Effects of Exclusive Breastfeeding for Four versus Six Months on Maternal Nutritional Status and Infant Motor Development: Results of Two Randomized Trials in Honduras[1]

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ABSTRACT To examine whether the duration of exclusive breastfeeding affects maternal nutrition or infant motor development, we examined data from two studies in Honduras: the first with 141 infants of low-income primiparous women and the second with 119 term, low birth weight infants. In both studies, infants were exclusively breastfed for 4 mo and then randomly assigned to continue exclusive breastfeeding (EBF) until 6 mo or to receive high-quality, hygienic solid foods (SF) in addition to breast milk between 4 and 6 mo. Maternal weight loss between 4 and 6 mo was significantly greater in the exclusive breastfeeding group (EBF) group than in the group(s) given solid foods (SF) in study 1 (-0.7 ± 1.5 versus -0.1 ± 1.7 kg, $P < 0.05$) but not in study 2. The estimated average additional nutritional burden of continuing to exclusively breastfeed until 6 mo was small, representing only 0.1–6.0% of the recommended dietary allowance for energy, vitamin A, calcium and iron. Women in the EBF group were more likely to be amenorrheic at 6 mo than women in the SF group, which conserves nutrients such as iron. In both studies, few women (10–11%) were thin (body mass index <19 kg/m^2), so the additional weight loss in the EBF group in study 1 was unlikely to have been detrimental. Infants in the EBF group crawled sooner (both studies) and were more likely to be walking by 12 mo (study 1) than infants in the SF group. Taken together with our previous findings, these results indicate that the advantages of exclusive breastfeeding during this interval appear to outweigh any potential disadvantages in this setting. J. Nutr. 131: 262–267, 2001.

KEY WORDS: • *breastfeeding* • *complementary feeding* • *maternal nutrition* • *lactation* • *amenorrhea* • *motor development*

There currently is an active debate about the recommended age of introduction of complementary foods to breastfed infants. The World Health Organization stipulates an age interval of 4–6 mo (World Health Organization 1995), whereas UNICEF and the American Academy of Pediatrics have used the wording "at about 6 mo"(UNICEF 1999, American Academy of Pediatrics 1997). Most of the evidence used to evaluate the optimal duration of exclusive breastfeeding (EBF)[3] has focused on infant intake, growth and morbidity, with little attention devoted to effects on the mother or on other functional outcomes for the infant (Brown et al. 1998). It has been argued that there may be tradeoffs between maternal and infant needs and that a comprehensive assessment of risks and benefits for both mother and infant is needed to formulate appropriate feeding recommendations (Frongillo and Habicht 1997, McDade and Worthman 1998).

Only two randomized intervention trials have been conducted to examine the effects of introducing complementary foods at 4 versus 6 mo of age, both in Honduras (Cohen et al. 1994, Dewey et al. 1999). The first study included 141 infants of low-income, primiparous women and the second included 119 term, low birth weight (LBW) (i.e., small-for-gestational age) infants. In both studies, there was significant displacement of breast milk intake when hygienic, nutrient-rich solid foods were introduced and no significant impact on infant growth (short or long term) or food acceptance to 12 mo of age (Cohen et al. 1995a and 1995b). The social and cultural feasibility of EBF for 6 mo was evaluated in both populations (Cohen et al. 1995c and 1999), and although there were several obstacles to achieving this goal, women who persevered became enthusiastic proponents of this practice. The present article describes findings from these two trials regarding other important outcomes: maternal nutritional status, lactational amenorrhea and infant motor development.

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[3] Abbreviations used: BMI, body mass index; EBF, exclusive breastfeeding group; LBW, low birth weight; RDA, Recommended Dietary Allowance; SF, group(s) given solid foods; SF-M, group given solid foods with maintenance of preintervention breastfeeding frequency.

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METHODS

Study design and selection criteria. Each study was designed as a prospective observational study from birth to 4 mo, followed by a randomized intervention trial to determine the impact of complementary foods from 4 to 6 mo and a follow-up period from 6 to 12 mo. Subjects were recruited from the two main maternity hospitals in San Pedro Sula, Honduras. Selection criteria for study 1 were that the mother is primiparous, willing to exclusively breastfeed for 6 mo, not employed outside the home before 6 mo postpartum, of low income (<$150/mo), 16 y or older and healthy (not taking medication on a regular basis) and that the infant is healthy, term and weighs ≥2000 g at birth. Selection criteria for study 2 (LBW) were similar except that the infant birth weight was 1500–2500 g, the maternal age was ≥15 y and there were no limitations on income or parity. Twins and infants with severe medical conditions that might interfere with food intake or growth were excluded from both studies.

