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Effectiveness of a new breastfeeding counselling intervention on breastfeeding prevalence, infant growth velocity and postpartum weight loss in overweight women: a randomized controlled trial

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Abstract

Background Maternal overweight is a risk factor for child obesity. Breastfeeding may decrease this risk, but breastfeeding prevalence is low in overweight or obese mothers.

Methods We conducted a randomized trial in 90 overweight/obese pregnant women in Bogotá-Colombia during 2019, to evaluate the effects of a new exclusive breastfeeding (EBF) counselling intervention for overweight/obese mothers, based on Carl Rogers' client-centered theory. The Intervention included individualized breastfeeding counseling, empowerment sessions, and a set of problem-solving strategies based on Carl Rogers' client-centered theory, conducted during late pregnancy, first week postpartum, 1 and 3 months postpartum. Primary outcomes were EBF during the last 24 h prevalence at 4 months postpartum, infant growth, and maternal weight loss at 4 months postpartum; secondary outcomes were serum and breast milk prolactin concentration, breast milk energy and macronutrient content, estimated breast milk volume at 1 and 4 months and EBF prevalence at interim time-points. Mothers were randomised in late pregnancy to intervention (new breastfeeding counselling; IG) or control group (standard breastfeeding support; CG).

Results The IG had significantly higher EBF prevalence at 4 months (82.8%) compared to the CG (30.6%) (Prevalence ratio or PR = 2.7; 95% CI = 1.6, 4.5). There were no intervention effects on infant growth velocity, maternal weight loss or secondary outcomes.

Discussion The intervention, which could be implemented in primary care settings, was highly effective for increasing the prevalence of EBF in overweight/obese mothers at 4 months postpartum. The results should, however, be interpreted in the context of the small sample size, short follow-up period and loss to follow-up. Further evaluation of the intervention is required in a larger sample including longer-term infant follow-up.

Trial registration (UTN) U1111–1228–9913 20 February 2019; ISRCTN15922904, retrospectively registered.

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Keywords Breastfeeding, Counselling, Prolactin, Obesity

Background

In 2022, the World Health Organization (WHO) reported an increased prevalence of obesity in children and adolescents aged 5–19 years from 2 to 8% globally from 1990 to 2022, while the prevalence in adults increased from 7 to 16% [1], perpetuating the intergenerational transmission of obesity. In Colombia, the reported prevalence of overweight and obesity is 56.5% in the adult population and 59.6% in woman; with a 6.3% prevalence of obesity in children under 5 years in 2015 [2].

Increasing evidence supports the role of breastfeeding in obesity prevention. A systematic review and metaanalysis including 25 studies ($n = 226{,}508$; 10 cross sectional studies and 15 cohort studies) reported a 22% lower risk of childhood obesity in breastfed children when compared with those who were never breastfed [3]. A more recent metaanalysis showed that breastfeeding protected against overweight or obesity even when controlling for socioeconomic status, birth condition and parental anthropometry [4]. However, coordinated efforts are needed to achieve WHO Exclusive Breastfeeding (EBF) recommendations during the first 6 months of life [5], including counselling, legislation and social and political mobilization [6].

Breastfeeding initiation and duration are lower in overweight women. Those with pre-pregnancy Body Mass Index (BMI) ≥ 30 kg/m^2 are less likely to intend to EBF compared with normal weight and overweight women [7]; whilst overweight women have significantly lower initiation and duration of breastfeeding than normal weight women [8], with a higher risk of poor latching during breastfeeding [9]. Low EBF and breastfeeding rates in overweight women [10] may be related to mechanical problems, delayed lactogenesis II [11], hypoplasia of the mammary gland and reduced stromal tissue [12]. Also, in animal models, obesity is associated with changes in prolactin levels that could affect BF performance [13].

In healthy women, breastfeeding support based on counselling by telephone or digital methods, professional or peer person-to-person, peer counselling and health care institution support strategies have been shown to be effective for improving breastfeeding initiation, duration and exclusivity [14]. To date, only three experimental studies have been conducted using interventions that specifically aimed to prolong the duration of EBF until 6 months in obese mothers [15–17]; all were conducted in high income countries, and no interventions have been developed for low or middle income countries.

Considering the intergenerational transmission of obesity, the window of opportunity during the first thousand days, the positive effect of EBF counselling in normal weight women and the lack of evidence supporting an effective intervention to improve breastfeeding and EBF in overweight women, we designed a new EBF counselling intervention for overweight and obese women, based on Carl Rogers´ Centred-Client Theory [18]. We tested the effects of the intervention on the prevalence of EBF, infant growth velocity and maternal postpartum weight loss in a randomised controlled trial.

Methods

Briefly, the study was designed as follow. Full methods were published previously [19]:

Study design and participants

A randomized controlled trial with two parallel groups and 1:1 allocation was conducted to investigate the effect of a new EBF counselling intervention specifically designed to support overweight or obese women, on the prevalence of breastfeeding and EBF, infant growth velocity and maternal postpartum weight loss at 4 months. Overweight or obese pregnant women were identified from medical records or referred by the health professional (nurse or physician); the researcher attempted to contact them and discussed the study before providing further study information. Recruitment was carried out after 32 weeks of gestation in a baby friendly primary care centre (Centro de Atención Primaria en Salud, Suba) in Bogotá, Colombia with a population coverage of 1,620,000 and a total of 591 pregnant women in the program of Servicios amigables en salud sexual y reproductiva (December 2016), with a high proportion in the lowest socioeconomic population.

Mothers were eligible if they had (i) a pregnancy BMI at 32 weeks ≥ 28.1 kg/m^2 using Atalah´s criteria [20]; (ii) a singleton pregnancy; (iii) were older than 18 years; (iv) did not have pre-eclampsia/eclampsia or gestational diabetes; (v) had permanent residence in Bogotá and (vi) intended to breastfeed.

Randomization and blinding

After receiving information about the study and providing written informed consent, the mothers were allocated after 32 weeks of gestation to one of two groups: (i) EBF counselling intervention group (IG) or (ii) standard breastfeeding counselling control group (CG) at a baby friendly institution where breastfeeding is supported. Randomization assignments were prepared by a member of the team who had no contact with the subjects, using computer blocks; assignments were held in sealed opaque envelopes. The researcher enrolled and randomised participants. It was not possible to blind the researcher performing the

intervention, collecting anthropometric and food intake data, and performing the measurement of macronutrients in human milk, but laboratory measurements of serum prolactin were carried out by an independent laboratory blinded to the intervention. Mothers were aware that the study involved assignment to one of two types of breastfeeding support, but they did not know the details of the support. To avoid contamination between groups, appointments were scheduled individually by telephone. After delivery, a second screening was performed; preterm infants (< 37 weeks) and infants born small for gestational age < 2500 g or with any condition that might interfere with breastfeeding were excluded from the study. The study was approved by Ethics Committee of the Health Secretary of Bogota, Colombia (Code Approval SNCI-021-CEI Acta 08, 28 April 2018) and Ethics Committee of the Science Faculty of Pontificia Universidad Javeriana and registered at isrctn.com as ISRCTN15922904 27 February 2019. The WHO Universal Trial Number is (UTN) **U1111-1228-9913**, 20 February 2019. The trial was retrospectively registered due to administrative delays in the submission of the information; recruitment was initiated in August 2018 and ended in July 2019.

