Lactation Counseling Increases Breast-Feeding Duration but Not Breast Milk Intake as Measured by Isotopic Methods[1]

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ABSTRACT The importance of exclusive breast-feeding in the first 6 mo of life is widely recognized, but most mothers still do not reach this goal. Several studies have shown that face-to-face lactation counseling is effective in increasing not only exclusive breast-feeding rates but also the total duration of breast-feeding. However, it is unclear whether counseling could increase breast milk intake. The purpose of this study was to evaluate the effect of lactation counseling on breast milk intake, assessed through the deuterium dilution method. This was a blind, randomized intervention trial of lactation counseling in a sample of 188 babies born in Pelotas, selected with the same criteria used for the WHO Multicentre Growth Reference Study (MGRS). The main outcomes were breast-feeding pattern and duration for all infants as well as breast milk intake for a subsample of 68 infants at the age of 4 mo. Mothers in the control group were almost twice as likely to stop breast-feeding by 4 mo as those in the intervention group (prevalence ratio 1.85; $P = 0.04$). Cox regression confirmed that the velocity of weaning was twice as high in the control group. Breast milk and total water intakes did not differ between the groups. The deuterium dilution technique proved to be a practical means of assessing breast milk intake. Lactation counseling reduced early weaning, but breast milk intake at 4 mo was not affected. J. Nutr. 133: 205–210, 2003.

KEY WORDS: • *human milk* • *breast-feeding* • *promotion* • *infant* • *deuterium dilution method*

Several authors have stressed the importance of breast-feeding and its advantages in terms of social, economic and health-related outcomes, particularly the reduction in morbidity and mortality caused by infectious diseases (1–10). Early introduction of other liquids or of complementary foods may reduce breast milk intake (11) and the protection afforded against several diseases (3,4,12). Thus, the WHO and UNICEF recommend that exclusive breast-feeding should be continued until the age of 6 mo (13).

Despite the wide recognition of the importance of breast milk, rates of exclusive breast-feeding are still low in most countries, and the duration of any breast-feeding is also unsatisfactory in most of the world. Studies carried out in the last decade show that face-to-face counseling by trained health workers is effective not only for reducing the early introduction of liquids or solids, but also for increasing the duration of breast-feeding (1,12,14,15). It has also been argued that counseling could increase breast milk intake among breast-fed infants (16). However, in a comprehensive literature search, we did not identify any studies assessing breast milk intake in relation to the use of counseling.

Isotopic methods have been developed in the last 20 y to measure breast milk intake. These have the advantage over test weighing for feeding frequency assessments because they do not interfere with normal patterns of behavior and are not time-consuming for the mothers involved (17–24).

The method consists of the oral administration of a fixed dose of deuterium to the mother, and the fate of the dose is traced in the body water of mothers and infants (18, 20–22, 25). The body water pools are modeled as two compartments with exchange from the mother to the infant only. Data are fitted to this model and estimates for water fluxes in mother, infant and transfer of water from the mother to the infant in milk can be found. The method also allows the estimation of water intake from sources other than breast milk.

The WHO is currently coordinating the Multicentre Growth Reference Study (MGRS)[3] in six countries with the objective of developing a new growth chart based on babies who are fed according to a set of recommendations that include breast-feeding (26). The city of Pelotas in Southern Brazil is one of the sites included in the study. Lactation support is an essential component of the MGRS, and a strong investment has been made in training and supervising counselors. The same criteria used to select mothers for the MGRS were employed in the present "mirror study" (a study that was subsequently developed but used the same methods as the MGRS), designed to address the effect of lactation counseling on breast milk duration and intake using the deuterium dilution method.

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[3] Abbreviations used: CI, confidence interval; MGRS, Multicentre Growth Reference Study; PR, prevalence ratio.

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SUBJECTS AND METHODS

The study was designed as a randomized, controlled trial, with lactation support as the intervention. It was carried out in Pelotas, a city of 330,000 inhabitants located in a relatively developed part of Brazil.