At 16 wk, infants who were still exclusively breastfed were randomly assigned to intervention groups. Subjects in study 1 were assigned to one of three groups: *1*) EBF to 26 wk, with no other liquids (water, milk or formula) or solids (EBF), *2*) introduction of solid foods at 16 wk, with ad libitum breastfeeding (SF) or *3*) introduction of solid foods at 16 wk, with maintenance of preintervention breastfeeding frequency (SF-M). Subjects in study 2 were assigned to one of two groups: EBF or SF-M, as described earlier. Complementary foods of high nutritional quality were provided in jars and fed twice daily to infants in the SF and SF-M groups, as described elsewhere (Cohen et al. 1994, Dewey et al. 1999).

Randomization was done by week of birth to facilitate provision of feeding instructions to each group during their visits to the research center. Subjects were not informed of their assignment until they had completed the first 16 wk of the study. Measurements of infant breast milk intake, milk composition and solid food intake were made at the research center for all subjects in study 1 at 16, 21 and 26 wk postpartum and for a subsample of 50% of subjects in study 2 at 16 and 26 wk postpartum (Cohen et al. 1994, Dewey et al. 1999). Home visits were conducted weekly from 1 to 26 wk postpartum and monthly thereafter (after the intervention phase) until 12 mo to record maternal return of menses and infant growth, morbidity, motor development and feeding practices. Infant blood samples were collected at 6 mo in study 1 (Dewey et al. 1998a) and at 2, 4 and 6 mo in study 2 (Dewey et al. 1998b). The study protocols were approved by the Human Subjects Review Committee of the University of California, Davis.

Maternal anthropometry. Maternal weight was measured shortly after delivery and monthly thereafter using a digital scale accurate to the nearest 0.2 kg. Accuracy of scales was checked weekly using standard weights. Maternal height was measured using a metal tape and headboard against a wall. Body mass index (BMI) was calculated as weight (in kg)/height (in m^2). The prediction equation of Pollock et al. (1975) was used to estimate maternal percent body fat.

Duration of lactational amenorrhea. At each home visit, women were asked if they experienced any menstrual bleeding since the previous visit, and if so, the dates and duration of each episode were recorded. Information on the use of hormonal contraceptives was also collected. The definition of the first menstrual period was based on the following criteria: *a*) it lasted >1 day, *b*) it occurred after 56 d postpartum and *c*) it was followed by an interval of at least 21 d but not >70 d before the next bleed, as previously described (Dewey et al. 1997). Data from study 1 were previously reported (Dewey et al. 1997) but are included here along with the new data from study 2 for completeness.

Infant motor development. At each home visit, mothers were also asked to report whether their infants could perform any of the following 10 motor milestones and, if so, when it first occurred. Field workers were trained to probe for the specific criteria listed for each milestone. The milestones included were: *1*) while lying face down, the infant can raise the head and look forward; *2*) while lying face down, the infant can raise the head and chest, supporting the body with the arms; *3*) the infant can regularly roll over (from back to front); *4*) the infant can crawl (sustained movement); *5*) from a lying down position, the infant can get into a sitting position; *6*) the infant can stand while holding on to furniture; *7*) the infant can pull to a standing position; *8*) the infant can walk while holding on to furniture ("cruising"); *9*) the infant can stand alone (for ≥30 s); *10*) the infant can walk unaided.

Data analysis. Data were analyzed by using SAS-PC software (SAS Institute 1987). Group comparisons of maternal weight and BMI were performed using Student's *t* test and analysis of variance (ANOVA), and the percentage who were amenorrheic at 6 mo was compared using χ^2 tests. The duration of lactational amenorrhea was analyzed using survival analysis (Kaplan-Meier, PROC: LIFEREG). For motor development, ANOVA was used in initial analyses to compare the average age at which each milestone was achieved across groups. However, some infants had not achieved all of the motor milestones by 12 mo. When this was the case (milestones 4–10), survival analysis (PROC: LIFEREG) was used to compare groups, including censored values for infants who had not achieved that particular milestone and for those who dropped out after 6 mo. Some infants never exhibited crawling (five in each of the three intervention groups in study 1; one in each of the two intervention groups in study 2) or sitting from a lying position (only in study 1: one in EBF, two in SF and one in SF-M), even though they achieved subsequent milestones; in these cases, the values were considered missing rather than censored. Survival analysis was not informative for the last milestone (walking) because fewer than half of the infants were walking by 12 mo; therefore, χ^2 analysis of the percentage who were walking by 12 mo was used instead. In the latter analysis, subjects who dropped out of the studies before 12 mo were excluded. In the ANOVAs, exclusion of dropouts did not change the results, so values for the total sample are presented.