Primary hypothesis and outcomes

We hypothesised that, compared to standard breastfeeding counselling, the implementation of a new EBF counselling intervention for overweight woman would result in (i) an increase in the prevalence of EBF at four months of age, (ii) slower infant weight for length growth from birth up to four months of age, (iii) an increase in weight loss in the overweight woman after delivery up to the fourth month postpartum. The primary outcomes were: (i) prevalence of EBF at 4 months, ascertained by asking the mother about infant feeding practices at 4 months postpartum, (ii) growth velocity as change in weight for length (WLZ) in kg/cm; and length for age (LAZ) in cm/day; from birth up to 4 months, and (iii) maternal weight loss in kg up to 4 month after delivery using maternal weight in the first week postpartum as baseline.

Determination of EBF and anthropometric measurements

- *Infant 24 h dietary recall*: EBF was defined as no consumption of other milks, infant formula, other beverages or solids during the previous 24 h in the first week postpartum, 1 month, 3 months and 4 months; this information, given by the mother, was confirmed with validation questions using two infant 24-hour recalls (a record of all the foods given to the infant), including consumption of specific beverages such as water, water with sugar, "agua de panela", fruit juice and broth, which are reported as frequently given to infants before 6 months [2].
- *Newborn and infant anthropometry*: Anthropometric variables - weight, length, MUAC and head circumference - were measured (in triplicate) by a trained nutritionist & dietitian following the WHO protocol [21] in both groups (IG and CG) at birth, 1, 3 and 4 months postpartum. Infant weight was measured using an electronic baby scale TANITA 1583 with precision of 10 g, capacity of 20 kg; the length was measured using a Roll-O-Meter infantometer, with folding mechanism and foot stop, measuring range up to 150 cm; head circumference and MUAC were measured using a Pediatric tape measure (SECA 201) for measuring body circumferences, measuring range from 0 to 205 cm and precision of 1 mm; Infant growth velocity, defined as the change in the Z-score of weight for length (WLZ), length for age (LAZ), head circumference for age (HCAZ) and mid upper arm circumference for age (MUACZ) from 0 to 4 months according to WHO growth standards [22].
- *Maternal anthropometric data*: Anthropometric measures (weight, height and MUAC) were measured at enrolment, during the first week postpartum, 1, 3 and 4 months. Weight was measured in duplicate with the mother wearing light clothing using an electronic scale (SECA 813, capacity 200 kg, precision 100 g). Height was measured using a portable stadiometer (SECA 213, lateral scale up to 205 cm), MUAC was measured in triplicate to the nearest cm using a SECA 203 measuring tape, with a measurement range of 0 to 205 cm and division of 1 mm.

Secondary hypotheses and outcomes

We hypothesised that the implementation of the new EBF counselling intervention would result in: (i) an increase in the estimated volume of breast milk in mL/day as a result of an increase in serum prolactin levels in ng/mL at 1 and 4 months, and (ii) higher milk prolactin concentration and adequate macronutrient content of protein, lactose, fat and energy, which would in turn be associated with more optimal infant growth (based on WHO growth standards). The secondary outcomes were the estimated breast milk volume, maternal serum levels of prolactin, prolactin concentration and macronutrients in the breast milk, measured at 1 and 4 months after delivery and EBF prevalence at interim follow-up time points.

Measurement of secondary outcomes

- *Breast milk volume*: defined as the amount (mL/day) of milk consumed over a 24-hour period was estimated at 1 month and 4 months based on the Olaya´s algorithm, described as follows:

- *Olaya´s algorithm (unpublished data)*: This used information recorded in the two 24 h recalls on (i) the number of breastfeeds during the day, (ii) Breastfeeding duration (time spent) of each feed, (iii) the number of breastfeeds per night and (iv) the infant's appetite based on the mother's perception (normal: defined as current food consumption of all foods without any problem feeding the baby; low: decreased amount of food eaten compared to normal and high: mother's perception that baby needed more food than usual and he or she was not satisfied). Data are presented in the algorithm as frequency of breastfeeding (from 1 to 10 breast feeds/day), duration of each feed (from 5 to 60 min per breastfed), volume of each feed (ounces or ml/breast feed), stratified by appetite. To estimate breast milk intake (mL/day): (i) the volume per feed was calculated from the algorithm based on the infant's appetite (low, normal or high), the mean duration per feed over the whole day and assuming a gastric capacity for infants less than 1mo of 0.5 ounces/kg and infants older than 2 months of 1 ounce/kg; ii) breast milk intake during the day was calculated by multiplying the number of feeds per day (6 a.m. to 6 p.m.) by the number of ounces/mL per feed (ii) breast milk intake during the night was determined by multiplying the number of feeds/night by the number of ounces/mL per feed) divided by 2 (assuming lower milk intake at night); iv) total breast milk intake (ounces/mL per day) = step ii) + step iii). We also estimated the intake volume based on WHO estimated intake at 1 month (562 g/day in EBF infants and 568 g/day in partially breastfed infants) and 4 months (768 g/day in EBF infants and 634 g/day in partially breastfed infants) [23].
- *Breast milk macronutrients*: Carbohydrate, protein, fat, and energy in human milk were determined using the Miris Human Milk Analyzer, which uses infrared transmission spectroscopy and requires a human milk sample of 5 mL. Expression of breast milk (foremilk) was performed at the 1st and 4th months postpartum at the researcher`s office with a Philips Single Electric Breast Pump under researcher supervision, during the morning. The breast milk samples were stored at -20 °C in the laboratory at the Pontificia Universidad Javeriana until the analyses. Analysis was done in duplicate from the same sample and the mean was used for further analyses.
- *Breast milk prolactin*: Determination of breast milk prolactin concentration was performed using an ABCAM ab226901 Human Prolactin SimpleStem Elisa Kit. The procedure required 2 mL of breast milk and the analysis was carried out in duplicate; the mean was used in the analyses. Breast milk samples were taken on the same day and at the same time as the blood sample to determine serum prolactin concentration.
- *Serum prolactin*: Blood samples were taken by an independent laboratory, within 2 h of waking in the morning and before any food was consumed. The procedure required 5 mL of maternal blood, analysed with Enzyme-Linked ImmunoSorbent Assay (ELISA). The analysis was performed once.
- *EBF prevalence at interim time-points of follow-up*: EBF prevalence during the first week postpartum, at 1 month and 3 months was ascertained by asking the mother about infant feeding practices at the follow-up visits.

