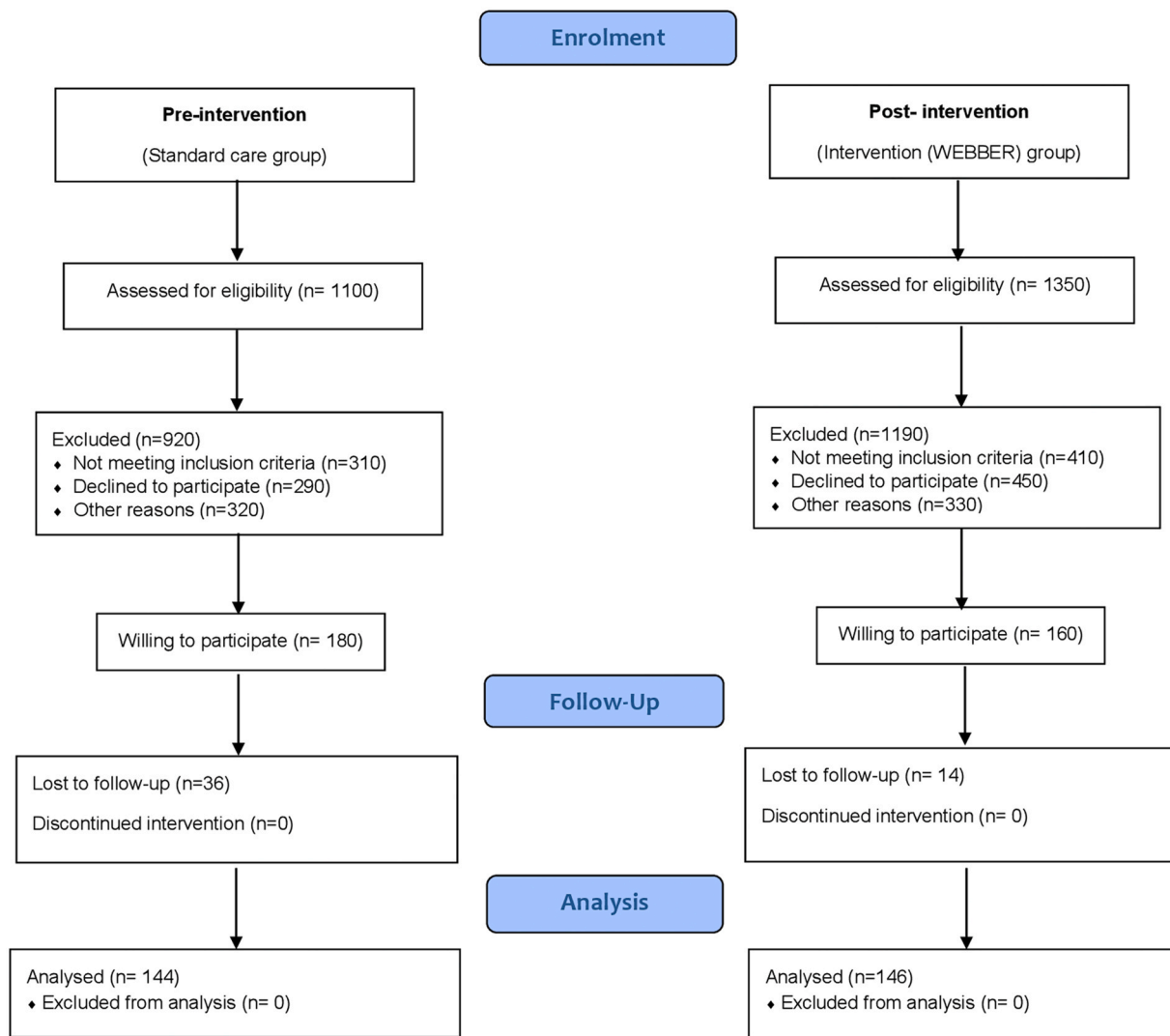

Fig. 1. CONSORT flow diagram.

confounding factors were adjusted using regression analysis. Due to the predicted primary outcome of interest being > 10 % in the control group, a log-binomial regression model was used to adjust for confounders, and the estimate was presented as a rate ratio (95 % CI) [36].