The three major hospitals, accounting for >90% of all births in the city, were visited daily from August 1999 to January 2000. All mothers delivering in these hospitals were interviewed for screening purposes. The same eligibility criteria were used as in the MGRS (15,26), i.e., residence in the urban area of Pelotas, single birth, gestational age between 37 and 42 full weeks, lack of significant perinatal morbidity (postnatal stay at the intensive care unit should be < 24 h), absence of maternal smoking, no economic constraints to growth (family income should be equal or superior to US$500/mo) and maternal intention to breast-feed.

As in the MGRS, mothers could be excluded at the first home visit 2 wk after the delivery. The two exclusion criteria at this stage were if the mother started smoking or if nonbreast milk had been introduced.

Four fieldwork teams were involved, i.e., hospital screening, home follow-up, lactation support and deuterium testing. The hospital team was in charge of screening all mothers using the MGRS questionnaire, determining eligibility and conducting randomization. Mothers were assigned to either intervention or control groups according to a random computer-generated code included in sealed envelopes that were opened after the mothers met the inclusion criteria. A lactation counselor was contacted to make the first visit while the mother was still in the hospital. Newborns were weighed using portable electronic scales with 100-g precision (UNISCALES, UNICEF, Copenhagen, Denmark).

The lactation support team included two registered nurses who received the 40-h WHO lactation support training course, delivered by two International Board Certified Lactation Consultants. The nurses had provided lactation support in the MGRS. In addition to the hospital counseling visit, mothers were counseled at home when the infant was aged 5, 15, 30, 45, 60, 90 and 120 d. The first visit included orientation of the mothers about the advantages of breast-feeding, observation of the mother breast-feeding and correction of the infant's position if needed, lessons on how to express milk manually and delivery of a breast-feeding promotion leaflet. The home visits included the same messages. If necessary, additional visits were made to advise on feeding problems, including breast problems. A hotline was open 24 h/d to request help and/or extra visits. In the first home visit, a breast-feeding video tape was loaned to each mother.

The control group did not receive lactation support team visits. Children in the control group attended pediatric clinics; general advice on advantages of breast-feeding may have been offered, but specific lactation counseling was not provided because there are no trained counselors in the city.

Two different field workers carried out the home visits for assessing outcomes at 14, 30, 45, 60, 90 and 120 d, also using the standard MGRS questionnaires (which contain information about socioeconomic family conditions, infants' and mothers' health as well as food and medication intake) and collecting the weight and length of the infants. The interviewers were not informed about the intervention or control status of each mother, and did not know about the study objectives. A separate team was in charge of the deuterium measurements for all breast-feeding mothers. They were also unaware of the status of mothers and infants.

Breast milk intake was measured using the dose to the mother deuterium dilution technique (18,21–22). This technique also allows estimation of nonbreast milk water intake. A baseline sample of 2 mL of saliva from the mother and a urine sample from the child were collected on d 0, after which the mother received an oral dose of 0.5 mol ^2H_2O. A further 3 saliva samples from the mother (d 1, 4, 14) and another 5 urine samples from the infant (d 1, 3, 4, 13, 14) were then collected over a 14-d period. Saliva collection was done after having been assured that the mother did not eat or drink in the previous 30 min. The time of collection was recorded. Weight of mother and child were measured at the beginning and end of the study using a portable electronic weighing scale calibrated to 100 g.

Small pieces of cotton wool were used to collect saliva samples (2 mL), after which saliva was expressed by compressing them in a syringe. For urine collection, urine samples (2 mL) were obtained as described elsewhere (27). Cotton wool balls were placed in clean diapers which were then checked every 10 min. After urination, the sample was collected from the cotton wool by compression in a syringe. Urine and saliva samples were stored on ice during transport on the days of field work, and were stored in the field worker's home freezer at the end of the day. Once a week samples were brought together in the laboratory and stored at −20°C until the end of the study. At the end of the study all samples were sent unfrozen by courier to the UK.