Procedures and questionnaires

Data in the two allocation groups were recorded at 5 study time-points (last month of pregnancy, first week postpartum, 1st, 3rd and 4th month) either by asking the mother or from her medical records: (i) sociodemographic and maternal health status (after enrolment); (ii) maternal food consumption pattern, using 24 h dietary recall by the multiple-pass dietary recall method [24, 25]; (iii) maternal intention to breastfeed [26]; (iv) maternal risk of postpartum depression [27]; (v) Maternal physical activity [28]; (vi) delivery information from medical records: data about the type of delivery, new-born APGAR score, time of breastfeeding initiation, maternal-infant complications including those which delay the initiation of breastfeeding and drugs administered during labour; and (vii) counselling process (problems, solutions and agreements). Counselling was verified with a questionnaire administered by an independent investigator blinded to the group allocation at the end of the study period (4th month).

Intervention

Mothers assigned to the CG received standard breastfeeding counselling based on the institutional and national policy for breastfeeding and baby friendly hospitals initiative (Colombian Ministry of Health Resolution 412 of the year 2000) during: (i) pregnancy (group talk about the importance of breastfeeding), (ii) labour (early contact and early initiation of breastfeeding); and (iii) hospital discharge (nutritional recommendations with an emphasis on EBF during the first 6 months). Mothers assigned to the IG received both the standard breastfeeding counselling and the new EBF counselling based on Carl Rogers' centered-client theory [18]. The intervention was conducted by a certified breastfeeding counsellor with listening skills, and an understanding of the individual problems faced by overweight women during breastfeeding, who analysed the environment and maternal breastfeeding problems to reach consensus solutions with the woman. To better focus the counselling intervention, mothers were

asked about self-perception of breast and nipples, and the counsellor performed a breast-latching observation [29]. For this study EBF counselling for overweight women was defined as a well-structured and permissive relationship built on trust between the counsellor and the pregnant and breastfeeding woman, using her feelings, beliefs, and sociocultural environment to gain an understanding of herself and her situation to empower the woman and achieve EBF for six months. During each session, counselling was supported by written educational materials given to the mother at each counselling visit, with key messages about successful EBF to reinforce counselling. Counselling was evaluated at each time-point using a structured questionnaire about maternal satisfaction and usefulness. Adherence to EBF was assessed by asking the mother if she had EBF during the last 24 h at each time-point. All questionnaires were administered by the researcher [19].

Statistical analysis

The sample size was calculated to detect a difference in the prevalence of EBF at 4 months between the IG and CG of 23% [15], assuming a baseline EBF of 22.8% in the CG [2]; with a power of 95%, an alpha error of 5% and a two-tailed calculation determined using the Epiinfo Statcalc program [30]. The planned sample size, assuming losses to follow-up of 25%, was 290 mother-child dyads, 145 per group; however, due to difficulties in contacting eligible mothers during pregnancy the sample size achieved during the time available for the study was 90. Analyses were performed on an intention-to-treat basis. Comparisons between IG and CG were carried out using *t* test, Mann-Whitney test, or Chi-square test as appropriate. Baseline characteristics between IG and CG were compared with the odds ratio (OR). The difference in prevalence of EBF between groups was analysed as the prevalence ratio (PR) at 4 months between IG and CG.

Results

Study population

Ninety overweight or obese mothers were recruited during late pregnancy from Centro de Atención Primaria en Salud (CAPS) in Bogotá, Colombia. Forty-three mothers were allocated to the IG and forty-seven to the CG. The planned sample size could not be achieved during the available timeframe, mainly due to difficulties contacting mothers who were identified as potentially eligible to provide them with information about the study (Fig. 1); from the original recruited mothers, 65 finished the study.

Maternal baseline characteristics in late gestation (Table 1), for those who remained in the study during the first week postpartum (Supplementary Table 1a) and at 4 months postpartum (Supplementary Table 1b) were similar between groups. Due to difficulties in contacting mothers within the first 24 h postpartum, maternal weight during the first week postpartum was considered as the maternal baseline weight. During late gestation, 10 mothers did not remember their prepregnancy weight, thus, maternal weight loss could not be estimated. Nine mothers were excluded from the study after delivery because the baby required admission to the neonatal intensive care unit (NICU, $n = 5$) or had a low birth weight ($n = 4$); no significant differences were found in delivery characteristics and newborn information between groups (Supplementary Table 1c). Losses were 27.7% ($n = 25/90$) during the 4 months of follow up without difference between CG and IG; mothers who remained in the study at 4 months were more likely to be sedentary than those who did not remain in the study at 4 months (OR = 3.6; 95% CI = 1.2, 11.3) but there were no other significant differences in baseline characteristics (Table 2).

Primary outcomes

The IG were significantly more likely to EBF at 4 months (PR = 2.7, 95% CI 1.6, 4.5) (Table 3). Infants in the IG were also more likely to EBF during the first week postpartum (PR = 1.4, 95% CI 1.01, 1.9), at 1 month (PR = 2.2; 95% CI = 1.4, 3.5) and 3 months (PR = 3.5; 95% CI = 1.9, 6.3) (Supplementary Table 1c). A sensitivity analysis assuming that all mothers lost to follow-up did not EBF also showed significantly higher EBF in the IG at 3 (PR = 3.03; 95% CI = 1.6, 5.7) and 4 months (PR = 2.4; 95% CI = 1.3, 4.2) but not during the first week postpartum (PR = 1.04, 95% CI = 0.7, 1.6) or 1 month (PR = 1.2; 95% CI = 0.9, 1.6) (data not shown).

Overall, the change in infant WLZ and LAZ from the first week postpartum to 4 months was 0.69±0.7 in IG and 0.25±0.9 in CG with no significant difference between groups (Table 3). Maternal weight loss measured as kg of weight loss or as percentage weight loss from the first week postpartum weight did not show significant differences (Table 3). IG women had higher weight but not BMI at 4 months (Mean dif.=6.8 kg; 95% CI = 0.7, 12.9) (Supplementary Table 1c).

Secondary outcomes

Breast milk expression data were available for 66/71 mothers at 1 month and 52/59 at 4 months (Fig. 1); data were missing either because the mother had difficulties expressing milk or because the mother could not attend an appointment in the morning. There were no significant differences between groups in milk true protein, fat, carbohydrate, and energy composition at 1 or 4 months (Table 4). Maternal serum prolactin measured at 1 and 4 months in a convenience subsample ($n = 19$ for both groups) showed an overall mean of 70.6 ng/mL ±380.1 at 1 month and of 37.5 ng/mL ±75.5 at 4 months with no significant difference between IG and CG; human milk