Results

The CONSORT flow diagram of the study is presented in Fig. 1. A total of 2450 women (1100 pre-intervention, 1350 post-intervention) between October 2022 and February 2023 were initially assessed for eligibility. After applying exclusion criteria, 340 participants (180 pre-intervention, 160 post-intervention) were selected for inclusion in the study. Around 50 participants dropped out (36 pre-intervention, 14 post-intervention), resulting in a final sample size of 144 in the standard care group and 146 in the intervention (WEBBER) group.

Demographics

All women in both groups were married, and the timing of their decision to breastfeed (before pregnancy, during pregnancy or after giving birth) varied with no significant differences. Furthermore, there was no significant difference between groups regarding employment status (employed or unemployed) and type of birth. However, women in the WEBBER group were older (28.1 ± 4.6 years vs 26.5±5.42 years, $p <$ 0.001) and had higher educational levels compared to the standard care group (Table 1). These confounding factors have been considered in the data analysis using regression analysis.

Primary outcome

The proportion of Saudi women who practiced exclusive breast-feeding up to one month after birth was significantly higher in the WEBBER group (66 %, n=97) compared to the standard care group (26 %, n=38), with an absolute difference of 40 % (95 % CI, 28.9–49.7 %, p<.001). Participating in the WEBBER intervention doubled the rate of exclusive breastfeeding at one month. Considering

Table 1
Characteristics of the study participants based on WEBBER support or standard care-only status.

	WEBBER (n=146)	Standard care only (n=144)	p-value
Age of women (years), Mean (SD)	28.1 (4.60)	26.5 (5.42)	0.001*
Educational level, n (%)			0.005*
Doctoral Degree	1 (1)	0 (0)	
Master's degree	7 (5)	1 (1)	
Bachelor's degree	72 (49)	52 (36)	
Diploma degree	29 (20)	34 (24)	
Secondary School	31 (21)	56 (39)	
Intermediate School	4 (3)	1 (1)	
No schooling but able to read and write	1 (1)	0 (0)	
Employment status, n (%)			0.123
Employed*	51 (35)	37 (26)	
Unemployed*	94 (64)	107 (74)	
Type of birth, n (%)			0.751
Normal vaginal birth	112 (77)	104 (72)	
Caesarean section	25 (17)	32 (22)	
Instrumental vaginal birth or assisted	8 (5)	7 (5)	
Decision time regarding breastfeeding the baby**			0.072
Before pregnancy	82 (56)	72 (50)	
During pregnancy	41 (28)	41 (28)	
After giving birth	20 (14)	18 (12)	

Note: * Employed women were on maternity leave, and unemployed were non-working women.
**3 missing data from the WEBBER group and 13 from the standard group

Table 2
Primary and secondary outcomes of interest.

	WEBBER (n=146)	Standard care only (n=144)	Difference (95 % CI), p-value
Primary outcome			
Exclusive breastfeeding at one month, n (%)	97/146 (66 %)	38/144 (26 %)	40 % (28.9–49.7 %), <0.001*
Secondary outcome			
Breastfeeding initiation after birth			
Within one hour	95/143 (66.4 %)	73/131 (55.7 %)	10.71 (-0.79, 22.21), 0.069
After 1 hour but within 24 hours	36/143 (24.7 %)	18/131 (12.5 %)	12.2 % (3.2–20.9 %), 0.008*
After 24 hours but within 48 hours(delayed***)	12/143 (8.2 %)	40/131 (27.8 %)	12.2 % (-28.1 to -10.9 %), <0.001*
During hospital stay			
Baby receiving premade infant formula in hospital[1]	62/146 (42 %)	106/144 (74 %)	-32 % (-41.3 to -19.9 %), <0.001*
At one month after birth			
Mixed feeding	41/146 (28 %)	85/144 (59 %)	-31 % (-41.1 to -19.7, <0.001*
predominant feeding	5/146 (3 %)	2/144 (1 %)	2 % (-2.0-6.5), 0.259
Intention to continue breastfeeding for 6 months or more	131/146 (90 %)	110/144 (76 %)	14 % (4.7–21.9 %), 0.002*