RESULTS

Maternal nutritional status and lactational amenorrhea. **Table 1** shows the changes in maternal weight and BMI between 4 and 6 mo for each of the two studies. Data for the two solid food groups in study 1 were pooled because there was no significant difference in maternal weight change between

TABLE 1

Maternal weight and body mass index 4–6 mo postpartum in lactating Honduran women

	EBF	SF (pooled)[1]
Study 1 (primiparous mothers)		
n	50	91
Weight, *kg*		
4 mo	53.4 ± 7.6[2]	53.4 ± 9.6
6 mo	52.7 ± 7.8	53.2 ± 10.1
Δ	−0.7 ± 1.5	−0.1 ± 1.7[3]
BMI, *kg/m*[2]		
4 mo	22.5 ± 3.3	22.7 ± 3.4
6 mo	22.0 ± 3.1	22.6 ± 3.6
Δ	−0.5 ± 1.6	−0.1 ± 0.8[3]
Study 2 (mothers of LBW infants)		
n	59	60
Weight, *kg*		
4 mo	51.8 ± 8.3	52.0 ± 9.0
6 mo	51.5 ± 8.4	51.9 ± 9.2
Δ	−0.3 ± 1.6	−0.1 ± 1.7
BMI, *kg/m*[2]		
4 mo	22.9 ± 3.2	23.0 ± 3.5
6 mo	22.8 ± 3.3	22.9 ± 3.6
Δ	−0.1 ± 0.7	−0.1 ± 0.8

[1] SF and SF-M groups combined in study 1.
[2] Values are means ± SD.
[3] $P < 0.05$, EBF vs. SF groups, Student's *t* test.
Abbreviations: BMI = body mass index; EBF = exclusively breastfeeding; LBW = low birth weight; SF = solid foods given to infants and breastfeeding ad libitum; SF-M = solid foods given to infants and maintenance of baseline nursing frequency.

TABLE 2

Theoretical maternal nutritional burden of exclusive breast feeding versus breastfeeding plus solid foods given to infants of Honduran women at 4–6 mo postpartum

	Energy	Vitamin A[1]	Calcium[2]	Iron[3]
	kcal[5]	*µg*	*mg*	
Study 1 (primiparous mothers)[4]				
Additional daily output	92	74	31	0.033
Percent RDA	3	6	3	0.2
Total 4–6 mo	5520	4440	1860	2.0
Percent body stores	~4[6]	2	0.2	0.7
Study 2 (mothers of LBW infants)[7]				
Additional daily output	45	45	19	0.02
Percent RDA	2	3	2	0.1
Total 4–6 mo	2700	2700	1140	1.2
Percent body stores	~2	1	0.1	0.4

1 Assumes milk concentration of 670 µg/L; RDA = 1300 µg/d; body stores 209 mg.
2 Assumes milk concentration of 280 mg/L; RDA = 1000 mg/d; body stores 1035 g.
3 Assumes milk concentration of 0.3 mg/L; RDA = 15 mg/d; body stores 300 mg.
4 Difference in milk volume between EBF and SF, 110 mL/d.
5 Multiply by 4.184 to convert to kJ.
6 Assuming an initial percent body fat of 25–30%.
7 Difference in milk volume between EBF and SF, 67 mL/d.
Abbreviations: LBW = low birth weight; RDA = Recommended Dietary Allowances.

the SF and SF-M groups (-0.2 ± 1.6 versus -0.1 ± 1.8 kg, respectively). In both studies, the EBF and SF groups were very similar in weight and BMI at 4 mo, before the intervention. Average BMI at 4 mo was ~23 kg/m^2 in both studies. In study 1, the EBF group lost significantly more weight (difference of 0.6 kg) and BMI (difference of 0.4 kg/m^2) during the 2-mo intervention than the SF group, but there was no significant difference between intervention groups in study 2. There was no significant interaction between initial maternal BMI (<22 or ≥22) and intervention group in either study.