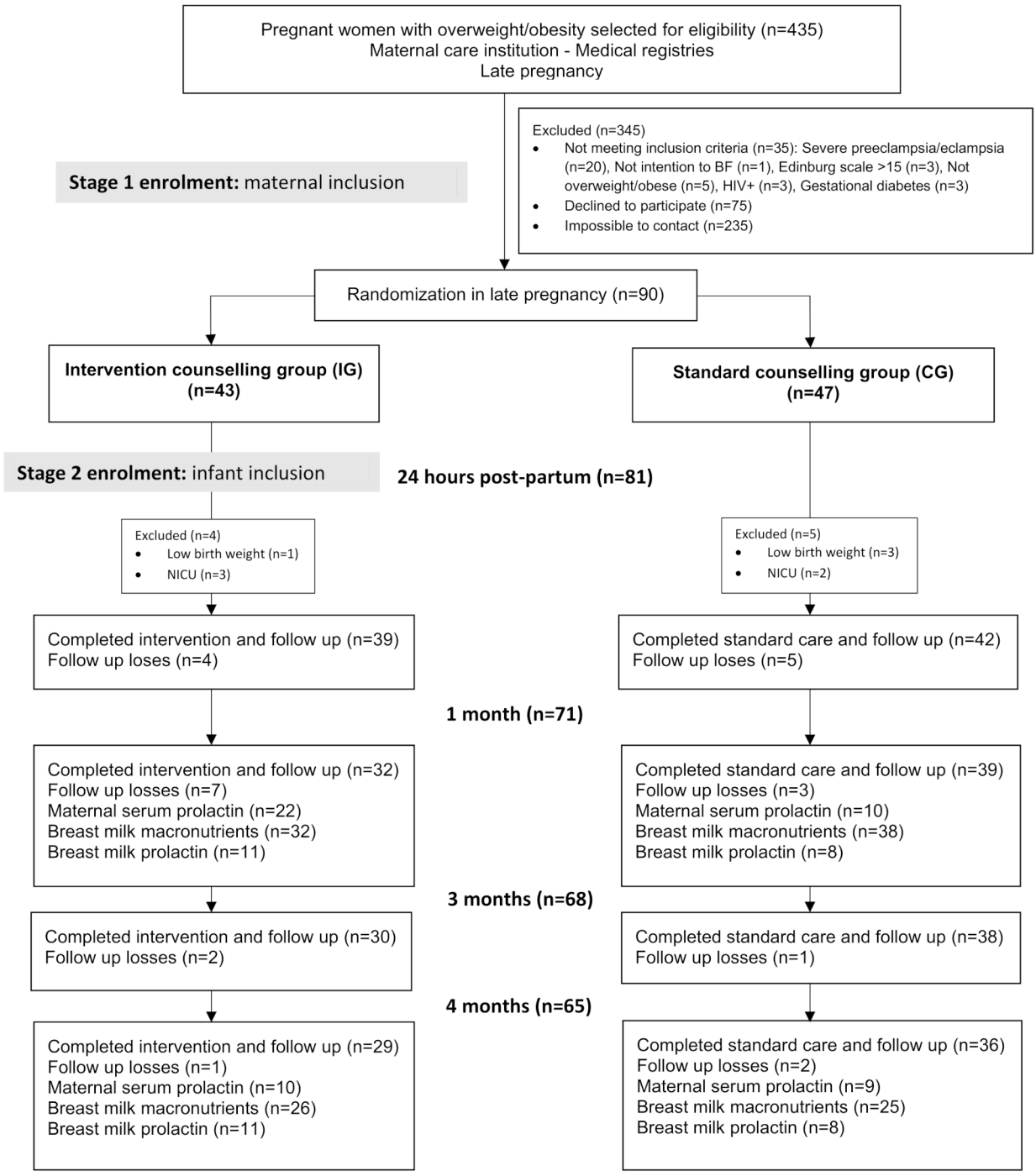

Fig. 1 CONSORT flow diagram. Losses to follow up were due to difficulties in contact the mother, such as change of cellular phone number or change of address

Table 1 Maternal baseline characteristics in late gestation

	Overall (*n* = 90)	IG (*n* = 43)	CG (*n* = 47)	OR/difference	95% CI	*p* value
Maternal characteristics						
Maternal age (y)(mean, SD)	26.8 (± 6.1)	26.1 (± 4.5)	27.4 (± 7.1)	-1.22	-3.7, 1.3	0.93
Nationality (n, %)						
Colombian	71 (78.9)	33 (76.7)	38 (80.9)	0.78	0.3, 2.1	0.63
Venezuelan	19 (21.1)	10 (23.3)	9 (19.1)			
National Health System (n, %)						
Transitory health insurance	20 (22.2)	10 (23.3)	10 (21.3)	1.12	0.4, 3.0	0.51
Subsidized coverage	64 (71.1)	31 (72.1)	33 (70.2)	1.09	0.4, 2.7	0.52
Contributive health plan	6 (6.7)	2 (4.7)	4 (8.5)	0.52	0.1, 3.0	0.68
Years living in Bogotá (mean, SD)	13 (± 11.8)	12.8 (± 11.7)	13.2 (± 12.0)	-0.36	-5.3, 4,6	0.99
Parity (n, %)						
Primiparous	38 (42.2)	18 (41.9)	20 (42.6)	1.01	0.4, 2.4	0.56
Multiparous	52 (57.8)	25 (58.1)	27 (57.4)			
Years of education (mean, SD)	11.7 (± 3.2)	11.7 (± 3.3)	11.7 (± 3.2)	0.02	-1.3, 1.4	0.98
Mother lives with the partner (n, %)						
Yes	63 (70)	29 (67.4)	34 (72.3)	1.26	0.5, 3.1	0.65
No	27 (30)	14 (32.6)	13 (27.7)			
Maternal occupation (n, %)						
Employed/Independent/Student	23 (25.6)	12 (27.9)	11 (23.4)	1.27	0.5, 3.3	0.64
Unemployed	67 (74.4)	31 (72.1)	36 (76.6)			
Pregestational nutritional status (n, %)						
Normal (BMI 20.0–25.0 kg/m^2)	19 (21.1)	11 (29.7)	8 (18.6)	1		
Overweight (BMI 25.1–30.0 kg/m^2)	40 (44.4)	15 (40.5)	25 (58.1)	2.29	0.7, 6.9	0.23
Obesity (BMI > 30.1 kg/m^2)	21 (23.3)	10 (23.3)	11 (29.7)	1.51	0.4, 5.3	0.74
Maternal weight gain during pregnancy (kg)(mean, SD)	12.4 (± 5.8)	12.4 (± 5.2)	12.4 (± 6.3)	0.04	-2.5, 2.6	0.97
Gestational BMI (kg/m^2)(mean, SD)	33.4 (± 3.4)	33.6 (± 3.7)	33.2 (± 3.1)	0.40	-1.0, 1.8	0.71
Physical activity during gestation						
Sedentary (< 1.49 MET/h/d)	43 (47.8)	23 (53.5)	20 (42.6)	0.41	0.1, 1.2	0.16
Light (1.5–2.9 MET/h/d)	25 (27.8)	13 (30.2)	12 (25.5)	0.43	0.1, 1.4	0.3
Moderate/Vigorous (> 3.0 MET/h/d)	16 (17.8)	7 (16.3)	15 (21.9)	1		
Screen time (h) (TV and cel/ular phone)	6.8 (± 3.9)	6.9 (± 3.9)	6.6 (± 3.8)	0.31	-1.3, 1.9	0.62
Breastfeeding support and expertise						
Family and/or friends support (n, %)						
Yes	85 (94.4)	41 (48.2)	44 (51.8)	0.71	0.4, 1.8	0.54
No	5 (5.6)	2 (51.8)	3 (48.2)			
Breast-fed a previous infant (n, %)						
Yes	48 (53.3)	21 (48.8)	27 (57.4)	1.4	0.6, 3.2	0.54
No	42 (46.7)	22 (51.2)	20 (42.6)			
Breast and nipple problems (self-reported)						
Normal form of the breast (n, %)						
Yes	87 (96.7)	42 (97.7)	45 (95.7)	nd	nd	nd
No	3 (3.3)	1 (2.3)	2 (4.3)			
Large breast (n, %)						
Yes	35 (38.9)	19 (44.2)	16 (34)	0.65	0.3, 1.5	0.32
No	55 (61.1)	24 (55.8)	31 (66)			
Normal nipple (n, %)						
Yes	77 (85.6)	37 (86)	40 (85.1)	0.92	0.3, 3.0	0.88
No	13 (14.4)	6 (14)	7 (14.9)			
Maternal feeding practices						
Food intolerance during gestation (n, %)						
Yes	52 (57.8)	25 (58.1)	27 (57.4)	0.97	0.4, 2.2	0.55
No	38 (42.2)	18 (41.9)	20 (42.6)			
Alcohol consumption (n, %)						

