







# The effect of electronic job aid assisted one-to-one counselling to support exclusive breastfeeding among 0–5-month-old infants in rural Bangladesh

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## Abstract

Exclusive breastfeeding (EBF) for the first 6 months has established benefits, yet had slow improvements globally. Little is known about electronic job aid-assisted counselling to support EBF. As a secondary outcome of a cluster randomized controlled trial in Bangladesh, we assessed the effect of electronic job aid-supported nutrition counselling and practical demonstration on EBF. We randomized pregnant women to one of five study arms in the trial and followed mother–child dyads until 2 years of age. Community health workers (CHWs) provided breastfeeding counselling with or without prenatal and complementary nutrient supplements in all four intervention arms. The comparison arm continued with the usual practice where mothers could receive nutrition counselling at routine antenatal and postnatal care, and during careseeking for childhood illnesses. We assessed breastfeeding indicators at birth and monthly until the child was 6 months old, in both intervention and comparison arms. To evaluate the effect of nutrition counselling on breastfeeding, we combined all four intervention arms and compared them with the comparison arm. Intervention newborns had half the risk (relative risk [RR]: 0.54, 95% confidence interval [CI]: 0.39, 0.76) of receiving prelacteal feeds than those in the comparison arm. EBF declined steeply in the comparison arm after 3 months of age. EBF was 16% higher in the intervention than the comparison arm at 4 months (RR: 1.16, 95% CI: 1.08, 1.23) and 22% higher at 5 months of age (RR: 1.22, 95% CI: 1.12, 1.33). Maternal background and household characteristics did not modify the intervention effect, and we observed no difference in EBF among caesarean versus vaginal births. Breastfeeding counselling and practical demonstration using an electronic job aid by CHWs are promising interventions to improve EBF and are scalable into existing community-based programmes.

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**KEYWORDS**

breastfeeding, cluster randomised controlled trial, community-based, community health workers, counselling, low- and middle-income countries, mHealth, newborn feeding behaviours

## 1 | INTRODUCTION

Childhood undernutrition with high geographic disparities and socioeconomic inequalities remains a major challenge in low- and middle-income countries (LMICs), where nearly all under-5 children with inadequate growth reside (Local & Burden of Disease Child Growth Failure Collaborators, 2020; Micha et al., 2020). During the 'first 1000 days of a child's life', exclusive breastfeeding (EBF) for the first 6 months and optimal breastfeeding up to 2 years is among the priority nutrition interventions (Keats et al., 2021). Breastmilk provides the best combination of nutrients, immunologic components, and hormones for newborns and infants. It helps in developing children's gut microbiota, reduces the risk of infections and contributes to proper physical and cognitive growth through multiple interconnected pathways (Ho et al., 2018; Victora et al., 2016). These are linked to long-term positive health effects including reduced risk of obesity, metabolic syndrome, diabetes, and certain cancers (Victora et al., 2016; Wisnieski et al., 2018). Despite the known benefits, breastfeeding practices are suboptimal globally and achieving universal coverage of 90% EBF remains a far-reaching target (Cai et al., 2012; Jones et al., 2003). In Bangladesh, the prevalence of EBF among 0–5-month-old children stagnated at around 65% between 2011 and 2017 (NIPORT et al., 2019). The high EBF prevalence (82%) among 0–2-month-old infants reduces by half to only 40% in those aged 4–5 months.

Hurdles against optimal breastfeeding practices often remain pervasive. Previous studies identified several barriers against EBF in LMICs, grouped under the prenatal period, the first day of birth, and the first 6-month period. Overall, identified barriers included poor maternal knowledge and awareness on benefits and techniques of EBF, lack of breastfeeding self-efficacy and long-term intention to breastfeed, poor understanding of children's hunger cues, perceived importance of the early introduction of weaning food, especially through elders of the family, the perceived association between EBF with mothers' health problems and inadequate dietary intake, inadequate knowledge of health care providers, and contextual challenges such as increased caesarean section births and maternal employment (Brockway et al., 2017; Kavle et al., 2017).

Nutrition intervention frameworks consistently include supporting and promoting optimal breastfeeding (Bhutta et al., 2013; Keats et al., 2021). A recent comprehensive systematic review of evidence from LMICs by Lassi et al. (2020) suggested nutrition education interventions provided in facilities, communities or both settings resulted in increased prevalence of EBF. Challenges to optimal breastfeeding can be mitigated through bottom-up counselling by skilled counsellors who can deliver the messages and practical demonstration of breastfeeding techniques in a person-sensitive, culturally appropriate way (Schmied et al., 2011). Community health

### Key messages

- Using an electronic job aid, repeated, one-to-one counselling and practical demonstration to mothers by locally recruited CHWs reduced prelacteal feeding and improved EBF practice by delaying the early introduction of complementary food.
- The positive effect of counselling on EBF remains similar with or without nutrient supplementation.
- Electronic job aid supported counselling to promote breastfeeding should be integrated into existing community-based maternal and child health programmes.

workers (CHWs) and peer support counsellors can effectively promote breastfeeding (Lassi et al., 2020; Shakya et al., 2017). However, proper training and job aids for them to support counselling are prerequisites, which remain challenging in LMICs. Breastfeeding counsellors need to be knowledgeable on breastfeeding issues and solutions for common problems, and job aids may be a useful tool for on-site support for counsellors.

With the global boost in digitalization of health interventions, electronic job aids showed improvements in health and nutrition service delivery (Källander et al., 2013). Several studies have shown a positive impact of electronic job aid tools in medical record-keeping and health applications. However, rigorous impact evaluations of mHealth (delivering health interventions with the support of mobile devices) are scarce (Aranda-Jan et al., 2014; Källander et al., 2013; Perri-Moore et al., 2015; Wang et al., 2017). Efforts to integrate digital health interventions to improve breastfeeding practices have mainly been made in high-income countries (Tang et al., 2019). Such initiatives include web-based learning and education platforms for healthcare providers and parents. These have been delivered through text messaging, phone calls, video conferencing and interactive kiosk or automated interactive agents for breastfeeding promotion and support to mothers, and mobile applications for improving paternal support in breastfeeding (Lau et al., 2016; Tang et al., 2019). Applications of electronic job aids for health care providers for supporting and promoting breastfeeding in LMIC settings are only emerging (Modi et al., 2019).

We conducted a community-based five-arm cluster randomized controlled trial (C-RCT) in a rural area of north-Eastern Bangladesh. The study primarily sought to explore the combined effect on children's linear growth of selected nutrition-specific interventions provided to mother–child pairs throughout the first 1000 days of life (Billah et al., 2017). The interventions included time-specific nutrition counselling and small quantities of lipid-based prenatal and complementary nutrient

supplements (LNS), provided in different combinations in the intervention arms. Women in the intervention arms received electronic job aid-supported one-to-one counselling and practical demonstration on appropriate breastfeeding practices between their third trimester of pregnancy to 5 completed months of children's age. In the present study, we analysed and presented a secondary outcome of the trial: effectiveness of the electronic job aid-supported nutrition counselling and practical demonstration intervention package on improving EBF practices in the first 6 months of the infant's life.