The theoretical maternal nutritional burden of continued EBF between 4 and 6 mo, based on observed differences in mean milk volume and energy output between intervention groups, is illustrated in **Table 2** for energy, vitamin A, calcium and iron. These nutrients were chosen because there are body reserves of each that may become depleted during lactation (Institute of Medicine 1991). The differences in the output of each nutrient are shown for the comparison of the EBF and SF groups in study 1 (the maximum difference observed in breast milk output) and for the EBF and SF-M groups in study 2 (the minimum difference observed in breast milk output). Also shown is the corresponding percentage of the RDA or estimated body stores (for a well-nourished woman) that the average difference represents. In study 1, the difference in the change in milk volume from 4 to 6 mo between the EBF and SF groups was ~110 mL/d, and the difference in milk energy output was ~92 kcal/d (385 kJ/d). This represents ~3% of the RDA of 2700 kcal/d. Over the 2-mo period, the total energy difference would be ~5520 kcal (23 MJ) or ~4% of body fat reserves (assuming an initial percent body fat of 25–30%; the average for women in study 1 was 30%; Perez-Escamilla et al. 1995). In study 2, the difference in the change in milk volume from 4 to 6 mo between the EBF and SF-M groups was ~67 mL/d, and the corresponding difference in milk energy output was ~45 kcal/d (188 kJ/d). As a result, the additional energy burden of EBF from 4 to 6 mo in study 2 was only 2% of the RDA and 2% of estimated body fat stores (again, assuming 25–30% body fat; the average for study 2 was 29%). Interestingly, the estimated total energy burdens (5520 and 2700 kcal in studies 1 and 2, respectively) are in close agreement with the between-group weight differences of 0.6 and 0.2 kg shown in Table 1, assuming that the weight lost was nearly all fat (9 kcal/g; 38 kJ/g).

For the other nutrients in Table 2, the additional burden of EBF from 4 to 6 mo represents 3–6% of the RDA for vitamin A, 2–3% of the RDA for calcium and 0.1–0.2% of the RDA for iron (the lower end of the range is for study 2, and the upper end is for study 1). The corresponding percentages of estimated body stores are 1–2% for vitamin A, 0.1–0.2% for calcium and 0.4–0.7% for iron.

Although the average values for the nutritional burden of continued EBF are all ≤6% of the RDA, there is considerable variability in breast milk output during this interval and thus in the nutritional burden for individual mothers. For example, in study 1 the standard deviation for the change in breast milk output in the SF group was 124 g/d, or 120% of the mean change. Using this coefficient of variation, the 95th percentile for the daily burden of continued EBF for these four nutrients can be estimated as 266 kcal (1113 kJ), 240 µg vitamin A, 101 mg calcium and 0.04 mg iron, which represents 11, 18, 10 and 0.3% of the RDA, respectively.

The nutritional burden of continued EBF may be modified by differences in the duration of postpartum amenorrhea, especially for nutrients such as iron. **Table 3** shows the percentage of women in each study who remained amenorrheic at 6 mo postpartum, after excluding users of oral contraceptives and those whose menses returned before 18 wk postpartum (which could not have been influenced by the intervention). The differences among the three intervention groups in study 1 were not statistically significant ($P = 0.11$), although the SF group tended to be less likely to be amenorrheic. In study 2, the percentage amenorrheic at 6 mo was significantly lower in the SF-M group than in the EBF group (even though these two groups had quite similar rates of amenorrhea in study 1). This difference decreased slightly over time, with the respective percentages being 55.6 versus 75.0% at 8 mo ($P = 0.07$) and 38.2 versus 53.5% at 10 mo ($P = 0.18$). Survival analysis

TABLE 3

Maternal amenorrhea at 6 mo postpartum in lactating Honduran women[1]

	EBF	SF-M	SF	*P*-value[2]
Study 1[3] (primiparous mothers)				
n	40	35	31	—
Percent amenorrheic	80.0	85.7	64.5	0.11
Study 2 (mothers of LBW[4] infants)				
n	45	38	—	—
Percent amenorrheic	88.9	68.4	—	0.02

1 Excluding oral contraceptive users and those whose menses returned before 18 wk postpartum.
2 χ^2 test.
3 Study 1 data previously published (Dewey et al. 1997).
4 EBF = exclusively breastfeeding; LBW = low birth weight; SF = solid foods given to infants and breastfeeding ad libitum; SF-M = solid foods given to infants and maintenance of baseline nursing frequency.

