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THE RECOVERY OF FERTILITY DURING BREAST-FEEDING IN ASSIUT, EGYPT

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Summary. A longitudinal study of twenty-six breast-feeding and twelve non-breast-feeding postpartum women was conducted in Assiut, Egypt in order to determine the time that ovulation resumed after childbirth, and the effect of breast-feeding frequency on the period of lactational anovulation. Breast-feeding women experienced the onset of follicular development, vaginal bleeding, ovulation and pregnancy significantly later than women who did not breast-feed. Ovulatory and non-ovulatory breast-feeders reported similar frequencies of breast-feeding episodes. The introduction of dietary supplements commonly preceded ovulation. An algorithm using three simple variables observable to the breast-feeding mother was found to predict up to 100% of the first ovulations. All breast-feeding women who did not give supplements and did not have a vaginal bleeding episode by 6 months postpartum were anovular by strict criteria for ovulation. Ovulation did not precede bleeding or supplementation in the women who experienced these events before 6 months, yielding a highly effective formula for preventing unplanned pregnancy by the informed use of breast-feeding.

Introduction

Family planning methods are not widely used by breast-feeding women in rural areas of Egypt. While about half of urban Egyptian women use contraceptive methods, only about 8–16% of rural women do so, and about one-third of rural women plan never to use contraceptives (Farid, 1986). In addition, combined contraceptive pills are often believed to have an adverse effect on the quality and quantity of breast-milk (Shirkie, 1982).

It is important to know when women recover their fertility during breast-feeding, if only to meet the public health objectives of promoting extended breast-feeding for the welfare of the infant and for child spacing, and to avoid double-protection of women against pregnancy by providing contraceptives during the period of natural lactational infertility. If couples knew that the woman was again at risk for pregnancy, then they might be more likely to become family planning acceptors or to

use a method properly. Further, double-protection against pregnancy is costly and unnecessary.

This paper reports on a study in a peri-urban hospital in upper Egypt that serves a large rural population. The objective of the study was to detect by hormone analysis the time of the return of ovulation in a group of breast-feeding women observed longitudinally. In this article, infant feeding factors (such as the beginning of supplementation and the frequency of breast-feeding) and other overt variables are investigated as possible predictors of the onset of ovulation.

Materials and methods

Two groups of volunteers were recruited for the study at the time of delivery in the obstetric service of the Assiut University Hospital. In the first, breast-feeding group, eligible women were healthy, parous, and aged 18–40 years, having successfully breast-fed one or more children. They had had a normal delivery of a normal singleton and agreed before the 15th postpartum day to participate in the study. The breast-feeding mothers were selected if they intended to breast-feed as long as possible and planned to postpone supplementary feeds for at least 3 months. In the second, non-breast-feeding group, the women had had full-term stillbirths and were recruited as a postpartum comparative group. All volunteers were informed and gave written informed consent to participate. Due to local sensitivities, it was not possible to collect data on frequency of intercourse, but none of the women used any contraceptives.

Once per week the women, with their babies, came to the hospital for a follow-up interview and to give an 8-ml blood sample. Infant feedings of all types during the days of the previous week were recorded at home on a simple pictorial chart. The chart was collected at the follow-up visit, and questions about vaginal bleeding, use of family planning methods and the health of mother and infant were asked at each visit.

Blood samples were drawn at least 2 hours after the last breast-feed. The serum was separated and stored frozen in small aliquots until assayed for the concentration of FSH, LH, prolactin, oestradiol and progesterone. Radioimmunoassays were performed using reagents obtained from the World Health Organization Special Programme for Research in Human Reproduction. An internal quality control system was operated continuously to assure the validity of the assays.

The women remained in the study until (1) pregnancy, (2) hormonal evidence of two successive ovulatory menstrual cycles (see below), or (3) the end of the first postpartum year. Some of the lactating mothers remained in the study beyond these events, if they so desired, in order to gain more information about their menstrual cycles during breast-feeding.