Table 1 (continued)

	Overall (*n* = 90)	IG (*n* = 43)	CG (*n* = 47)	OR/difference	95% CI	*p* value
Yes	5 (5.6)	3 (7)	2 (4.3)	nd	nd	nd
No	85 (94.4)	40 (93)	45 (95.7)			
Smoking (n, %)						
Yes	0	0	0	nd	nd	nd
No	90 (100)	43 (100)	47 (100)			
Second hand smoking (n, %)						
Yes	24 (26.7)	13 (30.2)	11 (23.4)	0.71	0.3, 1.8	0.46
No	66 (73.3)	30 (69.8)	36 (76.6)			
Monthly food expenditure (US$)(mean, SD)	27.88 (± 14.88)	29.61 (± 15.39)	26.37 (± 14.4)	3.3	-3.1, 9.6	0.26
Supplementation (Calcium, Iron, Folate) (n, %)						
Yes	71 (78.8)	34 (79.1)	37 (78.7)	0.97	0.3, 2.7	0.97
No	19 (21.2)	9 (20.9)	10 (21.3)			
Other medications (n, %)[a]						
Yes	33 (36.7)	15 (34.9)	18 (38.3)	1.15	0.7, 1.6	0.74
No	57 (63.3)	28 (65.1)	29 (61.7)			
Maternal intake (kcal)(mean, SD)	2053.7 (± 501.3)	2132 (± 521.4)	1981 (± 476.3)	151.4	-57.5, 360.4	0.22

Abbreviations: IG, intervention group; CG, control group; y, years; wk, weeks; BMI, body mass index; nd, no data; h, hour; d, day; SD, standard deviation; nd, no data; MET, metabolic equivalent; OR, Odds Ratio; CI, confidence interval

Group comparisons were performed with Chi^2-test for categorical variables and for continuous variables with U-Mann Whitney test and *t* test (gestational weight gain)

[a] acetaminophen, simethyl, topic antibiotics, thyroid hormones and misoprostol

prolactin showed an overall mean of 2.15 ng/mL ± 1.49 at 1 month and 1.29 ng/mL ± 0.73 at 4 months with no difference between groups (Table 4). The estimated breast milk intake was higher in the IG at 1 and 4 months with statistical significance at 1 month when analyzed with Olaya´s algorithm (Table 4).

Discussion

This study showed that the new EBF counselling approach in overweight or obese mothers significantly increased the prevalence of EBF at 4 months (82.8%), compared with the EBF prevalence of 36.1% at 6 months reported in 2015 for Colombian population [2]. Our intervention was successful despite the physiological difficulties that the overweight or obese women face when breastfeeding and the evidence that shows low rates of EBF in this population [12]. Our prevalence of EBF at 4 months is higher than reported in studies using intensive telephone based interventions (9 contacts) in obese mothers (EBF at 4 months of 65% compared with 48% in control group), which was lower than the Danish EBF rate reported at the time of the study (85%) [15]. Our CG had an EBF prevalence at 4 months of 30.6%, lower than reported for the Colombian population. The lack of success in achieving higher EBF rates in a baby friendly institution shows the importance of not only aiming to support breastfeeding and EBF but also implementing evidence-based strategies and rigorously monitoring and evaluating the effectiveness of such strategies [31].

Contrary to our hypothesis, and despite an increased prevalence of EBF, the intervention did not result in differences in growth between intervention and control group infants, which could partly be explained by the short duration of follow up. Other studies reported slightly greater differences in weight and length change (+ 29 g/month and + 1.1 mm respectively) in infants EBF for 3 months compared with EBF for ≥6 months in larger cohorts (*n* = 2,862) [32] but not in the pooled analysis examining the effect of the duration of EBF on infant growth in developing [33] or in a randomized clinical trial carried out in developed countries [34]. In overweight and obese mothers, there is a lack of evidence of the effect of EBF on infant growth; however, significant associations have been found between EBF in the first 4 months and lower weight for length percentile (16.81%) at 12 months, when compared with infant formula fed infants [35]. Our study population excluded women with gestational diabetes, so there were no macrosomic infants [36] who might be at greater risk of rapid infant growth and later obesity [37]. In fact, weight and length at birth, which are determinants of infant growth [38], were lower in our cohort (birthweight mean of 3.1 kg and length birth mean of 49 cm) than reported in other cohorts of normal weight women from developed countries (3.4 kg and 52 cm) [39], although similar to studies in the Colombian population which report birthweight and birth length of 3.1 kg and 49.8 cm respectively in low socioeconomic groups [40] and 3.1 kg and 50.2 cm in middle and high socioeconomic strata [41]. Also, the prevalence of predominant breastfeeding in our cohort was 41.2% (data not shown) in the CG which could explain the lack of differences in infant growth between groups. Thus, despite having overweight

Table 2 Comparison of maternal baseline characteristics in late gestation between mothers who finished the follow up to 4 months vs. mothers who did not finish the follow up