## 2 | METHOD

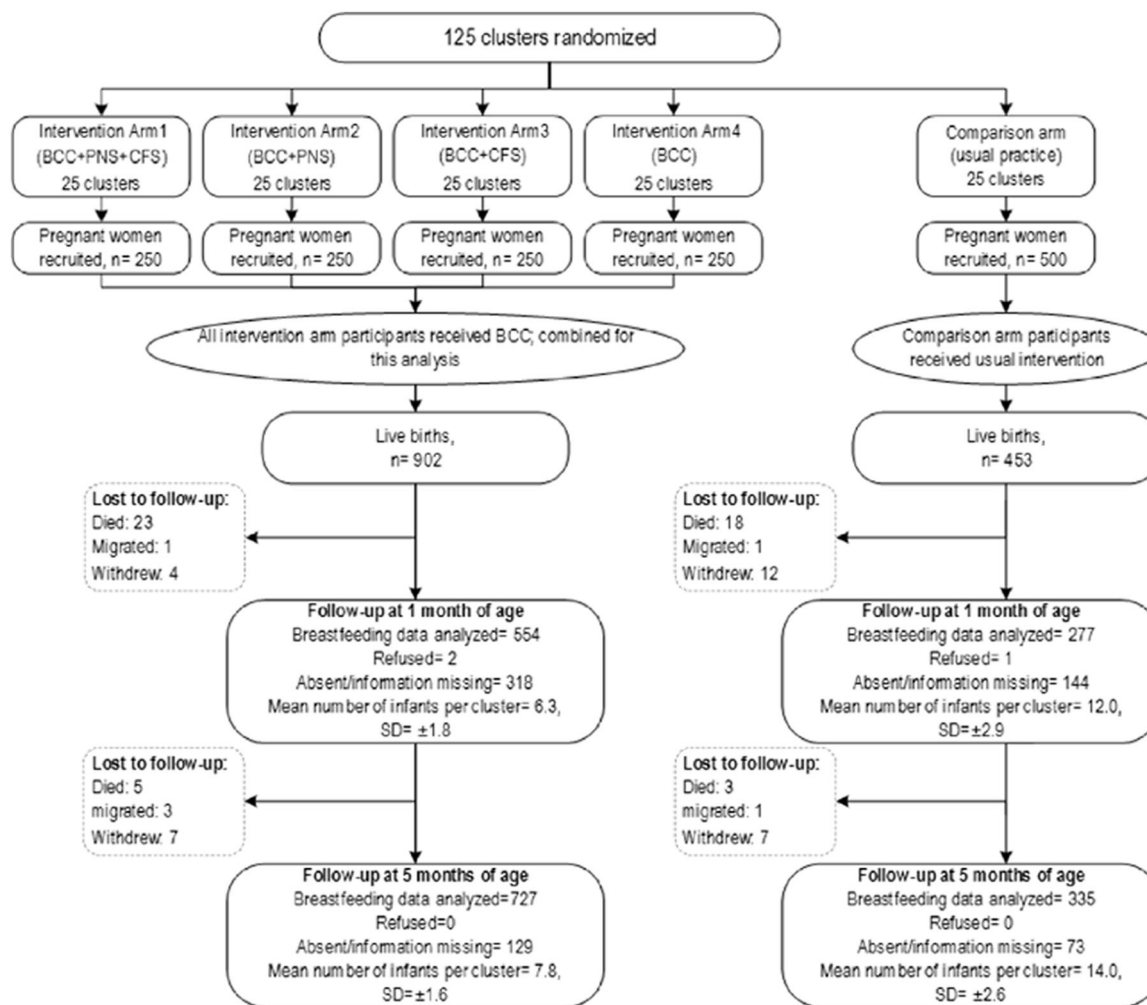
### 2.1 | Study settings

We implemented the C-RCT in Bahubal and Nabiganj sub-districts of Habiganj district, situated in Sylhet Division in the northeastern side of Bangladesh. This region has the highest infant mortality (52 per 1000

live births) and childhood stunting (43%; NIPORT et al., 2019). We selected 12 unions, the smallest administrative unit consisting of ~30,000 people, from the 2 subdistricts, excluding the unions with interrupted transport connectivity due to yearly monsoon flooding and ongoing targeted maternal and child nutrition promotion interventions in addition to routine public health nutrition services (Billah et al., 2017). The study area had ~350,000 inhabitants, about 40% literacy and agriculture was the main source of living (BBS, 2013).

### 2.2 | Trial design

We published a detailed description of the trial design in previous papers reporting the trial protocol and other outcomes (Billah et al., 2017, 2021). In summary, the C-RCT had four intervention arms and a usual practice comparison arm (Figure 1). All four intervention arms provided one-to-one counselling to participants on appropriate nutritional practices during pregnancy and age-appropriate feeding



BCC: Behaviour change communication, refers to counselling and practical demonstration on breastfeeding using an electronic job aid; PNS: Lipid-based prenatal nutrient supplement, CFS: Lipid-based complementary nutrient supplement during 6-23 months of age

FIGURE 1 Trial profile including study arms and participants.

practices for the child up to 2 years of age. Some counselling sessions also included practical demonstrations of breastfeeding techniques as required. Three of the four intervention arms also had LNS provided to pregnant women and/or children at 6–23 months. One arm had both pregnant mothers' and children's LNS (Arm 1: nutrition-specific behaviour change communication counselling [BCC] + lipid-based prenatal nutrient supplement [PNS] + lipid-based complementary nutrient supplement [CFS]), and two had either mothers' LNS or children's LNS (Arm 2: BCC + PNS; Arm 3: BCC + CNS; Arm 4 had BCC only). The LNS included 22 micronutrients and small amounts of lipid and protein. All intervention components were delivered by CHWs, extensively trained by the research team. Participants in the 'usual practice' comparison arm did not receive nutrition counselling visits by study CHWs. In all intervention and comparison arms, mothers could receive nutrition services during antenatal care (ANC) visits and advice on child feeding practices at postnatal care (PNC) and outpatient sick child management services, delivered at public, private and nongovernment health care services. Nonetheless, previous studies reported a low reach of these services during the antenatal and postpartum care continuum and suboptimal nutrition-specific services at these contacts (Billah et al., 2022; Saha et al., 2015). This study analyses the effect of one-to-one counselling and practical demonstration on breastfeeding indicators for children aged 0–5 months. We combined all four intervention arms into a single intervention arm and compared this intervention arm with the comparison arm (Billah et al., 2017, 2021).