Note: [1] Among the breastfeeding initiation after birth responses, there were some missing data. In the Intervention group, 3 data points were missing, and in the Standard care group, 16 data points were missing. * p-value is adjusted for mother's age, educational status, employment status, type of birth, Baby receiving premade infant formula in hospital, and intention of breastfeeding. **The details of the specific reasons and the frequency between the intervention and the standard care groups are presented in Fig. 2.

that the estimated number needed to treat was approximately 2.5, in other words, for every five women offered the intervention, we can expect an extra two women exclusively breastfeeding at one month (Table 2).

Secondary outcomes

Breastfeeding initiation within an hour after birth was higher in the WEBBER group (66.4 %, n=95) compared to the standard care group (55.7 %, n=73), with an absolute difference of 10.7 % (95 % CI, −0.79–22.21 %). However, the difference was not statistically significant (p=0.069). A higher proportion of women in the WEBBER group (24.7 %, n=36), with an absolute difference of 12.2 % (95 % CI, 3.2–20.9 %) breastfed within 24 hours compared to the standard care group (12.5 %, n=18) (p < 0.008). Conversely, more women in the standard care group (27.8 %, n=40), with an absolute difference of 12.2 % (95 % CI, −28.1 to −10.9 %) initiated breastfeeding after 24 hours compared to the WEBBER group (8.2 %, n=12) (p < 0.001). During the hospital stay, a lower proportion of babies in the WEBBER group (42 %, n=62), with an absolute difference −32 % (95 % CI, −41.3 to −19.9 %) received premade infant formula compared to the standard care group (74 %, n=106) (P<0.001). At one month after birth, the proportion of women who used mixed feeding method was lower in the WEBBER group (28 %, n=41), with an absolute difference −31 % (95 % CI, −41.1 to −19.7 %) compared to the standard care group (59 %, n=85) (p < 0.001). However, the majority of women in the WEBBER group (90 %, n=131), with an absolute difference of 14 % (95 % CI, 4.7–21.9 %) expressed their intention to continue breastfeeding for 6 months or more, compared to 76 % (n=110) in the standard care group (P=0.002) (Table 2).

Reasons for delayed BF

The most common reasons for delayed breastfeeding initiation and offering formula during hospital stay were the mother had a caesarean section (CS), the mother's tiredness, and the babies' admission to a nursery or Neonatal Intensive Care Unit (NICU) (Fig. 2).

Predictors of exclusive breastfeeding

The predictors of exclusive breastfeeding at one month included intention to continue breastfeeding for 6 months or more, access to WEBBER intervention, baby not receiving premade infant formula in the hospital, and unemployment status of the women (P<0.001) (Table 3).

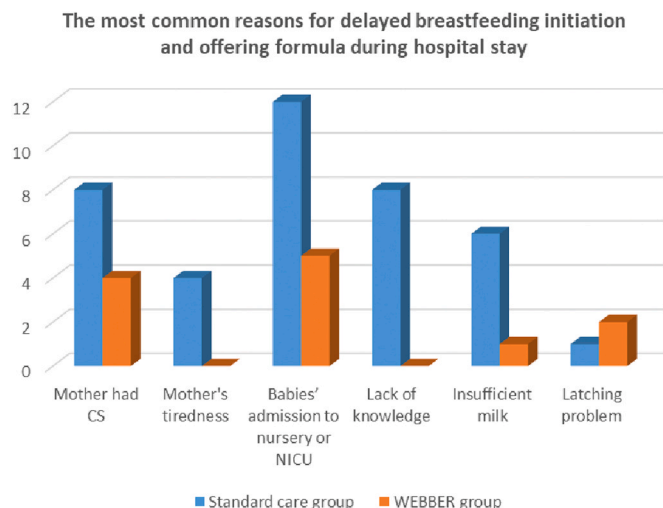The women in the intervention group were older and had higher

Fig. 2. The reasons for delayed breastfeeding initiation and giving formula.

Table 3
Predictors of exclusive breastfeeding at one month.