Normal hormone values for the population

Normal levels of the five hormones measured in this study had been previously determined for the local population in Assiut, Egypt (Shaaban *et al.*, 1980; Shaaban, Sayed & Ghaneimah, 1987) as follows. For one complete ovulatory menstrual cycle, twenty regularly menstruating non-lactating women between the ages of 19 and 23

Table 1. Serum concentrations of FSH, LH, prolactin, oestradiol and progesterone by cycle phase in ovulatory cycles (means ± SD)

Phase of cycle*	FSH IU/L	LH IU/L	Prolectin ng/ml	Oestradiol pg/ml	Progesterone ng/ml
Follicular	4·7 ± 1·5	10·3 ± 2·5	11·6 ± 3·8	72 ± 34	0·42 ± 0·1
Peak	8·7 ± 3·9	30·4 ± 1·8	15·1 ± 7·5	207 ± 61	1·00 ± 0·5
Luteal	3·4 ± 1·8	8·5 ± 3·6	14·6 ± 6·0	103 ± 19	5·20 ± 3·0

* Defined in text.

gave daily blood samples. The day of the LH mid-cycle peak was designated as day 0 for each cycle. The oestradiol mid-cycle peak occurred on the day of the LH peak or on the day before (day −1). These 2 days constituted the peak phase of the cycles. The period from day −2 retrospectively to the first day of the cycle was considered the follicular phase, and the time from day +1 prospectively to the last day in the menstrual cycle constituted the luteal phase. The average concentrations of the five hormones during these three phases of the menstrual cycle are given in Table 1.

Definitions

The date of the first bleeding episode was the first day on which any vaginal bleeding or spotting began which was not lochia. The date of the first supplementation was the date of the weekly follow-up interview in which dietary supplements were given as the beginning of subsequently regular supplementation. Very few isolated weeks of dietary supplementation occurred.

The beginning of follicular development was the time of the first rise in serum oestradiol above 50 pg/ml sustained at least until the next week. In four mothers (two breast-feeding women and two who were not breast-feeding), no postpartum drop in oestradiol was seen, so the onset of follicular development was dated as postpartum day 1. These four mothers experienced their first ovulations earlier than the norm, by either definition of ovulation, as follows.

The 'strict criteria' of first ovulation consisted of the first rise in serum progesterone above 5·0 ng/ml preceded by a rise in oestradiol above 100 pg/ml and followed by bleeding (after at least 10 days) or accompanied by conception. There were many episodes of elevated progesterone (above 3·0 ng/ml) which were highly suggestive of ovulation but in which one or more of the other components of the strict definition were not observed. A 'minimal criterion' of ovulation was also defined. Because a level of progesterone over 3·0 ng/ml is consistent with the possibility of an oocyte present in the fallopian tube capable of being fertilized, the first rise in serum progesterone above 3·0 ng/ml was considered to be the minimal criterion for ovulation. Subsequent bleeding was omitted from the minimal criterion because the uterus may have been atrophic and amenstrual due to breast-feeding.

Median times to the outcome events were estimated by the life table method. Differences between the groups in survival distribution (curves) were tested by the Breslow statistic (Lee, 1980).

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Table 2. Characteristics of volunteers

	Breast-feeding $N = 26$	Not breast-feeding $N = 12$
Residence		
Urban	4%	17%
Urban slum	40%	42%
Rural	56%	42%
Age at delivery		
Mean	29·1	30·1
Range	23–35	25–35
Years of education		
Mean	1·4	1·6
Range	0–6	0–6
Husband's occupation		
Agricultural labourer	31%	50%
Skilled labourer	27%	42%
Office worker	15%	
Other	27%	8%
Want more children		
No	19%	17%
Yes	42%	67%
Undecided	39%	17%
No family planning used before this pregnancy	81%	92%
Sex of infant		
Male	62%	NA
Female	39%	NA
No. of live births		
Mean	3·9	3·3
Range	1–7	1–6
No. of stillbirths		
Mean	0·4	1·0
Range	0–3	0–3
No. of spontaneous abortions		
Mean	0·8	0·8
Range	0–5	0–3
Reason for termination		
Pregnant	23%	42%
2+ ovulations	58%	58%
1 year in study	12%	
Missed too many follow-ups	8%	

Results

Volunteer characteristics

Twenty-six breast-feeding and twelve non-breast-feeding women were recruited into the study. Nine additional breast-feeding women recruited into the study withdrew soon after admission because of lack of interest or fear of repeated blood sampling. Women in both groups were similar except that those who were not breast-feeding had more stillbirths (this is essentially the reason that they were not breast-feeding) and were more likely to desire another pregnancy (Table 2). The women were from rural areas or slum areas on the outskirts of the city. They averaged about 29–30 years of age, had little if any formal education and did not work outside the home. Few had used family planning prior to this pregnancy and they had an average of 3–4 live births including the current one.