### 2.3 | Randomization and participant enrolment

In the original C-RCT, we created clusters of an average size of 2000 people and randomized 125 clusters in the five study arms. We applied computer-assisted block randomization of clusters to ensure balance in cluster size across the study arms. An independent statistician ran the block randomization sequence for the study clusters blinded to the cluster name and location. During participant enrolment, the field-based study data collectors were unaware of the cluster allocation status. We removed blinding of the CHW after participant enrolment, and there was no blinding of the participants. The field team enrolled pregnant women within 125 days since the first date of the last menstrual period and permanent residents in the study village.

### 2.4 | Sample size

For the original study, we estimated the sample size for the study based on the primary outcome of 0.4 higher mean height-for-age Z score at 2 years of age (Billah et al., 2017). As presented in the current analysis, we doubled the sample size in the comparison arm to increase the power for estimating the intervention effect on secondary outcomes, such as EBF among 0–5-month-old children. We enrolled 1500 pregnant women, 1000 in the 4 intervention arms

(250 per arm) and 500 in the comparison arm, adjusting for possible follow-up losses (miscarriages, abortions, stillbirths, migration-out, mortality among 0–23-month-old children and other dropouts). Accordingly, the sample size for the present analysis is as follows: 1355 live births (intervention, 903 and control, 453) from enrolled pregnancies for initial breastfeeding indicators, and 1250 children (intervention 847 and control 403) for whom breastfeeding practice data were available from at least one follow-up visit between 1 and 5 month of children's age.

### 2.5 | Ethics approval and participant consent

The ethical review committee of icddr,b approved the trial. We registered the trial at ClinicalTrials.gov before completing the enrolments and starting the outcome evaluations. We obtained written informed consent from each participant twice, once at initial enrolment during pregnancy and after that during enrolment of resultant live births/children.

### 2.6 | Intervention description: Exclusive breastfeeding counselling using an electronic job aid

Participant mothers in the intervention arms received extensive counselling and practical demonstration of exclusive breastfeeding provided by CHWs throughout the third trimester of pregnancy and during the first 6 months of the child's life. We adapted UNICEF's Infant and Young Child Feeding (IYCF) counselling package according to the national IYCF training manual and translated it into Bangla (MOH&FW, 2013; UNICEF, 2012). We developed an android application incorporating breastfeeding counselling modules, which the CHWs used as an electronic job aid. The application included images and short texts to aid the CHWs, while counselling on the importance and continuation of exclusive breastfeeding, and provided cues to common breastfeeding-related challenges and solutions. The application also assisted CHWs in a practical demonstration of breastfeeding techniques. The application was compatible with running online and offline, generated visit schedules, and triggered colour-coded notifications for the scheduled visits. CHWs synced the electronic application with the central database server daily, to check for application updates, new live births notified by the evaluation team and uploaded records of their home visits.

We deployed 25 female CHWs exclusively for the intervention team. Each CHW delivered interventions to ~40 participants. We recruited CHWs from the local community, who had at least 12 years of schooling, and some had previous experience in community-based programmes. CHWs received an 8-day training on counselling content and skills, techniques of observing and assessing a mother's breastfeeding behaviour, and providing practical culturally appropriate demonstrations for correct positioning and attachment. Expert trainers from the Training Assistance for Health and Nutrition foundation, a local nutrition training agency, conducted training

sessions under the supervision of a national expert and the research team. Training also included the use of the application in android tablets and on record keeping. We held two practical sessions with mothers of children under 6 months of age following the classroom sessions.

During participants' pregnancy, CHWs counselled at 7 months of gestation and then at 8–9 months. In the postpartum period, CHWs provided counselling within 2 weeks of a live birth, followed by monthly visits for up to 6 months of children's age. Each counselling session was approximately half an hour and generally had three parts as follows: (i) providing general messages on maternal and child wellbeing, maternal nutrition, dispelling common misconceptions about maternal diet during lactation, appropriate hygiene and care-seeking practices for illness; (ii) specific breastfeeding counselling and observation of breastfeeding technique including EBF; and (iii) troubleshooting on common challenges related to breastfeeding. The two antenatal counselling sessions also included messages on colostrum feeding, early initiation of breastfeeding (EIBF) and health risks of prelacteal feeding. From the third gestational trimester to the child's fifth month, each mother received up to eight scheduled counselling visits, depending on their presence at home at those visits. We invited other adult females and fathers to join the counselling sessions and engage in the discussions.

## 2.7 | Outcome measures

For this analysis, we included indicators of breastfeeding practices among children aged 0–5 months. The percentage of EBF measured monthly between 1 and 5 months was the primary outcome indicator. Following the World Health Organization (WHO) guidelines, we defined EBF as children receiving nothing other than breastmilk within the past 24 h of the interview. We excluded prescribed oral rehydration solutions and medications when assessing EBF status (WHO, 2008). Secondary outcomes were as follows: EIBF (within 1 h of birth), colostrum feeding and prelacteal feeding, breastfeeding with the provision of water, breastfeeding with other nonmilk liquids, breastfeeding with formula feeding/nonhuman milk, early introduction of complementary food and bottle feeding. We defined early introduction of complementary food as a child below 6 months of age receiving any soft, solid or semisolid food irrespective of receiving breastmilk in the past 24 h of the interview.

## 2.8 | Data collection

We employed 24 data collectors exclusively for the evaluation team and trained them to collect information about participants' backgrounds, healthcare-seeking behaviour and IYCF practices from intervention and comparison arms. At enrolment during pregnancy, we collected data on maternal background and household characteristics, and maternal knowledge of IYCF. The knowledge assessment tool had 10 items on IYCF identified from the UNICEF IYCF guideline

(UNICEF, 2012). We collected follow-up data within 2 weeks of birth, including information on care-seeking behaviour for ANC, delivery care and PNC, breastfeeding initiation, colostrum feeding, prelacteal feeding and perceived birth size. If the mother was absent from home at the first postbirth visit, we collected the information at the subsequent follow-up visit. Afterwards, interviewers conducted five home visits, once monthly, between 1 and 5 months of the children's age for interviewing mothers on IYCF practices. If a mother was absent on a scheduled visit date, up to two repeat attempts were made within the month. The minor change in data collection time alignment is not likely to have impact analyses and conclusions as the child remains in the same month of age. Interviewers used a structured 24 h dietary recall questionnaire adapted from the Bangladesh Demographic and Health Survey's child nutrition questionnaire (NIPORT et al., 2016). We developed an electronic data collection application based on structured questionnaires for the data collectors. They received extensive training on the purpose and description of the tools, consent taking, interviewing skills and using the tablets with the data collection application. We ensured data quality by setting internal consistency and range checks in the electronic application and conducting random spot checks by field supervisors and the study investigator.