	Model RR (95 % CI) Un-adjusted	Adjusted (all variables)		Adjusted (final model)[a]	
WEBBER (yes vs. no)	2.52 (1.62–3.91)	< 0.001	1.8 (1.1–2.93)	0.018	1.75 (1.09–2.82)	< 0.001
Employment status (unemployed vs. employed)	1.61 (1.05–2.46)	0.028	1.61(0.97–2.70)	0.068	1.55 (0.99–2.42)	< 0.001
Baby receiving premade infant formula in hospital (yes vs. no)	0.39 (0.26–0.60)	< 0.001	0.52 (0.32–0.83)	0.006	0.51 (0.33–0.81)	< 0.001
Intention to continue breastfeeding for 6 months or more (yes vs no)	5.07 (1.97–13.06)	< 0.001	3.73 (1.40–9.94)	0.009	3.67 (1.40–9.63)	< 0.001
Age (1+yr)	1.03 (0.99–1.07)	0.183	1.0043 (0.96–1.05)	0.857		
Educational level						
Bachelor's degree	1.0 (ref)		1.0 (ref)			
Doctoral Degree	NE		NE			
Master's degree	1.55 (0.51–4.67)	0.436	0.85 (0.25–2.88)	0.677		
Diploma degree	0.98 (0.58–1.68)	0.953	1.09 (0.61–1.94)	0.772		
Secondary School	0.84 (0.51,1.39)	0.497	1.16 (0.65,2.07)	0.616		
Intermediate School	1.24 (0.29,5.36)	0.773	1.39 (0.3,6.47)	0.677		
No schooling but able to read and write	NE		NE			
	Model RR (95 %CI) Un-adjusted	Adjusted (all variables)		Adjusted (final model)[a]	
Type of birth						
Caesarean section	1.0 (ref)		1.0 (ref)			
Normal vaginal birth	0.93 (0.56,1.56)	0.79	0.9 (0.5,1.61)	0.711		
Instrumental vaginal birth or assisted vaginal birth	1.09 (0.41,2.86)	0.868	1.22 (0.41,3.66)	0.719		

[a] Final model variables based on stepwise selection. Due to missing events in some categories, the rate ratio was not able to be estimated (NE) due to zero events.

educational levels compared to the standard care group, as shown in Table 1. After adjusting for these potential confounders (age of the women and educational level) using a log-binomial regression model, intention to continue breastfeeding for 6 months or more was the strongest predictor, increasing the probability of exclusive breastfeeding by nearly four times at one month. Additionally, women who accessed the WEBBER intervention had a 75 % higher probability of exclusive breastfeeding compared to those in the standard care group. Employment status played a significant role; unemployed women had a 55 % higher probability of exclusive breastfeeding compared to employed women. Giving infant formula to the baby during the hospital stay reduced the probability of exclusive breastfeeding, almost halving it compared to those who did not receive infant formula (0.51 versus 1.0 for those not receiving infant formula).

Discussion

Based on the hypothesis of the study, using the online educational intervention called WEBBER as a routine breastfeeding educational resource increased the rate of exclusive breastfeeding at one month after birth among Saudi women The results of the study revealed that the rate of exclusive breastfeeding in the WEBBER group at one month after birth was almost three times higher than the standard care group. Additionally, there was a significant increase in breastfeeding initiation rate within the first 24 hours and exclusive breastfeeding rate during the hospital stay among women who were in the WEBBER group compared to the women in the standard care group. The observed increase of 40 % in exclusive breastfeeding rate at one month in the WEBBER group exceeded the original figure of 17 % predicted during the sample size calculation, indicating the effectiveness of the WEBBER intervention.

This is the first study in Saudi Arabia that has demonstrated an increase in the rate of exclusive breastfeeding both during women's hospital stay and at one month after birth. The reasons for the success of this intervention are multi-dimensional. One reason is the adoption of the Milky Way app, which was based on a successful woman-centred breastfeeding educational intervention called the Milky Way program [23] with a focus on the early introduction of antenatal breastfeeding education and postnatal support [22,27]. The results of different systematic reviews highlighted the importance of early antenatal education and postnatal support for improving breastfeeding outcomes [17,37].