Most of the women terminated the study after having demonstrated fertility (either conception or ≥ 2 ovulations), although 20% of the breast-feeding mothers were either followed for a year without evidence of ovulation or else were removed from the study because they missed too many follow-ups to be sure that they had not ovulated.

When recalling the previous breast-fed child's history, the mothers reported initiating dietary supplements at around 6 months of age (Table 3). In the current study it appeared that supplements were already being offered by 3–3½ months of age, on average. When asked to recall the baby's age at the resumption of menses, the mothers retrospectively reported bleeding, on average, between 3 and 6½ months postpartum. In the current study the first vaginal bleeding episode occurred between 4 and 5 months, on average.

Return of vaginal bleeding

Among the breast-feeding mothers, 22 of the 26 experienced their first postpartum vaginal bleeding episode while in the study. None of the remaining four ovulated (or conceived) during the study. Eleven of the twelve non-breast-feeding women experienced vaginal bleeding during the study. The one who did not, conceived at her first (unheralded) ovulation on about postpartum day 32. The median times to bleeding were 127 days (4·2 months) for the breast-feeding mothers and 45 days (1·5 months) for the others ($P < 0{\cdot}0001$).

Table 3. Time (months) until selected fertility-related events among breast-feeding group ($N = 26$)

	Previous experience		Current experience	
Event	Mean	Median	Mean	Median
Supplementation	5·8	5·8	3·4	3·3
Menses	6·5	3·0	5·4	4·2
Stopped breast-feeding	14·4	14·2	Not available	

Return of ovulation

By either the minimal or the strict criteria, all twelve non-breast-feeding volunteers ovulated, at medians of 36 days (1·2 months) and 57 days (1·9 months), respectively. Among the breast-feeding mothers, 24 of the 26 ovulated by the minimal criterion (the two who did not dropped out of the study prematurely at 151 and 172 days postpartum) while only fifteen of the 26 ovulated by the strict criteria. The median times to ovulation by the minimal and strict criteria were 165 days (5·4 months) and 239 days (7·8 months) respectively. Regardless of criteria, the breast-feeding women ovulated significantly later than the comparative group ($P < 0{\cdot}0001$).

Onset of follicular development

Follicular development, as reflected in elevated serum oestradiol levels, began as early as immediately postpartum (in both breast-feeding and non-breast-feeding women) and as late as 8·7 months and 1·9 months in a breast-feeding and non-breast-feeding woman, respectively. The median times to the onset of follicular development were 45 and 15 days, respectively, and the difference between the groups in time to follicular development was highly significant ($P = 0{\cdot}002$).

Subsequent pregnancies

Six of the twenty-six breast-feeding mothers conceived during the study at a rate of 32·8 pregnancies per 100 woman years. Four of the twelve non-breast-feeding women conceived at a rate of 105·1 pregnancies per 100 woman years. The non-breast-feeding women conceived 3·2 times as quickly, and the difference between the groups was significant ($P < 0{\cdot}01$). The earliest conception among the non-breast-feeding women occurred at about postpartum day 32, while the breast-feeding mother with the earliest pregnancy conceived at about postpartum day 91. This breast-feeding mother initiated supplements within the first 4 weeks and experienced a vaginal bleeding episode at 6 weeks postpartum, prior to the conception. No breast-feeding mother conceived during amenorrhoea.

Predictors of the first ovulation

The dates of several easily observed milestones, such as the initiation of supplements, the first vaginal bleeding episode and the baby's monthly birthday, were compared with the date of the first ovulation to see how often the milestones preceded (predicted) the potential onset of fertility. Using either the minimal (Table 4) or the strict (Table 5) criteria for ovulation, the initiation of supplements was the single best predictor of the first ovulation for the breast-feeding women, preceding fertility 81% and 96% of the time, respectively. When two or three milestones were evaluated in combination the prediction was enhanced. The combination of the three milestones heralded all ovulations up to the 6-month birthday.