## 2.9 | Statistical analysis

We summarized maternal baseline characteristics and healthcare-seeking behaviour by intervention and comparison arms, using frequencies, percentages or means and SDs. We used household wealth as quintiles based on a score comprising household possession of agricultural land and ownership of dwelling land, building materials of the house, type of household sanitation facility, furniture, connection to national grid electricity supply, motorized and nonmotorized vehicles, selected electronic appliances, and poultry and livestock (Vyas & Kumaranayake, 2006). We summarized maternal knowledge of IYCF as a score out of 10, with each item given a weight of 1 for the correct answer (Cronbach's  $\alpha$  0.65). We calculated maternal body mass index (BMI) by dividing mother's weight in kilogram (kg) with height in metre squared ( $m^2$ ) and created three categories—too thin (BMI < 18.50 kg/ $m^2$ ), normal (BMI 18.50–24.99 kg/ $m^2$ ) and overweight/obese (BMI  $\geq$  25.0 kg/ $m^2$ ; WHO, 2000).

All outcomes were binary. Each outcome indicator was coded 1, where 1 denoting the practice was done. We summarized raw percentages for each outcome by study arm. We reported intervention effects for each outcome by relative risks (RR), with 95% confidence interval (CIs) and Wald test  $p$ , estimated from Poisson models with empirically adjusted SEs (Zou, 2004). We analysed the outcome at the individual level using intention-to-treat according to the original study arms. We also analysed by aggregating participants into one arm receiving the nutrition counselling intervention versus a usual practice comparison arm. We applied separate Poisson models to estimate the effect on EIBF, colostrum feeding, prelacteal feeding

and EBF. All models included study arm and randomization blocks as fixed effects and a random effect for the study cluster for C-RCT design. For EBF, we report the RR by month (1–5) after birth, estimated by adding month as a categorical fixed effect and an interaction effect with the study arm. We also included an additional random effect for the child nested within the random effect for study clusters in the model to take into account the repeated measurements of EBF. We conducted a sensitivity analysis for EBF and prelacteal feeding, which adjusted for any maternal, household or birth characteristics with an observed imbalance between study arms. We also explored posthoc whether any maternal background and household characteristics, knowledge of breastfeeding, healthcare-seeking during pregnancy and mode of birth altered the effect (modified) of counselling on EBF when the children were 5 months old. We conducted all analyses using a 0.05 significance level. We used Stata 14 for all statistical analyses (StataCorp 2015).

### 3 | RESULTS

The 1500 pregnant women enrolled in the trial delivered 1355 live births, for whom we collected information on initial breastfeeding indicators, that is, EIBF, colostrum feeding and prelacteal feeding (Figure 1). There were 847 mother–child pairs in the intervention arm and 403 pairs in the comparison arm, who provided information on breastfeeding practices up to a maximum of five visits between 1 and 5 months of age. Visit completion was lower at earlier ages of children due to the absence of participants from the enrolment address (Table S1). Most of these absences were due to mothers' relocation to their parents' home around birth.

Participants' background characteristics were similar between the combined intervention and the comparison arms at baseline (Table 1). However, participants in the intervention arm had more female infants (53% vs. 46%) and slightly higher term births ( $\geq 37$  weeks of gestation; 84% vs. 79%). Place of birth, skilled attendance at birth, mode of birth and receiving PNC within the first 7 days of birth were similar in the two arms (Table 2). Receiving ANC visits four or more times was higher in the intervention arm (25% vs. 18%). At 5 months of infants' age, 83% of mothers reported receiving advice on IYCF in the intervention arm compared with 31% in the comparison arm. CHWs from the study were the main source of IYCF-related advice in the intervention arm (82%). In contrast, most mothers in the comparison arm reported receiving IYCF-related advice from relatives and neighbours (25%).

Overall, EIBF was similar (~75%) in both arms (Figure 2). Prelacteal feeding was already marginal in the comparison arm; further, children in the intervention arm had half the risk of receiving prelacteal feeds (6% vs. 11%, RR: 0.54, 95% CI: 0.39, 0.76) than those in the comparison arm. The effect of counselling on prelacteal feeding was similar (adjusted RR [aRR]: 0.57, 95% CI: 0.41, 0.78) after adjusting for maternal background, health care-seeking during pregnancy and mode of birth covariates (Figure S2). Among infants who received prelacteal foods, honey was given to 18% of newborns

**TABLE 1** Background characteristics of participants, maternal knowledge of IYCF and household characteristics

Characteristics	Intervention N = 902% (n) <sup>a</sup>	Comparison N = 453% (n) <sup>a</sup>
Maternal characteristics		
Age (in years)		
<24	53.1 (479)	48.8 (221)
25–29	30.3 (273)	30.2 (137)
30+	16.6 (150)	21.0 (95)
Education—Mean( $\pm$ SD) years of schooling	5.94 ( $\pm$ 3.22)	6.13 ( $\pm$ 2.88)
Occupation		
Employed	4.2 (38)	4.4 (20)
Homemaker	95.8 (864)	95.6 (433)
BMI, Mean( $\pm$ SD)	20.81 ( $\pm$ 3.47)	20.74 ( $\pm$ 3.44)
Normal (BMI = 18.50–24.99 kg/m <sup>2</sup> )	62.1 (560)	58.5 (265)
Too thin (BMI < 18.50 kg/m <sup>2</sup> )	25.5 (230)	28.3 (128)
Overweight/obese (BMI > 25.0 kg/m <sup>2</sup> )	12.4 (112)	13.3 (60)
Parity		
Nulliparous	46.2 (417)	43.5 (197)
Multiparous	53.8 (485)	56.5 (256)
Knowledge of IYCF <sup>b</sup> —Median (IQR) of (0–10 score)	7 [6, 8]	7 [6, 9]
Infant characteristics		
Gestational age (in weeks)		
Less than 32	1.3 (12)	2.4 (11)
32–36	15.0 (135)	18.5 (84)
37 or more	83.7 (755)	79.0 (358)
Type of birth		
Singleton	98.7 (890)	98.0 (444)
Multiple	1.3 (12)	2.0 (9)
Sex <sup>*</sup>		
Male	47.2 (426)	53.9 (244)
Female	52.8 (476)	46.1 (209)
Perceived birth size <sup>c</sup>		
Normal	85.4 (770)	89.0 (403)
Larger than normal	4.4 (40)	4.0 (18)
Smaller than normal	8.2 (74)	5.3 (24)
Household characteristics		
Wealth quintile		
Lowest	20.7 (187)	17.7 (80)

TABLE 1 (Continued)

Characteristics	Intervention N = 902% (n) <sup>a</sup>	Comparison N = 453% (n) <sup>a</sup>
Second	18.1 (163)	22.5 (102)
Middle	20.7 (187)	20.8 (94)
Fourth	20.0 (180)	20.8 (94)
Highest	20.5 (185)	18.3 (83)
Household food insecurity <sup>c</sup>		
Secure	43.2 (390)	44.8 (203)
Mild insecurity	10.8 (97)	8.4 (38)
Moderate insecurity	33.6 (303)	36.0 (163)
Severe insecurity	12.2 (110)	10.8 (49)

Abbreviations: BMI, body mass index; EIBF, early initiation of breastfeeding; IYCF, UNICEF's Infant and Young Child Feeding.