Variables	Overall (*n* = 90)	Finished follow-up		OR/difference	95% CI	*p* value
		Yes (*n* = 65)	No (*n* = 25)			
Maternal characteristics						
Maternal age (y)(mean, SD)	26.8 (± 6.1)	27.2 (± 6.1)	25.6 (± 5.9)	1.6	-1.2, 4.4	0.19
Nationality (n, %)						
Colombian	71 (78.9)	52 (80)	19 (76)	1.1	0.8, 1.5	0.77
Venezuelan	19 (21.1)	13 (20)	6 (24)			
Health care insurance (n, %)						
Transitory health insurance	20 (22.2)	13 (20)	7(28)	0.87	0.6, 1.2	0.41
Subsudized coverage	64 (71.1)	47 (72.3)	17 (68)	1.06	0.8, 1.4	0.79
Contributive health plan	6 (6.7)	5 (7.7)	1 (4)	1.2	0.8, 1.7	0.99
Years living in Bogotá (mean, SD)	13 (± 11.8)	13.8 (± 12.1)	10.7 (± 10.7)	3.2	-2.3, 8.7	0.42
Parity (n, %)						
Primiparous	38 (42.2)	30 (46.2)	8 (32)	0.85	0.7, 3.2	0.24
Multiparous	52 (57.8)	35 (53.8)	17 (68)			
Years of education (mean, SD)	11.7 (± 3.2)	11.8 (± 3.0)	11.2 (± 3.6)	0.6	-1.0, 2.2	0.49
Mother lives with the partner (n, %)						
Yes	63 (70)	45 (69.2)	18 (72)	1.03	0.8, 1.4	0.99
No	27 (30)	20 (30.8)	7 (28)			
Maternal occupation (n, %)						
Employed/Independent/Student	23 (25.6)	19 (29.2)	4 (16)	0.55	0.2, 1.4	0.28
Unemployed	67 (74.4)	46 (70.8)	21 (84)			
Pregestational nutritional status (n, %)						
Normal (BMI 20.0–25.0 kg/m^2)	19 (21.1)	15 (25.9)	4 (18.2)	nd	nd	nd
Overweight (BMI 25.1–30.0 kg/m^2)	40 (44.4)	29 (50)	11 (50)			
Obesity (BMI > 30.1 kg/m2)	21 (23.3)	14 (24.1)	7 (31.8)			
Maternal weight gain during pregnancy (kg)(mean, SD)	12.4 (± 5.8)	12.2 (± 5.5)	12.8 (± 6.5)	0.61	-3.5, 2.2	0.67
Gestational BMI (kg/m^2)(mean, SD)	33.4 (± 3.4)	33.4 (± 3.5)	33.4 (± 3.0)	0.001	-1.6, 1.6	0.77
Physical activity during gestation						
Sedentary (< 1.49 MET/h/d)	43 (47.8)	35 (53.8)	8 (32)	3.6	1.2, 11.3	0.04*
Light (1.5–2.9 MET/h/d)	25 (27.8)	18 (27.7)	7 (28)	2.1	0.6, 7.1	0.21
Moderate/Vigorous (> 3.0 MET/h/d)	16 (17.8)	12 (18.5	10 (40)	1		
Screen time (h) (TV and cel/ular phone)	6.8 (± 3.9)					
Breastfeeding support and expertise						
Family and/or friends support (n, %)						
Yes	85 (94.4)	61 (93.8)	24 (96)	nd	nd	nd
No	5 (5.6)	4 (6.2)	1 (4)			
Breast-fed a previous infant (n, %)						
Yes	48 (53.3)	34 (52.3)	14 (56)	1.04	0.8, 1.3	0.81
No	42 (46.7)	31 (47.7)	11 (44)			
Breast and nipple problems (self-reported)						
Normal form of the breast (n, %)						
Yes	87 (96.7)	63 (96.9)	24 (96)	nd	nd	nd
No	3 (3.3)	2 (3.2)	1 (4)			
Large breast (n, %)						
Yes	35 (38.9)	22 (33.8)	13 (52)	1.2	0.9, 1.6	0.15
No	55 (61.1)	43 (66.2)	12 (48)			
Normal nipple (n, %)						
Yes	77 (85.6)	54 (83.1)	23 (92)	nd	nd	nd
No	13 (14.4)	11 (16.9)	2 (8)			
Maternal feeding practices						
Food intolerances during gestation (n, %)						
Yes	52 (57.8)	36 (55.4)	16 (64)	1.1	0.8, 1.4	0.48

Table 2 (continued)

Variables	Overall (*n* = 90)	Finished follow-up		OR/difference	95% CI	*p* value
		Yes (*n* = 65)	No (*n* = 25)			
No	38 (42.2)	29 (44.6)	9 (36)			
Alcohol consumption (n, %)						
Yes	5 (5.6)	4 (6.2)	1 (4)	nd	nd	nd
No	85 (94.4)	61 (93.8)	24 (96)			
Smoking (n, %)						
Yes	0	0	0	nd	nd	nd
No	90 (100)	65 (100)	25 (100)			
Second hand smoking (n, %)						
Yes	24 (26.7)	18 (27.7)	6 (24)	0.9	0.7, 1.2	0.79
No	66 (73.3)	47 (72.3)	19 (76)			
Monthly food expenditure (US$)(mean, SD)	27.88 (± 14.88)	26.3 (± 12.7)	31.9 (± 19.3)	-5.5	-12.6, 1.5	0.38
Supplementation (n, %)						
Yes	71 (78.8)	49 (75.4)	22 (88)	nd	nd	nd
No	19 (21.2)	16 (24.6)	3 (12)			
Other medications (n, %)[a]						
Yes	33 (36.7)	23 (35.4)	10 (40)	1.05	0.8, 1.4	0.80
No	57 (63.3)	42 (64.6)	15 (60)			
Maternal intake (kcal)(mean, SD)	2053.7 (± 501.3)	2052 (± 528)	2056 (± 432)	-4.5	-240, 231	0.83

Abbreviations: IG, intervention group; CG, control group; y, years; wk, weeks; BMI, body mass index; nd, no data; h, hour; d, day; SD, standard deviation; nd, no data; MET, metabolic equivalent; OR, Odds Ratio; CI, confidence interval

Group comparisons were performed with Chi2-test for categorical variables and for continuous variables with U-Mann Whitney test and *t* test (gestational weight gain)

[a] acetaminophen, simethyl, topic antibiotics, thyroid hormones and misoprostol

Table 3 Primary outcomes comparisons between IC and CG

Variables	Overall	IG	CG	PR/difference	95% CI	*p* value
EBF prevalence at 4 months (*n* = 65; IG = 29; CG = 36)						
Yes	35 (53.8)	24 (82.8)	11 (30.6)	2.7	1.6, 4.5	< 0.001**
No	30 (46.2)	5 (17.2)	25 (69.4)			
	Overall (*n* = 65)	**IG (*n* = 29)**	**CG (*n* = 36)**	**PR/difference**	**95% CI**	**p value**
Infant change in WLZ (mean, SD)						
Change in WLZ from 0 to 4mo	0.69 (± 0.7)	0.75 (± 1.3)	0.65 (± 1.7)	0.1	-0.6, 0.8	0.76
Change in LAZ from 0 to 4mo	0.25 (± 0.9)	0.4 (± 0.9)	0.1 (± 1.0)	0.22	-0.3, 0.7	0.36
Maternal weight loss						
1st wk pp to 4 months in kg (mean, SD)	3.1 (± 5.0)	1.9 (± 4.7)	4.2 (± 5.1)	-2.2	-0.2, 4.8	0.07
1st wk pp to 4 months in % (mean, SD)	4.03 (± 6.6)	2.5 (± 6.4)	5.4 (± 6.5)	-2.9	-0.38, 6.2	0.08

Abbreviations: IG, intervention group; CG, control group; EBF, exclusive breastfeeding; WLZ, weight for length Z-Score; LAZ, length for age Z-Score; PR, prevalence ratio.

* Statistical significance at the level of < 0.05.

Group comparisons were performed with Chi2-test for categorical variables and for continuous variables with *t* test as all continuous variables were normally distributed.

or obese mothers, the infants in our study may not have been at high risk of rapid infant weight gain, which may have limited our ability to detect effects of the intervention on this outcome.