Another reason for its success was that WEBBER was tailored to the consumers' needs, as recommended in the persuasive system design model. According to the PSD model, tailoring for the end user is highlighted as crucial in designing e-technology-based interventions for breastfeeding, ensuring the best success [16,26].

More importantly, the WEBBER was embedded into routine breastfeeding education and support services, and its use was reinforced by the head of the Breastfeeding Support Committee via an agreement and approval from the stakeholders of the study setting. According to the findings of the systematic review, introducing e-technology-based interventions without reinforcing their usage may not lead to effective outcomes in health behaviour changes [38]. This has been demonstrated in other mHealth interventions that utilised PSD models to reinforce various health behaviours, such as those related to weight loss [25], compliance with medication [39], and smoking cessation [40,41]. Furthermore, other studies have also highlighted the effectiveness of smartphone-based and Mobile Health interventions in improving breastfeeding practices when their use was reinforced by health professionals or peers [42,43].

The findings of this study make significant contributions to the existing literature on rates of breastfeeding initiation. The breastfeeding initiation rate within 24 hours after birth was significantly higher in the WEBBER group compared to the standard group (91.1 % vs 68.2 %). These results highlight the importance of the WEBBER intervention in improving breastfeeding initiation, particularly in Saudi Arabia, where rates of early initiation are relatively low, ranging from 31.5 % to

43.6 % [11,44]. While the study did not directly investigate the relationship between early initiation of breastfeeding and exclusive breastfeeding, previous research has shown a positive association between these practices [45].Thus, promoting early initiation through the WEBBER intervention is likely to have a positive impact on improving exclusive breastfeeding practices for a longer duration as well.

In this study, the four main predictors of exclusive breastfeeding at one month were identified: a) accessing to the WEBBER intervention, b) employment status, c) whether the baby received infant formula during a hospital stay and d) the intention to continue breastfeeding for 6 months or more. Intention to continue breastfeeding for six months or more was the strongest predictor in this study. Women who intended to continue breastfeeding for long periods were five times more likely to exclusively breastfeed at one month after birth. These findings are consistent with other studies as well [10,46,47].

Unemployed women in this study were more likely to breastfeed exclusively at one month compared to employed women who were on maternity leave, which is consistent with the findings of previous studies [47,48]. However, in some studies, employment status was not a significant predictor of exclusive breastfeeding [10]. This variation in findings may be attributed to employee support for breastfeeding women in Saudi Arabia, where they have limited or no parental leave or baby-friendly breastfeeding policies [49]. Paid maternity leave for employed women is crucial for maternal and child health. In 2019, employed women in Saudi Arabia were given 70 days of paid maternity leave in general [12]. Extending maternity or paternity leaves with a baby-friendly workplace environment can improve breastfeeding practices [49,50].

Finally, our study revealed a significant association between the introduction of infant formula to babies in the hospital and a decreased probability of exclusive breastfeeding at one month after birth. By introducing formula to an infant in the hospital, the likelihood of exclusive feeding at one month was reduced by half. It is noteworthy that offering premade infant formula to women after birth is a common practice in Saudi Arabia [8,9,11,44]. However, women who were engaged with the WEBBER intervention were less likely to use the free premade infant formula and gave only their milk to their infants, whereas approximately 74 % of women in the standard care group used the provided premade infant formula during their hospital stay. In many Saudi hospitals, infant formula is commonly offered to babies immediately after birth, which has been associated with reduced duration and exclusivity of breastfeeding [51].

Although the World Health Organization has developed the International Code of Marketing of Breastmilk Substitutes to address these concerns and recommends against promoting infant formula in public hospitals, recently, social media has been identified as the current platform for formula companies to promote using infant formula among pregnant women [52]. The WEBBER study in Saudi Arabia is the first of its kind to report a significant reduction in the use of infant formula among women who received educational intervention through the WEBBER. Empowering women to decline the use of infant formula is an outstanding achievement for long-term breastfeeding success, which is aligned with respectful and woman-centred care [53].