The ^2H enrichment in the saliva and urine samples was measured by isotope ratio mass spectrometry after equilibration with H_2 gas as described elsewhere (28). Precision of the measurements was 0.26 μg/g. The intake of breast milk and water from nonmilk sources was calculated by fitting the isotopic (tracer) data to a model for water (tracee) turnover in the mothers and infants and the transfer of milk from mother to the infant (18,22).

Quality control measures included the use of standardized questionnaires and interviewer guides, thorough training of interviewers, checking of all questionnaires by a supervisor and the repetition of a random sample of 10% of all interviews. There were also standardization sessions every 2 mo to check the quality of the anthropometry measurements and a visit to each intervention mother was made to check the quality of the breast-feeding support team orientations.

The study had 80% power to detect a 100-mL difference in breast milk intake between the intervention and control group, with a two-tailed α of 5% and assuming a SD of 130 mL. This required 27 mothers in each group. The SD estimate of 130 mL was approximately the median in published references on breast milk intake (11,18,21,24,29,30). Because there were no similar studies in the literature, a difference of 100 mL was arbitrarily specified as being both biologically significant and resulting in a manageable sample

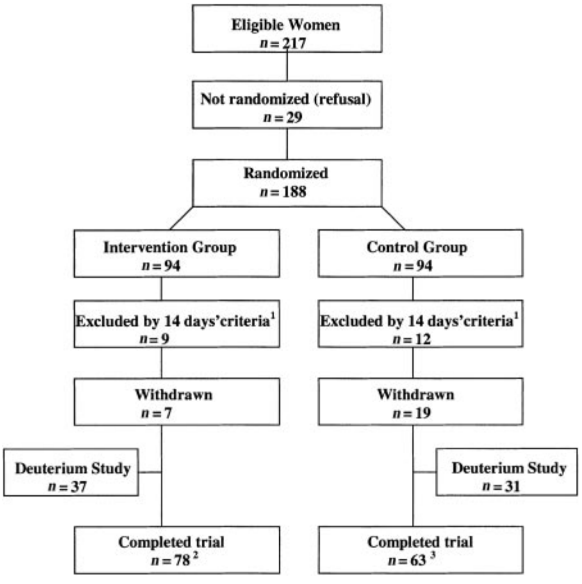

FIGURE 1 Flow diagram of the subject progress through the various stages of a blind, randomized intervention trial of lactation counseling in 188 women. The diagram includes flow of participants and withdrawals; *1*) one mother from the control group was excluded due to smoking; all other exclusions were due to early introduction of formula; *2*) 78 women completed the trial, but analyses also included another four women who withdrew from the intense data collection phase but who later provided retrospective information on outcomes, thus allowing "intent to treat" analyses; *3*) 63 women completed the trial; however, analyses also included another 12 women who withdrew from the intense data collection phase but who later provided retrospective information on outcomes, thus allowing "intent to treat" analyses.

size. For the larger sampling of breast-feeding behaviors, the study had 80% power to detect a difference of 20% by 4 mo of age.

Breast-feeding was classified according the current WHO recommendations (13), i.e., exclusive breast-feeding; predominant breast-feeding (breast milk plus other liquids such as water, tea or juice) and partial breast-feeding (other food or milk in addition to breast milk). "Any breast-feeding" was defined as at least one breast milk feed a day, regardless of the use of other liquids or solids.

Feeding patterns in the intervention and control groups were compared using the χ^2 test for heterogeneity and mean intakes using Student's *t* test (31). Cox's proportional hazard model was used to compare the duration of exclusive and total breast-feeding (31). Several confounding factors were considered (family income, maternal education, maternal age, type of delivery, parity, infant's sex and birthweight) but none of them were associated (at $P < 0.20$) with the intervention and with the outcomes; therefore there was no need for multivariate analyses. All statistical analyses were performed using the SPSS software package (Chicago, IL).

The Medical Ethics Committee of the Federal University of Pelotas, affiliated with the Brazilian Medical Council, approved the project. Written informed consent was obtained from all mothers and confidentiality was ensured.