<sup>a</sup>Cells reported % (n) if not mentioned otherwise in the variable name.

<sup>b</sup>Knowledge items included colostrum feeding, EIBF, duration of EBF and continued breastfeeding, benefits of breastfeeding, the timing of introduction to water, nonmilk liquids, and solids and semisolids, breastfeeding during child's and mother's illness.

<sup>c</sup>Missing information: perceived birth size (n = 26), household food insecurity (n = 2).

\*p < 0.05.

(10/56) in the intervention arm compared with 40% (17/50) in the comparison arm.

Nearly all infants in both arms were breastfed during the first 6 months. The proportion of EBF was high until the second completed month of age in both arms and then the decline was steeper in the comparison arm (Figure 3a). In the intervention arm at 5 months of age, 83% of infants were exclusively breastfed compared with 68% in the comparison arm. The prevalence of predominant breastfeeding (breastfeeding with water and nonmilk liquids) and breastfeeding with other nonhuman milk were similar in both the intervention and comparison arms across ages (Figure 3b,c). However, early introduction to solid and semisolid complimentary food was higher in the comparison arm than in the intervention arm (9% vs. 25% at 5 months of age in intervention and comparison arms, respectively; Figure 2d). Overall, bottle feeding was low (<5%) with no substantial difference between intervention and comparison arms (Figure S3).

Not surprisingly, the effect of counselling and practical demonstration on EBF practice changed over time (p = 0.001). EBF in the intervention arm was higher compared with the comparison arm by 16% (RR: 1.16, 95% CI: 1.08, 1.23) and 22% (RR: 1.22, 95% CI: 1.12, 1.33) at 4 and 5 months of age, respectively (Figure 4). The effect of the intervention on EBF was the same after adjusting for maternal background, IYCF knowledge and healthcare-seeking behaviour covariates in the sensitivity analysis (aRR: 1.15, 95% CI: 1.08, 1.23 at 4 months of age and aRR: 1.22, 95% CI: 1.12, 1.33 at 5 months of age, respectively; Figure S2).

TABLE 2 Maternal and newborn healthcare-seeking and source of receiving IYCF advice

Characteristics	Intervention % (n) N = 902	Comparison % (n) N = 453
Maternal and newborn healthcare-seeking		
Number of ANC visits <sup>a,*</sup>		
None	25.3 (206)	35.3 (160)
1-3	49.8 (449)	46.4 (210)
4 or more	24.6 (222)	18.3 (83)
Place of birth		
Home	59.7 (538)	60.5 (274)
Health facility	39.9 (360)	39.3 (178)
Others	0.4 (4)	0.2 (1)
Attendance at birth <sup>a</sup>		
Skilled birth attendant	46.8 (422)	42.6 (193)
Unskilled/traditional health provider	48.8 (440)	53.6 (243)
Others	4.0 (36)	3.3 (15)
Mode of childbirth		
Normal vaginal delivery	76.3 (688)	75.3 (341)
Assisted vaginal delivery	6.1 (55)	7.5 (34)
Caesarean section delivery	17.6 (159)	17.2 (78)
Service provider of PNC for a newborn within 7 days of birth <sup>a</sup>		
None/no PNC received	44.6 (363)	40.2 (202)
Medically trained provider	51.4 (463)	47.2 (214)
Other providers	2.4 (22)	1.6 (7)
Source of IYCF advices <sup>b</sup>		
	N = 728	N = 335
From any source <sup>***</sup>	83.4 (607)	31.0 (104)
Govt/NGO health care provider*	4.4 (32)	8.1 (27)
Study CHWs <sup>***</sup>	81.6 (594)	3.0 (10)
Other untrained providers	1.4 (10)	1.5 (5)
Relatives and neighbours <sup>***</sup>	12.9 (94)	24.5 (82)

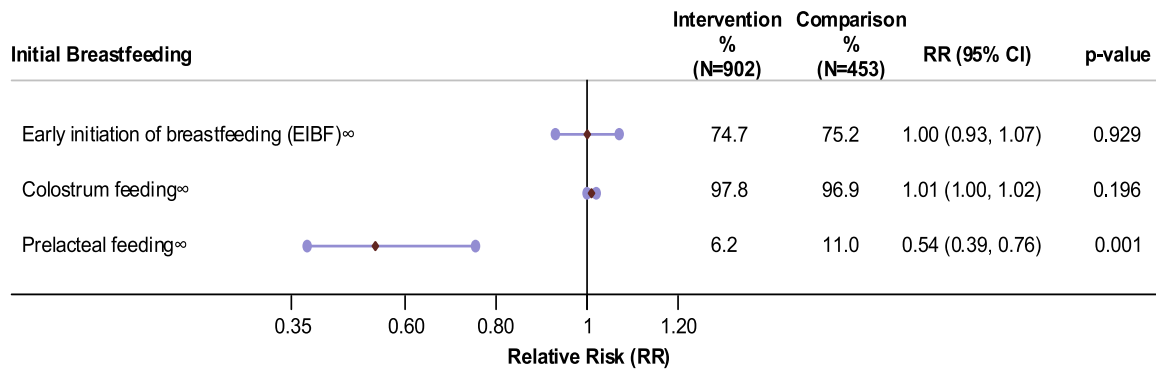
Abbreviations: ANC, antenatal care; CHW, community health worker; IYCF, UNICEF's Infant and Young Child Feeding; PNC, prenatal care.

<sup>a</sup>Information missing: number of ANC (n = 3), attendance at birth (n = 6), PNC (n = 84).