TABLE 4

Motor development milestones in a general sample of term infants (study 1) or a sample of low birth weight, term infants (study 2) in Honduras

	Study 1	Study 2 (LBW)[1]	P-value[2]
n	140	108	
Raise head	1.2 ± 0.7[3]	1.0 ± 0.8	0.02
Raise head and chest	1.9 ± 0.9	1.9 ± 1.5	0.79
Roll over	3.1 ± 1.2	3.8 ± 1.9	0.0003
Crawl	7.0 ± 1.7 (4)[4]	7.2 ± 1.8	0.20
Sit, from lying position	6.9 ± 1.3	7.8 ± 1.6 (5)	<0.0001
Stand with assistance	7.5[5] (4)	8.5 (10)	<0.0001
Pull to stand	8.0 (6)	9.0 (15)	<0.0001
Walk with assistance	9.0 (8)	9.5 (16)	<0.0001
Stand alone	10.5 (28)	11.0 (38)	<0.001
Walk by 12 mo[6]	46% (62/134)	22% (22/99)	<0.001

[1] LBW = low birth weight.
[2] ANOVA for the first three milestones; survival analysis for the remainder (except walking, tested by χ^2).
[3] Mean age achieved (mo) ± SD.
[4] Number of censored values in survival analyses.
[5] Median age achieved (mo), from survival analysis including censored values.
[6] Percentage who walked by 12 mo, excluding dropouts.

indicated a significant difference in the duration of amenorrhea between the EBF and SF groups in study 2 (median duration 331 versus 255 d, $P = 0.04$) but not in study 1. The percentage of women still breastfeeding at 12 mo was ≥90% across intervention groups in both studies, and mean breastfeeding frequency from 6 to 12 mo did not differ significantly among intervention groups in study 1 (Cohen et al. 1995b) or in study 2 (14 times per day in both groups).

Infant motor development. Motor development of infants in the two studies is compared in **Table 4**. For seven of the milestones (all except the first two milestones and crawling), the LBW infants (study 2) were significantly delayed compared with the infants in study 1. For example, half as many were walking by 12 mo (22 versus 46%). **Table 5** shows the mean or median age of achievement of each milestone by intervention group within each study. In both studies, there were no significant differences among intervention groups for the milestones that occurred before the intervention (on average), indicating that the groups were similar at baseline. In both studies, infants in the EBF group crawled sooner than infants in the SF groups, although the difference was only marginally significant in study 2; in the survival analyses with data from both studies included (combining the SF and SF-M groups in study 1), there was a significant difference ($P = 0.007$) between the EBF and SF groups. Crawling occurred, on average, at ~7 mo, 1 mo after the 2-mo intervention period. In study 2, there was also a marginally significant difference between groups ($P = 0.09$) in the age at which the infants were able to sit, which occurred earlier in the EBF group. In study 1, infants in the EBF group were more likely to have walked by 12 mo than infants in the SF groups ($P = 0.07$ with three groups; $P = 0.02$ with the SF and SF-M groups combined: 60 versus 39%).

Although both studies were randomized trials and there were no statistically significant differences in initial characteristics across intervention groups (Cohen et al. 1994, Dewey et al. 1999), there were slight differences in birth weight, infant sex and maternal education that may have confounded these results, particularly in study 1. Within study 1, birth weight was not significantly correlated with the first four milestones (including crawling), but the remaining milestones were achieved earlier in infants with higher birth weights ($P < 0.05$). Infant sex was not significantly associated with any of the milestones. Greater maternal education was associated