RESULTS

The hospital screening team interviewed 2622 mothers; 217 met all eligibility criteria and 29 of these (13%) refused to take part in the study. Of the 188 mothers included, 94 were allocated to each group (intervention or control). Nine mothers in the intervention and 12 in the control group were excluded at 14 d due to smoking or introduction of nonbreast milk. The study population, therefore, comprised 85 intervention and 82 control mother-infant pairs. A further seven pairs in the intervention and 19 in the control group dropped out during follow-up. An attempt was made at the end of the study to obtain feeding information on all 167 pairs in the study population, regardless of participation. It was possible to locate 82 and 75 mothers, respectively, totaling 94% of the study population (**Fig. 1**) (32). The analyses of feeding patterns were based on these groups.

Counselors were extensively trained and performed well under supervision. The number of visits each mother received varied because counseling was interrupted when breast-feeding stopped. The mean number of contacts with mothers who complied with the intervention was 6.8. The number of planned visits was seven. The study coordinator visited each mother in the intervention group at least once. Nearly all mothers reported enjoying the visits. After the infant was 14 d old, there were only three refusals in this group vs. 10 in the comparison group.

Breast-feeding was assessed at the age of 3.5 mo. The first 76 of the 115 mothers who were still breast-feeding on this occasion were recruited for the isotope study, and 68 accepted (this limitation was based on the number of tests available). Due to the effect of breast-feeding promotion, there were more pairs in the intervention ($n = 37$) than in the control group ($n = 31$).

The distribution of women with feeding information according to baseline variables is presented in **Table 1**. The only significant difference between the groups was the higher proportion of nulliparae in the intervention group. However, this variable was not associated with any of the outcomes under study; thus, there was no need to control for it in the analyses.

TABLE 1

Distribution of the sample according to socioeconomic, demographic, reproductive and nutritional characteristics

Variable	Enrolled in the study[1]		Completed the study		*P*-value[2]
	Intervention	Control	Intervention	Control	
			%		
Family income, *US$/mo*					
500–829	53	57	54	56	0.77
≥830	47	43	46	44	
Maternal education,[3] *y*					
<9	23	27	21	26	0.42
≥9	77	73	79	74	
Maternal age, *y*					
<20	16	10	15	9	0.59
20–35	72	78	73	79	
>35	12	12	12	12	
Type of delivery					
Vaginal	47	44	46	41	0.53
Cesarean section	53	56	54	59	
Parity[3], *n*					
0	57	41	56	39	0.04
≥1	43	59	44	61	
Infant's sex					
Male	50	54	49	59	0.22
Female	50	46	51	41	
Infant's birthweight, *g*					
<2500	2	—	2	—	0.50[4]
≥2500	98	100	98	100	
Total	94	94	82	75	

1 Intervention and control groups at baseline.
2 *P*-value for the difference among intervention and control group mothers who completed the study.
3 Ten mothers had missing information for education and parity.
4 Fisher's Exact Test.

TABLE 2

Weight of infants in a blind, randomized intervention trial of lactation counseling at seven time points[1]

Age (d)	Intervention	Control	*P*-value[2]
	kg		
0	3.19 ± 0.40 (94)	3.18 ± 0.34 (94)	0.86
14	3.47 ± 0.42 (88)	3.56 ± 0.42 (80)	0.17
30	4.05 ± 0.45 (82)	4.15 ± 0.49 (68)	0.20
45	4.54 ± 0.50 (76)	4.71 ± 0.56 (67)	0.07
60	5.21 ± 0.51 (78)	5.38 ± 0.68 (65)	0.09
90	5.97 ± 0.62 (80)	6.12 ± 0.81 (62)	0.20
120	6.65 ± 0.67 (78)	6.80 ± 0.87 (63)	0.29

[1] Values are means ± SD (*n*).
[2] *t* test.

The infant weights at the seven time points did not differ between the groups (**Table 2**).