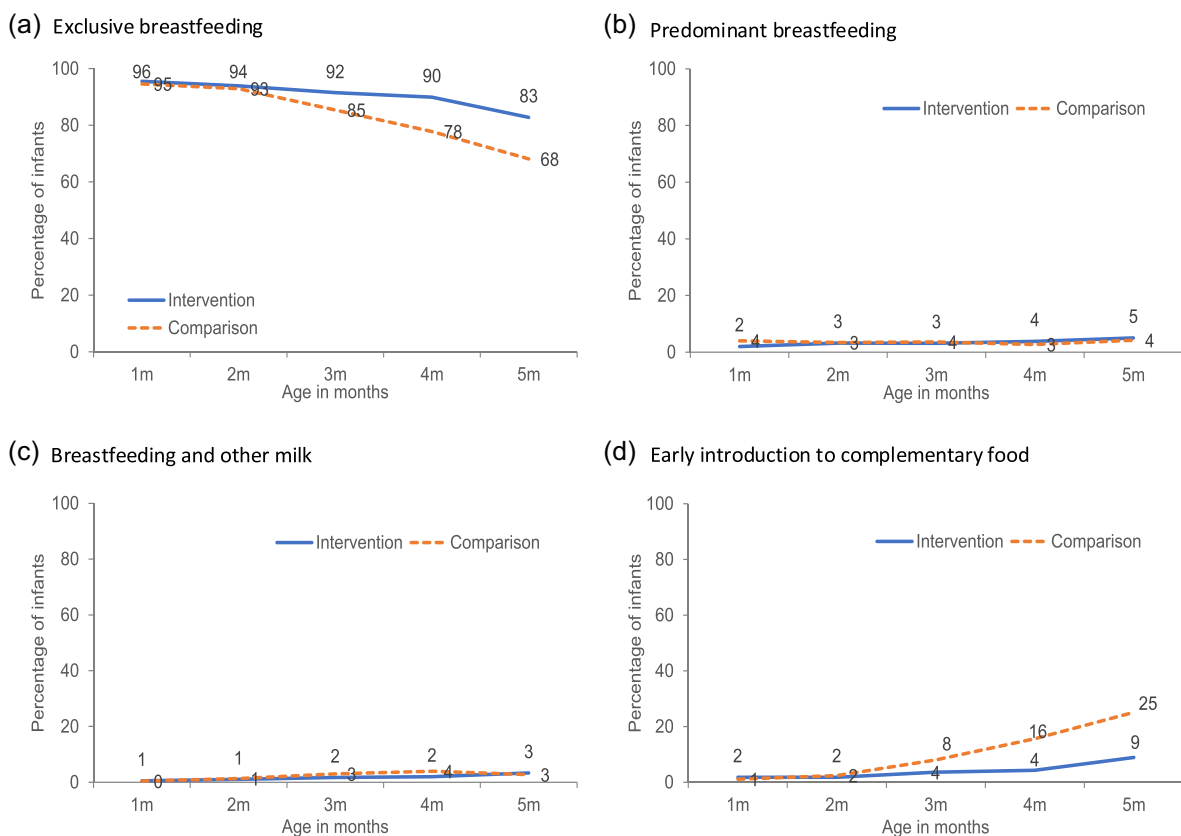
<sup>b</sup>Source of IYCF advice was assessed at 5 months of child's age.

\*p < 0.05; \*\*\*p < 0.001.

Maternal background characteristics and maternal knowledge of IYCF at baseline did not modify the effect of the intervention on EBF practice at 5 months of age (interaction p > 0.05; Table 3). However, the intervention effect varied by mode of birth (interaction p = 0.012). In the



**FIGURE 2** Effect of nutrition counselling and practical demonstration on initial breastfeeding practices. EIBF, initiation of breastfeeding within 1 h of birth; <sup>∞</sup>, information missing: EIBF ( $n = 13$ ), colostrum feeding ( $n = 5$ ), prelacteal feeding ( $n = 5$ ); relative risk (RR) > 1 is favourable intervention effect for EIBF and colostrum feeding, and RR < 1 is favourable intervention effect for prelacteal feeding.



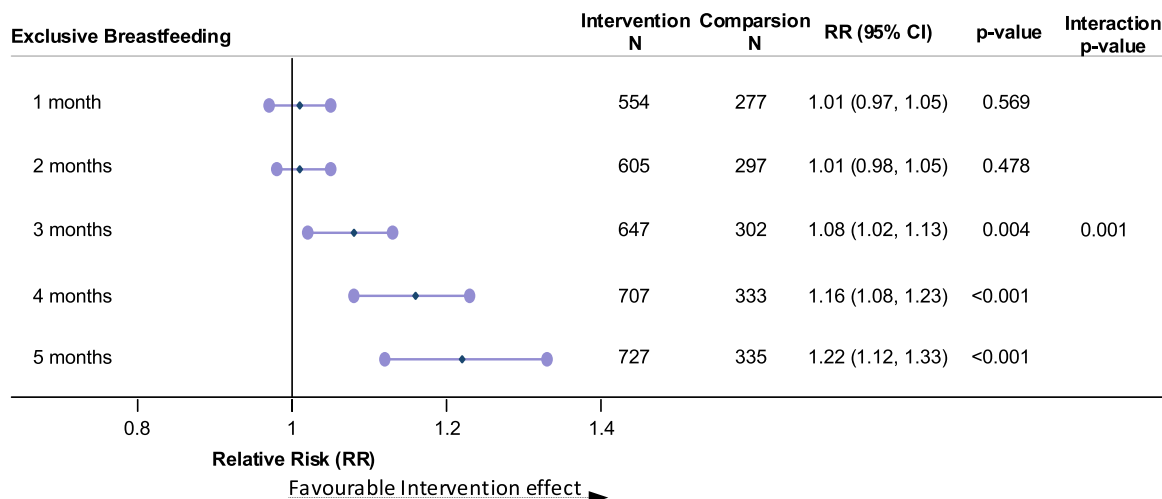
**FIGURE 3** Infants aged 1-5 months were (a) exclusively breastfed, (b) predominantly breastfed (breastfeeding with other non-milk liquids), (c) Breastfed and received other milk, (d) introduced to complementary food, by study arm. Breastfeeding categories (a,b,c) and introduction to complementary food (d) are mutually exclusive.

intervention arm, infants who had a normal vaginal delivery and assisted vaginal birth were 1.25 times (95% CI: 1.14, 1.37) and 1.50 times (95% CI: 1.06, 2.14) more likely to be exclusively breastfed, compared with those in the comparison arm. In contrast, there was no statistically significant difference in EBF between intervention and comparison for caesarean births (RR: 1.04, 95% CI: 0.89, 1.21). A sensitivity analysis of the intervention effect according to the original randomization demonstrated a similar effect on EBF across all intervention arms individually and in the four intervention arms combined (Table S4).