TABLE 5

Motor development milestones of Honduran infants by feeding mode at 4–6 mo

	Study 1				Study 2 (LBW)[1]			Pooled survival analysis[2]
	EBF	SF	SF-M	P-value[3]	EBF	SF	P-value[3]	P-value (EBF vs. SF)
n	49	47	44	—	56	52	—	248
Raise head	1.1 ± 0.7[4]	1.3 ± 0.7	1.2 ± 0.6	0.24	1.0 ± 1.0	1.0 ± 0.6	0.74	—
Raise head and chest	1.8 ± 0.8	2.0 ± 1.0	1.8 ± 0.9	0.50	1.9 ± 1.6	1.8 ± 1.3	0.67	—
Roll over	2.9 ± 1.1	3.4 ± 1.4	2.9 ± 1.1	0.15	3.8 ± 2.0	3.8 ± 1.8	0.93	—
Crawl	6.3 ± 1.8 (2)[5]	7.3 ± 1.7 (1)	7.2 ± 1.4 (1)	0.02	6.8 ± 1.7 (2)	7.4 ± 1.9 (2)	0.08	0.007
Sit, from lying position	7.0 ± 1.5 (3)	7.0 ± 1.2 (1)	6.8 ± 1.1 (1)	0.68	7.4 ± 1.6 (3)	8.0 ± 1.6 (2)	0.09	0.63
Stand with assistance	7.5[6] (2)	7.5 (1)	7.0 (1)	—	8.5 (6)	9.0 (4)	—	0.83
Pull to stand	8.0 (3)	8.0 (1)	8.0 (2)	—	9.0 (8)	9.0 (7)	—	0.90
Walk with assistance	8.5 (4)	9.5 (2)	9.0 (2)	—	9.5 (10)	9.5 (6)	—	0.82
Stand alone	10.0 (8)	10.5 (7)	10.5 (13)	—	11.0 (24)	11.0 (14)	—	0.61
Walk by 12 mo[7]	60% (28/47)	41% (19/46)	37% (15/41)	0.07	18% (9/50)	27% (13/49)	0.31	—

[1] EBF, exclusively breastfeeding; LBW, low birth weight; SF, solid foods given to infants and breastfeeding ad libitum; SF-M, solid foods given to infants and maintenance of baseline nursing frequency.
[2] Studies 1 and 2 combined, SF and SF-M groups combined, controlling for study (see text for description of studies 1 and 2).
[3] Analysis of variance for first five milestones; χ^2 test for walk by 12 mo.
[4] Mean age achieved (mo) ± SD.
[5] Number of censored values in survival analyses.
[6] Median age achieved (mo), from survival analysis, including censored values.
[7] Percentage who walked by 12 mo, excluding dropouts.

with the earlier achievement of raising the head and chest but the later achievement of crawling; it was not a significant predictor of the other milestones. Controlling for maternal education in the pooled survival analysis for crawling did not change the results. To control for birth weight in the analyses of walking by 12 mo (for study 1 only), we performed a logistic regression analysis with the independent variables being intervention group (EBF versus combined SF groups), birth weight (as a continuous variable) and infant sex (because its inclusion improved the *P*-values for both group and birth weight). Intervention group remained significant ($P = 0.05$) in this model.

DISCUSSION

Continued EBF between 4 and 6 mo postpartum led to significantly greater maternal weight loss in study 1 but not in study 2. The difference between studies is probably related to the fact that the net difference between intervention groups in milk volume, and thus in energy demand, was larger in study 1 than in study 2. Is greater maternal weight loss good or bad? The difference in the amount of weight lost in study 1 (0.6 kg) is not large, but for thin women it may be of concern. There was no interaction between initial maternal BMI and feeding mode; in other words, weight loss was greater in the EBF group than the SF group even in the low BMI subgroup in study 1. On the other hand, the average BMI (in both studies) was not low, and very few women had a BMI below 19 kg/m^2 (10% in study 1 and 11% in study 2). It can be argued that the effect of continued EBF on maternal weight is protective against maternal obesity in affluent populations and those in transition but could contribute to maternal depletion in undernourished populations (Adair and Popkin 1992, Winkvist and Rasmussen 1999). From a public health perspective (considering both the mother and the infant), in the latter situation it is probably safer to supplement lactating women than to advocate a shorter duration of EBF.

The calculated impact of continued EBF from 4 to 6 mo (compared with breastfeeding plus complementary feeding) on maternal losses of nutrients other than energy is quite low. The average daily additional burden is only 3–6% of the RDA for vitamin A, 2–3% of the RDA for calcium and a minute fraction of the RDA for iron (because there is very little iron secreted in breast milk). Of course, many women do not consume the RDA for certain micronutrients, so these percentages would be somewhat higher if based on actual nutrient intake. These estimates do not imply that deficiencies of such nutrients are unlikely among lactating women, only that the risk of deficiency is not appreciably greater in exclusively breastfeeding women than in those who introduce solid foods before 6 mo. However, we did not collect data on maternal micronutrient status, so further research is needed to verify this conclusion.