The effect of lactation promotion on feeding patterns is shown in **Table 3**. When the breast-feeding variable was kept in four categories, there was no significant association with the intervention ($P = 0.22$). However, mothers in the control group were almost twice as likely to have stopped breast-feeding than those in the intervention group [prevalence ratio (PR) 1.85; 95% confidence interval (CI), 1.01 to 3.41; $P = 0.04$]. The prevalence of exclusive breast-feeding was 24% lower in the control group but this was not significant (PR 0.76; CI, 0.50 to 1.17; $P = 0.21$). Similar results were obtained for exclusive or predominant breast-feeding (PR 0.81; CI, 0.58–1.14; $P = 0.22$).

These results are consistent with those of the Cox regression analyses (**Fig. 2**). The intervention affected total breast-feeding, with the velocity of weaning twice as high in the control group. Velocities of stopping exclusive, and of stopping exclusive or predominant breast-feeding generally were ~40% higher in the control group. The hazard ratios were 1.37 (95% CI, 0.92–2.02; $P = 0.12$) for exclusive breast-feeding, 1.43 (95% CI, 0.92–2.20; $P = 0.11$) for exclusive or predominant breast-feeding and 2.06 (95% CI, 1.04–4.10; $P = 0.04$) for any breast-feeding.

Breast milk intake did not differ between the two groups ($P = 0.48$, **Table 4**). Infants in the intervention group tended to consume 88 mL/d of nonbreast milk water less than those in the control group ($P = 0.16$). The total water intake (water from breast milk + other water) did not differ between groups ($P = 0.36$).

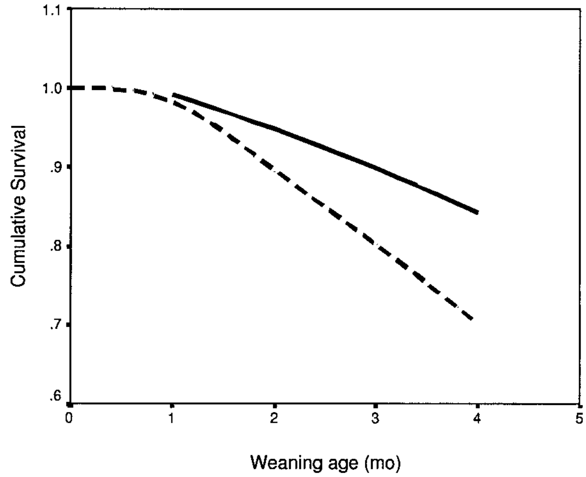

FIGURE 2 Cox survival analysis for stopping any breast-feeding of infants up to 4 mo of age for mothers without lactation support compared with those with lactation support, with a hazard ratio of 2.06 (95% CI 1.04–4.10; $P = 0.04$) for any breast-feeding. The hazard ratios were 1.37 (95% CI 0.92–2.02; $P = 0.12$) for exclusive breast-feeding and 1.43 (95% CI 0.92–2.20; $P = 0.11$) for exclusive or predominant breast-feeding. Solid line: Intervention Group; dashed line: Control Group.

DISCUSSION

In the last few decades, there has been important progress in helping mothers breast-feed. From large-scale, mass-media campaigns in several countries, whose effectiveness was often disputed (33), there was a strong tendency to provide face-to-face advice by trained lactation counselors. The original hypotheses of the study were that lactation counseling could increase the proportion of babies who were breast-fed as well as breast milk intake among those who continued to breast-feed. By counseling the mothers, it was expected that they would become more self-confident, breast-feeding on demand and adequately positioning their babies. Counselors were also expected to diagnose and prevent potential risk factors for early weaning, such as emotional problems, drug intake, poor attachment or breast problems (16). The literature shows that lactation support increases the duration of exclusive breast-

TABLE 3

Effect of a lactation counseling intervention on breast-feeding pattern at 4 mo postpartum

	Intervention		Control		
Breast-feeding pattern	*n*	%	*n*	%	*P*-value[1]
Fully weaned	13	(16)	22	(29)	
Exclusive breast-feeding	33	(40)	23	(31)	0.22
Predominant breast-feeding	10	(12)	9	(12)	
Partial breast-feeding	26	(32)	21	(28)	
Any breast-feeding[2]	69	(84)	53	(71)	0.04
Total	82		75		

[1] Compared with fully weaned infants.
[2] Breast milk plus other liquids and/or food.