## 4 | DISCUSSION

Our study showed that home-based counselling and practical demonstration by CHWs using an electronic job aid improves EBF by preventing the early introduction of complementary food before 6 months of children's age. Although several studies in LMICs have shown a positive effect of breastfeeding counselling provided by peer counsellors and community- and facility-based health care providers, evidence of an intervention using an electronic job aid in





**FIGURE 4** Effect of nutrition counselling and practical demonstration on exclusive breastfeeding among infants aged 1–5 months.

breastfeeding counselling is limited (Lassi et al., 2020). A systematic review of digital technology in breastfeeding promotion identified some web platform-based interventions for health care providers' knowledge improvement. However, none used an electronic job aid to support health care providers during breastfeeding counselling on-site and none were from LMICs (Tang et al., 2019). Our study adds important evidence of the effect of an intervention promoting breastfeeding in Bangladesh, where EBF is plateauing at the population level and where appropriate job aid for service providers is a logistics-related challenge in the health system (NIPORT & ICF, 2020). Nonetheless, the Government of Bangladesh has taken initiatives to digitalize health service delivery and record keeping by primary healthcare providers and frontline health workers (MEASURE Evaluation, 2019). The digital job aid tool can be adopted in the existing digital health service initiative to support the healthcare providers offering breastfeeding counselling in prenatal and postpartum health service contacts.

High coverage of colostrum feeding and EIBF reported in the study population are consistent with current national reports, with steady increases of these practices over the last decade in Bangladesh (Ara et al., 2018; Haider et al., 2010; NIPORT & ICF, 2020). Like several other studies, we found a negative association between caesarean section births and EIBF (Kavle et al., 2017; Prior et al., 2012). However, caesarean section births among our study participants were lower (17% in both arms) than the national rate (33%; NIPORT & ICF, 2020), which may explain the high proportion of EIBF in both study groups. The prevalence of prelacteal feeding in the comparison arm was low, similar to a recent estimate from the region (NIPORT & ICF, 2020). Counselling on this topic during the facility-based ANC visits may explain the lower prelacteal feeding in the intervention arm (Ara et al., 2018; Kushwaha et al., 2014).

Our study showed that a counselling and practical demonstration intervention effectively improved EBF, consistent with findings from nutrition education interventions promoting breastfeeding in LMICs (Keats et al., 2021). Although we found a 16–22% higher prevalence

of EBF among intervention children at 4–5 months of age, Lassi et al.'s (2020) meta-analysis of nutrition education interventions from LMICs found a 53% increase in EBF at six months of age. However, most studies in the meta-analysis had a lower prevalence of EBF (<30%) among the control participants than in our study (Aksu et al., 2011; Bhandari et al., 2003; Gu et al., 2016; Ochola et al., 2013; Tylleskär et al., 2011). EBF prevalence at 5 months in our comparison arm (68%) was higher than the national EBF prevalence of 40% at 4–5 months (NIPORT & ICF, 2020). However, the effect of our intervention was similar to other community-based nutrition education studies conducted in rural Bangladesh and other LMICs (Abdulahi et al., 2021; Aidam et al., 2005; Arifeen et al., 2009; Azad et al., 2010; Flax et al., 2014; Khan et al., 2017; Younes et al., 2015).

In contrast to some previous studies, we found only a small difference in EBF between the intervention and comparison arms in the first 3 months (Aidam et al., 2005; Aksu et al., 2011; Ara et al., 2018; Bhandari et al., 2003; Flax et al., 2014; Gu et al., 2016; Ochola et al., 2013; Tahir & Al-Sadat, 2013). The high prevalence of EBF (85%) in the comparison arm up to 3 months of age helps explain this finding, which is consistent with the trend of high EBF in the first 2 months followed by a steep decline found in LMICs (NIPORT & ICF, 2020; Ochola et al., 2013). Reduction of EBF in our comparison arm was primarily due to the early introduction of complementary food, which is unlikely to occur during the first 3 months of life (Abiyu & Belachew, 2020; NIPORT & ICF, 2020; Przyrembel, 2012). A qualitative assessment from Bangladesh reported that mothers thought all foods should be introduced to infants from 3 months to familiarize the infants with eating (Haider et al., 2010). Previous studies have identified several breastfeeding-related knowledge gaps, misperceptions, and incorrect beliefs among mothers. These include mothers producing inadequate milk, mothers not having enough food to produce milk, children not getting enough milk, infants showing hunger cues, lack of confidence among mothers to continue EBF, lack of support for troubleshooting breastfeeding problems and knowledge of the duration of EBF, which result in early

**TABLE 3** Effect of nutrition counselling and practical demonstration

Characteristics	Int. N	Com. N	Int. %	Com. %	RR (95% CI)	Interaction <i>p</i>
Maternal age (in years)						
<24	382	152	84.6	64.5	1.32 (1.16, 1.51)	0.144
25–29	218	115	79.8	71.3	1.11 (0.97, 1.27)	
30+	127	68	82.7	70.6	1.17 (0.99, 1.38)	
Maternal education						
Primary	385	187	80.8	64.2	1.26 (1.12, 1.42)	0.097
Secondary	293	135	86.1	71.1	1.20 (1.08, 1.35)	
Tertiary	49	13	79.6	92.3	0.95 (0.76, 1.19)	
Parity						
Nulliparous	328	134	85.1	67.2	1.28 (1.14, 1.45)	0.269
Multiparous	399	201	81.0	68.7	1.17 (1.05, 1.31)	
Maternal knowledge of IYCF						
Low	420	166	82.6	69.3	1.21 (1.09, 1.34)	0.883
Medium	159	73	83.7	63.0	1.27 (1.05, 1.52)	
High	148	96	82.4	69.8	1.20 (1.04, 1.40)	
Number of ANC visits						
None	161	112	83.9	71.4	1.19 (1.02, 1.39)	0.912
1–3	365	155	83.9	66.5	1.24 (1.12, 1.38)	
4 or more	187	66	79.7	65.2	1.23 (1.01, 1.51)	
Mode of birth						
Normal vaginal	556	258	82.0	68.3	1.25 (1.14, 1.37)	0.012
Assisted vaginal	48	23	85.4	56.5	1.50 (1.06, 2.14)	
Caesarean section	123	54	85.4	81.5	1.04 (0.89, 1.21)	
Household food security						
Secure	332	145	86.7	75.9	1.14 (1.02, 1.27)	0.421
Mild insecurity	81	25	76.5	56.0	1.42 (1.04, 1.94)	
Moderate insecurity	242	126	80.6	61.9	1.30 (1.09, 1.55)	
Severe insecurity	81	39	81.5	66.7	1.24 (0.94, 1.63)	
Socioeconomic status						
Lowest	148	62	82.3	62.9	1.34 (1.13, 1.59)	0.219
Second	137	76	81.8	59.2	1.37 (1.11, 1.71)	
Middle	140	73	87.1	76.7	1.12 (0.98, 1.28)	
Fourth	141	68	77.3	67.7	1.15 (0.95, 1.39)	
Highest	161	56	85.1	75.0	1.15 (0.99, 1.33)	

Note: Effect of nutrition counselling and practical demonstration on exclusive breastfeeding among infants aged 5 months by subgroups of maternal and household characteristics, healthcare-seeking and mode of birth.