Our study also found no effect of the counselling on maternal weight loss, as we did not include weight loss counselling as part of the intervention. Studies in this field are inconclusive; at 12 months the maternal weight loss could be small but significantly higher in EBF vs. non-breastfeeding or non-EBF groups (1.4 kg) [42]; while other studies have shown an effect of breastfeeding on maternal weight loss when the duration of breastfeeding is longer than 6 months [43]. Although our intervention improved the prevalence of EBF, the intervention was not designed to give nutritional advice for the mother about healthy diet or physical activity and both did not differ between groups. The results could also be explained by the small sample size, short duration of follow up and the fact that the CG also included EBF mothers.

The institution where study participants delivered appeared to implement the 10-steps of the baby friendly hospital initiative effectively, as the prevalence of early

Table 4 Secondary outcomes comparisons between IC and CG

	Overall	IG	CG	Difference	95% CI	*p* value
1 months						
Human milk energy and macronutrient composition (mean, SD)($n=66$; IG = 36; CG = 30)						
Energy (kcal/100mL)	73.2 (± 14.6)	70.9 (± 11.9)	74.8 (± 16.7)	3.9	-3.3, 11.2	0.28
Protein (g/100mL)	1.07 (± 0.19)	1.09 (± 0.20)	1.06 (± 0.19)			0.64
Fat (g/100mL)	3.69 (± 1.55)	3.4 (± 1.2)	3.9 (± 1.8)	0.49	-0.27, 1.26	0.2
Carbohydrate (g/100mL)	8.27 (± 0.67)	8.36 (± 0.74)	8.21 (± 0.62)			0.45
Maternal intake at 1 month (mean, SD)($n=68$; IG = 31; CG = 37)						
Energy (kcal/d)	1,956 (± 507.8)	2,008 (± 510.1)	1,800 (± 499)	-168	-413, 77	0.18
Protein (g/d)	74.5 (± 24.4)	75.3 (± 28.1)	67.6 (± 20.4)	-8.8	-20, 2.9	0.14
Fat (g/d)	63.1 (± 25.2)	61.3 (± 27.6)	63.8 (± 23.3)	-0.73	-13, 11	0.9
Carbohydrate (g/d)	270.4(± 84.9)	283.5(± 88.5)	254.9(± 81.6)	-22.17	-63, 19	0.29
Maternal serum prolactin (median, IQR)($n=32$; IG = 20; CG = 12)	70.6(380.1)	65.4 (380.0)	74 (223.4)			0.72
Human milk prolactin (mean, SD)($n=19$; IG = 11; CG = 8)	2.15 (± 1.49)	1.72 (± 1.4)	2.75 (± 1.48)	1.03	-0.38, 2.43	0.14
Breast milk volume estimation (g/d)($n=53$; IG = 24; CG = 29) by WHO recommendation	563.1(± 238)	562 (± 169)	563 (± 276)	-1.0	-0.3, 2.3	0.12
Breast milk volume estimation (g/d)($n=53$; IG = 24; CG = 29) by Olaya´s algorithm	471.3 (± 71.0)	492.7 (± 29.7)	452.9 (± 88.7)	39.8	5.4, 74.2	0.04*
4 months						
Human milk energy and macronutrient composition (mean, SD)($n=52$; IG = 26; CG = 26)						
Energy (kcal/100mL)	69.9(± 18.2)	69.86 (± 19.81)	70.09(± 16.8)	0.23	-9.99, 10.45	0.96
Protein (g/100mL)	0.87 (± 0.13)	0.86 (± 0.15)	0.88 (± 0.11)	0.02	-0.58, 0.09	0.62
Fat (g/100mL)	3.42 (± 1.95)	3.48 (± 2.18)	3.37 (± 1.73)	-0.11	-1.20, 0.98	0.85
Carbohydrate (g/100mL)	8.4 (± 0.72)	8.27 (± 0.76)	8.52 (± 0.67)	0.25	-0.15, 0.64	0.22
Maternal intake at 4 months (mean, SD)($n=49$; IG = 22; CG = 27)						
Energy (kcal/d)	1876 (± 486.7)	2,039 (± 423)	1,923 (± 534)	-116	-398, 166	0.41
Protein (g/d)	74.4 (± 20.2)	78.3 (± 19.3)	71.6 (± 20.9)	-6.69	-18.39, 4.99	0.25
Fat (g/d)	62.9 (± 21.6)	67.0 (± 19.3)	68.3 (± 23.7)	1.28	-11, 13	0.84
Carbohydrate (g/d)	256.7 (± 80.2)	289.7 (± 81.0)	253.1 (± 77.2)	-36.62	-82.2, 8.95	0.11
Maternal serum prolactin (median, IQR)($n=19$; IG = 10; CG = 9)	37.5 (75.77)	24 (73.27)	39.6 (55)			0.18
Human milk prolactin (mean, SD)($n=19$; IG = 11; CG = 8)	1.29 (± 0.73)	1.27 (± 0.70)	1.33 (± 0.83)	0.06	-0.679, 0.81	0.855
Breast milk volume estimation (g/d)(mean, SD)($n=64$; IG = 25; CG = 39) WHO recommendation	707 (± 312.1)	713.9 (± 281.5)	701.5 (± 340.2)	12.4	-183.4, 208.2	0.9
Breast milk volume estimation (g/d)($n=64$; IG = 25; CG = 39) Olaya´s Algorithm	631.8 (± 194.1)	692.2 (± 118.8)	587.6(± 226.7)	104.6	-10.5, 210	0.07

Abbreviations: IG, intervention group; CG, control group; SD, standard deviation; d, day

Group comparisons were performed with *t* test, U-Mann Whitney test (energy and fat at 1 month, breast milk volumen at 1 and 4 months) or independent samples median test (maternal serum prolactin at 1 and 4 months)

*Statistical significance at the level of $p < 0.005$

**Statistical significance at the level of $p < 0.001$

initiation of breastfeeding (1 h after delivery), skin-to-skin contact and joint accommodation was 84%, 95.1% and 92.6% respectively, higher than national data for early initiation of breastfeeding (72.6%) [2]. However, the use of infant formula during the first week postpartum was high in both groups (44.4%) and could negatively affect later breastfeeding outcomes [44].

There is a lack of data on milk composition in overweight or obese mothers. In our study, the overall mean protein concentration at 1 month and 4 months was similar to values previously reported for the general population [45]; however, carbohydrates, fat and energy were higher than previously reported. Some authors found no association between maternal diet and breast milk macronutrient composition [46], whereas others reported that maternal intake could explain macronutrient variability in human milk [47]. In our sample, maternal intake was not different between IG and CG, but future

analyses are planned to investigate associations between breast milk macronutrient content and maternal diet in this cohort.

Estimated breast milk volume tended to be higher in the IG, the group with the higher prevalence of EBF, at 1 and 4 months, reaching significance at 1 month when analyzed by Olaya´s algorithm. This is in accordance with other studies that have shown a higher consumption of breast milk in infants exclusively breastfed for 6 months compared to those who receive complementary foods from 4 months in developed [48] and developing countries [49]. Studies in humans and in animal models suggest a lower prolactin response to suckling in overweight and obese mothers when compared with normal weight mothers during the first week postpartum [11, 50, 51]; our findings suggest that the intervention may have improved the low prolactin response to suckling in these mothers. However, this finding must be interpreted with caution. It would be preferable to determine milk intake using stable isotopes [52], but this was not considered feasible in our study due to concerns that it would adversely affect compliance in this already-challenging group of mothers.