TABLE 4

Effect of a lactation counseling intervention on infants' milk and water intakes at 4 mo postpartum[1]

Intake	Intervention	Control	*P*-value[2]
	mL/d		
Breast milk intake	761 ± 184	723 ± 241	0.48
Non breast milk, oral water intake	107 ± 225	195 ± 287	0.16
Total water intake (water from breast milk[3] + other water)	770 ± 193	825 ± 280	0.36

[1] Values are means ± SD, $n = 68$.
[2] *t*-test.
[3] Water corresponds to approximately 87.1% of breast milk intake.

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feeding (1,14,15,34) and that babies who are exclusively breast-fed have higher breast milk intake (11); until now, however, there have been no data on the effects of lactation counseling on breast milk intake.

This study had some limitations. The first concerns its external validity to developing countries because the strict eligibility criteria resulted in the exclusion of >90% of the mothers screened. However, the choice of mothers with a high standard of living was important for controlling nutritional and environmental factors that could have constrained breast-feeding and child growth. In addition, sample sizes were relatively small and as a consequence, statistical power was low for some comparisons. It is important to take into account, however, that this is one of the largest studies in the literature using isotopic techniques. The number of refusals was considerably higher in the control group, but it was possible to obtain information on breast-feeding duration in many mothers who had initially refused. In fact, the smaller number of dropouts in the intervention group provides indirect evidence of the success of lactation promotion.

Standard deviations in the actual study samples were considerably larger (184 and 241 mL, respectively in the intervention and control groups) than the value of 130 mL used in the sample size calculations. Based on the actual SD, the study had 64% power of detecting a difference of 100 mL between the two groups, with $\alpha = 5\%$ (one-sided). Therefore, the present results have to be interpreted in the light of the relatively low power of the study, although it is reassuring that the observed difference was only 38 mL.

The deuterium dilution technique proved to be a feasible and precise way of estimating breast milk intake, as previously reported (18,19,21). Other advantages include the fact that intake is assessed over a 14-d period, thus avoiding daily fluctuations, and it also allows assessment of the exclusiveness of breast-feeding (18). The traditional test-weighing approach, weighing the infant before and after each feed, is time-consuming and interferes with the mother's feeding routine and other activities (17). In addition, it is difficult to use when the infant is breast-fed on demand, when several night feeds may occur.

Despite the relatively small sample size for assessing changes in feeding patterns, it was possible to demonstrate a significant effect on the total duration of breast-feeding, and a possible ($P = 0.12$) effect on the duration of exclusive breast-feeding. These findings are in agreement with the literature (1,14,15,34). The fact that many babies in both groups received water or teas (predominant breast-feeding) shows that the intervention was unable to effectively change this deeply ingrained cultural practice, which is often supported by pediatricians themselves (35).

Breast milk intakes were similar to those observed in other studies (11,18,24) and were only 38 mL (5%) higher in the intervention group ($P = 0.48$). Therefore, the original hypothesis that lactation support could increase milk intake by 100 mL or more was rejected. Nevertheless, there was some evidence that mothers in the intervention group provided less (88mL/d; $P = 0.16$) nonbreast milk water (including teas, water, formula or cow's milk) than those in the comparison group.

It is important to note that this analysis was restricted to infants from both groups who were being breast-fed at 4 mo of age. In the comparison group, a significantly higher proportion of mothers had already weaned their children, perhaps because feeding problems (e.g., poor positioning and attachment, cracked nipples) led to lower milk production and thus to the introduction of formula. If intake measurements had been carried out at earlier ages, e.g., at ~1 mo, when the vast majority of infants are still breast-fed regardless of the intervention, a different result might have been found.

Even without an effect on infant milk intake, we found that breast-feeding support decreased the speed of weaning and this is very important, especially for young babies.

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