Strengths and limitations

The study has several strengths that contribute to its validity and effectiveness. One of the main strengths is the design of the WEBBER, which was based on the previous successful Milky Way breastfeeding intervention with early antenatal education. Its appropriateness for the women's needs and use as a routine breastfeeding resource in the study setting are also strengths. Furthermore, WEBBER's availability in both Arabic and English languages suits Saudi women's needs and makes it accessible to all, including Arabic and non-Arabic-speaking women.

Several limitations must be considered. Due to restrictions caused by the COVID-19 pandemic, the quasi-experimental study was conducted

only in one hospital among Saudi primiparous women, which consequently introduces limited generalisability of the study and the possibility of sampling bias, as the majority of women in the WEBBER Study were educated and potentially better-informed. This could have impacted the study outcome, as highly educated women are more likely to initiate and continue breastfeeding in developed countries. [11]. To manage this limitation and to mitigate potential biases, the data analysis employed log-binomial regression analysis to adjust for confounding factors, including education level and employment status.

Implications and recommendations

This study highlights the value of tailored educational resources, early education, culturally appropriate intervention, and supportive policies to promote exclusive breastfeeding. By incorporating these recommendations into practice, stakeholders can contribute to healthier mothers, infants, and communities. Healthcare practitioners should consider incorporating similar interventions into routine antenatal and postnatal care. These interventions can be tailored to address the specific needs and preferences of diverse populations, thereby enhancing their impact.

Given that many women decide to breastfeed before pregnancy, healthcare providers should offer educational and support services well before childbirth. Antenatal classes and counselling sessions can provide evidence-based and comprehensive information about the benefits of breastfeeding, proper latch techniques, and common challenges. Early intervention can empower women to make informed decisions and enhance their confidence in breastfeeding. Tailoring interventions to suit different educational backgrounds and cultural contexts can ensure that all women receive appropriate support and guidance. Healthcare facilities should prioritise implementing evidence-based practices that support breastfeeding, including skin-to-skin contact immediately after birth and avoiding unnecessary formula supplementation.

The implementation of WEBBER can have significant value among Saudi women. However, it can be used among populations with Arabic cultural backgrounds in English- and Arabic-speaking countries. Future studies may consider translating the website to other languages based on the needs of specific populations to enhance the accessibility and effectiveness of the intervention. Furthermore, while this study assessed the impact of WEBBER intervention on exclusive breastfeeding during hospital stay and at one month after birth, further studies should aim to assess its impact on breastfeeding outcomes up to six months after birth or beyond.

Finally, future studies should consider utilising a randomised controlled trial approach to evaluate the effectiveness of WEBBER in multiple hospitals across diverse regions of Saudi Arabia to reduce potential bias and improve the generalisability and validity of the findings. As part of our study, we collected qualitative data through interviews to better understand the women's experiences using the WEBBER during antenatal and postnatal periods. The qualitative data will be published separately.

Conclusion

This study highlights the effectiveness of WEBBER intervention in promoting breastfeeding initiation and exclusive breastfeeding rates during the hospital stay and one month after birth in a hospital setting where giving infant formula is a common practice. The findings of this study suggest that embedding woman-centred and culturally appropriate digital resources into routine breastfeeding education is an effective intervention for women in Saudi Arabia.

These results provide valuable information for healthcare professionals, policymakers, and researchers aiming to enhance breastfeeding rates and support new mothers in their breastfeeding journey. Further research is warranted to explore the long-term effects of the WEBBER intervention and to refine strategies for promoting exclusive breastfeeding.

Ethical consideration

Ethical approval was received before starting any data collection from the University of Wollongong, Australia (Approval No. 2022/245) and Maternity and Children Hospital, Dammam, Saudi Arabia (Approval No. EXT-BF-2022–001).

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CRediT authorship contribution statement

All persons who meet authorship criteria are listed as authors, and all authors certify that they have participated sufficiently in the work to take public responsibility for the content, including participation in the concept, design, analysis, writing, or revision of the manuscript. Furthermore, each author certifies that this material or similar material has not been and will not be submitted to or published in any other publication before. All authors have seen and approved the manuscript being submitted. The author(s) abide by the copyright terms and conditions of Elsevier and the Australian College of Midwives.

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Conflict of Interest

None to declare.

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