Although maternal nutrient losses may be somewhat greater with exclusive rather than partial breastfeeding, there is an important tradeoff with regard to the duration of amenorrhea. The difference in amenorrhea among intervention groups in study 1 was not large, but in study 2, the median duration of amenorrhea was 1.3 mo longer in the EBF group than in the SF group. This would translate into a "savings" of 15.6 mg of Fe, assuming menstrual losses of 0.4 mg/d (INACG 1981). After subtracting the additional iron losses in milk attributable to EBF during the 4- to 6-mo interval (Table 2), this represents a savings of ~5% of estimated body stores. Increased duration of amenorrhea may also result in a longer interval before the next pregnancy, which allows the mother to be more fully repleted and more time to care for the infant before another child is born.

In both studies, infants in the EBF group were reportedly able to crawl earlier, and in study 1 they were more likely to be walking by 12 mo (60 versus 39%) than infants in the SF groups. There are several limitations to this component of the studies. First, neither the mothers nor the field workers were blind to group assignment. However, they had no reason to suspect that there would be differences between intervention groups (there were no a priori hypotheses regarding these outcomes), so this should not have biased the results. Second, no data were collected to validate the mothers' reports of their infants' motor skills. This is a standard practice, but it is difficult to compare data across studies because the definitions of the milestones vary considerably. Nevertheless, the average ages at which infants in study 1 achieved pull to stand, walk with assistance and walk alone were similar to the 50th percentiles of the Denver (Frankenburg and Dodds 1967) and Bayley (The Psychological Corporation 1969) scales, the values for crawling and sitting were similar to those reported for Indonesian (Pollitt et al. 1994) and Pakistani (Yaqoob et al. 1993) infants and the values for walking were similar to those reported for Pakistani (Yaqoob et al. 1993) and Guatemalan (Bentley et al. 1997) infants. Furthermore, the fact that there were highly significant delays in most of the milestones among the LBW (small-for-gestational age) infants compared with the infants in study 1, which is consistent with other reports (Goldenberg et al. 1998), indicates that the method used was able to capture biologically important differences.

It is noteworthy that crawling typically occurs just after the 4- to 6-mo interval. The mechanism by which EBF during this interval might affect motor development is unknown. Certain constituents of breast milk (e.g., docosohexaenoic acid) are known to be associated with infant mental development (Koletzko and Rodriguez-Palmero 1999, Uauy et al. 1995), but there is little evidence that they affect motor development. On the other hand, Vestergaard et al. (1999) reported that achievement of two motor skills (crawling and pincer grip) was linked to the duration of breastfeeding in a large sample of Danish infants, even after adjustment for potentially confounding variables. It is thus possible that greater consumption of breast milk in the EBF groups accounts for our findings, although the difference in breast milk intake between intervention groups was only 67–110 mL/d. Breastfeeding frequency was similar between intervention groups after 6 mo, but the volume of breast milk consumed may have continued to differ for several months after the intervention period. Other possible mechanisms include lower absorption of micronutrients by partially breastfed than exclusively breastfed infants (Bell et al. 1987, Oski and Landaw 1980) or differences in maternal caregiving or infant motivation to explore the environment or be upright (Biringen et al. 1995), all of which could be altered by the amount of time spent nursing. Whatever the mechanisms for these findings, the differences in motor development observed may be predictive of later functional outcomes. Although motor development in infancy is not correlated with later cognitive development in well-nourished populations, Pollitt and Gorman (1990) reported that motor test scores (although *not* mental scores) of Guatemalan infants at 15 mo were significantly associated with several indices of cognitive performance in adolescence and speculated that this may also be the case in other nutritionally at risk populations.

In summary, these results indicate that EBF from 4 to 6 mo postpartum leads to *1*) a small but significant difference in maternal weight loss, *2*) little additional maternal nutritional burden compared with the nutrient demand of breastfeeding plus complementary feeding, *3*) a longer duration of postpartum amenorrhea and *4*) earlier development of certain motor milestones by the infant. The public health implications of these findings depend on the context; for example, greater maternal weight loss may be beneficial in affluent populations but detrimental in malnourished populations. The differences in motor development may be even larger in situations where the complementary foods are of poor nutritional and microbiological quality (which was not the case in these two studies). Taken together with previously reported results (Brown et al. 1998), these results support the conclusion that in most populations, the advantages of EBF during this interval are likely to outweigh any potential disadvantages.

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