To our knowledge, our results are the first to explore the concentration of prolactin in serum and breast milk of overweight and obese mothers. Although there were no differences between groups, overall serum prolactin was similar to that reported in normal weight lactating mothers [53]. We hypothesized that the increment in suckling, as consequence of the EBF counselling intervention, would result in a higher concentration of maternal serum and breast milk prolactin in the IG. Our findings, which are from a small sub-group of the participants, did not confirm this hypothesis. Given that the counseling intervention increased the prevalence of EBF in our study, it could be inferred that there is a normal prolactin response to suckling in overweight and obese women, contrary to findings in animal models [13], but a weaker transport of prolactin to the breast milk.

To our knowledge, this is the first randomized control trial performed in Colombia or Latin America that evaluates the effect of an intervention in overweight or obese mothers to promote EBF. Our intervention is a theory-based counselling, carried out with 4 visits in a low-income setting. Also, we offered a well-structured counselling approach that could be used routinely in a primary care setting which could increase the adherence of the mothers rather than being offered on demand [54].

Strengths and limitations

The main strength of our study is the use of an experimental approach to evaluate our theory-based counselling intervention to support EBF in the overweight or obese mother. This contrasts with most studies on this topic which are observational, partly due to ethical concerns related to the random allocation of mothers to an intervention or control group (in our study, the control group received standard support for breastfeeding and EBF) [55]. The counselling intervention was oriented specifically to support overweight and obese mothers in a low socioeconomic setting based on a theoretical framework and using a face-to-face approach, in contrast with other studies in overweight and obese mothers that failed to improve the duration of EBF using a telephone based approach [17].

Although well defined by WHO, EBF is difficult to measure and is prone to information bias. We assessed EBF from information given by the mother in two 24 h recalls of infant intake but this was checked using other methods, including questions about the consumption of other beverages or infant formula, the counsellor observing latching and milk expression that allowed her to confirm the information about EBF, as well as the verification of information about duration of EBF and counselling by a verification questionnaire delivered by an independent researcher. Finally, to our knowledge, this is the first study to describe macronutrients and prolactin in human milk and maternal serum prolactin in overweight or obese mothers and the first attempt to evaluate the impact of these parameters on infant growth.

We also faced limitations, and our findings should be interpreted accordingly. Our main constraints were not reaching the planned sample size and the losses to follow-up. The participants were from a low income and transient population, sometimes with limited access to cellular phones and health care services. This situation made contact with mothers and follow up difficult, so we were unable to reach the planned sample size, a common problem in low income settings [56] and also in studies that attempt to prolong EBF in overweight or obese mothers [17]. Sedentary mothers were more likely to remain in the study, probably because the more physically active women were involved in other activities such as working and studying which did not allow them to participate in the study. Despite greater than 20% losses to follow-up, the homogeneity of the sample was maintained across the study during the first week postpartum and at 4 months, and the sensitivity analysis still showed a higher effectiveness of the counselling intervention when compared with the CG. We also faced time limitations that limited the follow up our cohort to 4 months. Future studies should ideally include longer follow-up to better understand the effect of the EBF counselling on the risk of overweight and obesity later in life. Finally, due to limited economic resources, we were only able to determine concentrations of serum and milk prolactin in a sub-group and we were not able to measure other potentially relevant hormones such as leptin.

Conclusion

This randomized control trial showed a high efficacy of a counselling intervention based on the client-centered theory of Carl Rogers when compared with the primary standard care in a group of Colombian mothers with low socioeconomic status. The intervention increased the prevalence of EBF at 4 months but did not influence infant growth velocity or maternal weight loss. The concentration of prolactin in human milk or maternal blood did not differ between groups but the estimated breast milk volume was higher in the intervention group at 1 months. This study was designed to help overweight and obese mothers to achieve their EBF goals in a low-income setting. As such, it was designed as an easy to implement and low-cost strategy. Given the finding that effective EBF support is achievable in this population, the next step is to refine the intervention, considering staffing and financial resources in the primary care setting to support the overweight or obese mother in prolonging the duration of EBF, in Colombia and other developing countries. The results should be interpreted in the context of the small sample size and loss to follow-up. Given the difficulties in recruitment to the study, we need to identify effective ways to engage and facilitate the adherence to the counselling. Further evidence is needed to investigate the hormonal, physiological and social factors that contribute to sub-optimal BF initiation and duration in this group of women.

Abbreviations

aOR	Adjusted Odds Ratio
BF	Breastfeeding
BMI	Body Mass Index
CAPS	Centro de Atención Primaria en Salud (Primary Care Health Attention Center)
CG	Control Group
CI	Confidence Interval
cm	Centimeters
EBF	Exclusive Breastfeeding
g	Grams
HCAZ	Head Circumference for Age Z-score
IG	Intervention Group
kg	Kilograms
LAZ	Length for Age Z-score
mL	Mililiters
mm	Milimeters
MUAC	Middle Upper Arm Circumference
MUACZ	Middle Upper Arm Circumference Z-score
ng	Nanograms
NICU	Neonate Intensive Care Unit
OR	Odds Ratio
PR	Prevalence Ratio
WHO	World Health Organization
WLZ	Weight for Length Z-score

Supplementary Information

The online version contains supplementary material available at https://doi.org/10.1186/s13006-025-00703-x.

Supplementary Material 1: Supplementary table 1a: EBF counselling submission paper – Sup Table 1a.docx.

Supplementary Material 2: Supplementary table 1b: EBF counselling submission paper – Sup Table 1b.docx

Supplementary Material 3: Supplementary table 1c: EBF counselling submission paper – Sup Table 1c.docx

Supplementary Material 4: EBF counselling database.xlsx

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Author contributions

FAP contributed with study conception, design, drafting the protocol, data collection, data analysis, paper writing and revising the manuscript; GOV contributed with study conception, supervision of data collection, critical review of manuscript and MF contributed with input to study protocol and data analysis, critical review, and revision of manuscript.

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Data availability

Data is provided within the manuscript or supplementary information files.

Declarations

Ethics approval and consent to participate

Ethics approval was obtained from the Subred Norte Ethics Committee, Secretaría de Salud de Bogotá, Colombia (ID: SNCI-021-CEI) and Ethics Committee, Science Faculty, Pontificia Universidad Javeriana. During recruitment, the researcher explained the study procedures and answered participants' questions about the study. Every woman who agreed to participate gave written informed consent and the researcher explained that data would be confidential; paper records would be kept in a locked filing cabinet at Pontificia Universidad Javeriana and electronic data stored in password-protected files. (UTN) U1111-1228-9913 20 February 2019; ISRCTN1592290440 27 February 2019, retrospectively registered.

Competing interests

The authors declare no competing interests.

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