Abbreviations: ANC, antenatal care; CI, confidence interval; Com., Comparison; Int., Intervention; IYCF, UNICEF's Infant and Young Child Feeding; RR, relative risk.

weaning (Haider et al., 2010; Hmone et al., 2016; Kavle et al., 2017; Nsiah-Asamoah et al., 2020; Rahman & Akter, 2019).

Consistent with findings from previous studies in Bangladesh, we found that relatives, friends and neighbours were the most reported source of information and advice on breastfeeding among the comparison arm participants (Haider et al., 2010; Kavle et al., 2017; Nsiah-Asamoah et al., 2020; Santacruz-Salas et al., 2020; Wanjohi et al., 2016). In-built into the counselling modules, we had prompts for the CHWs to clarify breastfeeding-related misconceptions to mothers and household members, which reduced negative influences like in other studies (Aksu et al., 2011; Younes et al., 2015). Our CHWs identified and addressed established problems against successful breastfeeding, such as suboptimal positioning and attachment practices, switching breasts and sitting positions (Haider et al., 2010). Such support enhances confidence and self-efficacy, and reduces mothers' frustrations and doubts about continuing EBF (McFadden et al., 2019; Santacruz-Salas et al., 2020; Shafaei et al., 2020).

We provided eight home-based counselling and practical demonstration visits between the third trimester of pregnancy and 6 months of infant's age. In previous studies, at least four counselling contacts showed a higher positive impact on EBF than less than four contacts (WHO, 2018). Ochola et al. (2013) also showed that seven home-based counselling visits positively impacted EBF at 3 and 6 months compared with no impact of health facility-based one-to-one counselling with a lower frequency. Similar high intensity and timely contacts effectively improved mothers' attitudes and prevalence of EBF among children below 6 months of age (Abdulahi et al., 2021).

Our study is among the few trials in LMICs that explored the effect of an electronic job aid-supported counselling and practical demonstration provided by CHWs to promote EBF among infants 0–5 months old. Although evidence is limited, previous studies reported that adoption of an electronic job aid improved health care providers' adherence to the recommended protocol for childhood illnesses and promotion of EBF (Borkum et al., 2015; Mitchell et al., 2013; Tang et al., 2019). Like a large-scale electronic job aid-supported community-based intervention in India, our counselling application with colour coded schedule reminders and electronic performance tracking might have ensured on-schedule completion of home visits by CHWs (Borkum et al., 2015). Counselling on maternal and child health and nutrition interventions by front-line workers in India supported by audio-visual job aids influenced their credibility and acceptance among the study participants (Chamberlain, 2014; Gopalakrishnan et al., 2020). We think there is likely a similar effect of counselling by our CHWs using our study's electronic device and application. Practical demonstration of appropriate breastfeeding technique and duration with context-relevant visual illustrations in the electronic application may have also enhanced the mothers' engagement and internalization of messages provided by the CHWs (Rahman et al., 2012). However, we cannot disentangle the effect of the electronic job aid alone on improved EBF, as we did not have an arm with counselling provided by CHWs without the electronic job aid. Nevertheless, the consistent, structured counselling visits multiple times by trained CHWs using the electronic job aid may have improved EBF among intervention children

compared with the comparison group receiving infrequent infant feeding advice mostly from relatives and neighbours.

Several studies from high, middle and low-income countries have demonstrated a consistent negative association between caesarean birth and exclusive breastfeeding up to 6 months (Kavle et al., 2017; Khatun et al., 2018; Santacruz-Salas et al., 2020). However, our study found no statistical difference in EBF between infants with caesarean births in intervention and comparison arms, as the proportion of EBF in comparison arm was much higher than the proportions among normal and assisted vaginal delivery. Regarding prenatal LNS, a previous study in rural Bangladesh reports no difference in EBF practices between mothers who received LNS and those who did not, similar to our findings (Khan et al., 2017).

The main strength of our study is the C-RCT design and we found similar background characteristics between intervention and comparison arms, which is likely to reduce bias on the trial outcome. Secondly, adherence to the intervention schedule was high and, overall, lost to follow-up at 5 months of age was low (<15%) with no substantial difference between intervention and comparison arms. Thirdly, we used a locally adapted IYCF assessment tool used extensively in similar trials and nationwide surveys and implemented an independent assessment of outcomes (NIPORT et al., 2016).

Our study had some limitations. Firstly, we assessed breastfeeding practice outcomes based on mothers' self-reporting. We used a validated structured questionnaire with questions for consistency checking to minimise the bias. Data collectors were independent of the CHWs, unaware of outcome indicator definitions, and the same data collectors interviewed participants in both intervention and comparison arms. Secondly, we did not include assessment of breastfeeding self-efficacy among intervention and comparison arm mothers and in-depth process evaluation involving qualitative data collection techniques that could explain the effect pathway. Thirdly, the trial lacked an arm with CHWs providing counselling and practical demonstration in a conventional way without the electronic job aid. Therefore, assessing the effect of the electronic job aid on CHWs' skills and performance in delivering counselling and on EBF was not discernible. All these could be the focus of future research involving electronic job aid-based breastfeeding promotion interventions. Fourthly, we combined all four intervention arms into a single intervention arm, which had the intervention of interest of this analysis, that is, nutrition counselling using an electronic job aid. Combining the intervention arms is unlikely to have introduced any bias as neither the LNS provided during 0–5 months of children's age nor prenatal LNS would impact breastfeeding of the infants. Further, we have done an intention to treat analysis according to the original randomization and found the intervention effect consistent across all intervention arms.

## 5 | CONCLUSION

Promoting and supporting exclusive breastfeeding is the most important nutrition intervention during the first 6 months of a child's life. Our study provides evidence that counselling and practical

demonstration provided by CHWs using an electronic job aid results in higher retention of EBF in a low resourced rural area in Bangladesh. Our findings also indicate that repeated counselling and demonstration visits by CHWs can prevent the critical faltering point of EBF at 3 months of age due to the early introduction of complementary food and can sustain EBF up to 6 months.

### AUTHOR CONTRIBUTIONS

Shams El Arifeen, Sk Masum Billah, Purnima Menon, Tahmeed Ahmed, Stuart Gillespie, John Hoddinott and Michael J. Dibley designed the trial. Sk Masum Billah and Tarana E. Ferdous coordinated the field implementation. Nuzhat Choudhury and Tarana E. Ferdous developed the data collection tools. Rukhsana Haider coordinated the training of CHW to provide nutrition counselling. Abu Bakkar Siddique supported in data curation. Sk Masum Billah conducted the data analysis with inputs from Patrick Kelly. Sk Masum Billah drafted the manuscript with inputs from Michael J. Dibley, Camille Raynes-Greenow, Tarana E. Ferdous and Patrick Kelly. All authors reviewed, provided necessary edits and approved the final manuscript.

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### CONFLICT OF INTEREST

The author declare no conflict of interest.

### DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

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