Supplementation as a predictor of the first ovulation

Although among the breast-feeding mothers the median time to supplementation was about 3·3 months postpartum, six women initiated supplements very early. Four mothers had already started regular supplements by the time of the first weekly

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Table 4. Predictors of ovulation: percentage of women in which the event(s) preceded ovulation, given minimal criterion for ovulation

Event	Cases			Controls		
	%	(95% ci)*	*N*†	%	(95% ci)*	*N*
Single event						
First vaginal bleeding episode	35	(17, 53)	26	8	(0, 23)	12
Initiation of supplements	81	(66, 96)	26		NA‡	
Cessation of night breast-feeding	8	(0, 19)	24		NA	
3-month birthday	73	(56, 90)	26	0		12
4-month birthday	65	(47, 83)	26	0		12
5-month birthday	54	(35, 73)	26	0		12
6-month birthday	38	(19, 57)	24	0		12
Two events						
Initiation of supplements and first bleeding episode	81	(66, 96)	26		NA	
Initiation of supplements and 3-month birthday	92	(82, 100)	26		NA	
First bleeding episode and 3-month birthday	77	(61, 93)	26	8	(0, 23)	12
Initiation of supplements and 4-month birthday	92	(82, 100)	26		NA	
First bleeding episode and 4-month birthday	73	(56, 90)	26	8	(9, 23)	12
Initiation of supplements and 5-month birthday	92	(82, 100)	26		NA	
First bleeding episode and 5-month birthday	65	(47, 83)	26	8	(0, 23)	12
Initiation of supplements and 6-month birthday	85	(71, 99)	26		NA	
First bleeding episode and 6-month birthday	54	(35, 73)	26	8	(0, 23)	12
Three events						
Initiation of supplements, first bleeding episode and 3-month birthday	92	(82, 100)	26		NA	
Initiation of supplements, first bleeding episode and 4-month birthday	92	(82, 100)	26		NA	
Initiation of supplements, first bleeding episode and 5-month birthday	92	(82, 100)	26		NA	
Initiation of supplements, first bleeding episode and 6-month birthday	85	(71, 99)	26		NA	

* 95% confidence interval = $p \pm 1{\cdot}96$ (SE) where p = percent and SE = $\sqrt{p(1-p)/N}$.
† In some cases neither ovulation nor the event occurred, so it could not be determined whether the event was a viable predictor of ovulation.
‡ Not applicable.

Table 5. Predictors of ovulation: percentage of women in which the event(s) preceded ovulation given strict criteria for ovulation

Event	Cases			Controls		
	%	(95% ci)*	*N*†	%	(95% ci)*	*N*
Single event						
First vaginal bleeding episode	68	(49, 87)	22	58	(30, 86)	12
Initiation of supplements	96	(88, 100)	26		NA‡	
Cessation of night breast-feeding	13	(0, 30)	15		NA	
3-month birthday	89	(77, 100)	26	8		12
4-month birthday	77	(61, 93)	26	8		12
5-month birthday	62	(43, 81)	26	8		12
6-month birthday	54	(34, 74)	24	0		12
Two events						
Initiation of supplements and first bleeding episode	96	(88, 100)	26		NA	
Initiation of supplements and 3-month birthday	100	(100, 100)	26		NA	
First bleeding episode and 3-month birthday	92	(82, 100)	26	58	(30, 86)	12
Initiation of supplements and 4-month birthday	100	(100, 100)	26		NA	
First bleeding episode and 4-month birthday	88	(76, 100)	26	58	(30, 86)	12
Initiation of supplements and 5-month birthday	100	(100, 100)	26		NA	
First bleeding episode and 5-month birthday	85	(71, 99)	26	58	(30, 86)	12
Initiation of supplements and 6-month birthday	96	(88, 100)	26		NA	
First bleeding episode and 6-month birthday	77	(61, 93)	26	58	(30, 86)	12
Three events						
Initiation of supplements, first bleeding episode and 3-month birthday	100	(100, 100)	26		NA	
Initiation of supplements, first bleeding episode and 4-month birthday	100	(100, 100)	26		NA	
Initiation of supplements, first bleeding episode and 5-month birthday	100	(100, 100)	26		NA	
Initiation of supplements, first bleeding episode and 6-month birthday	100	(100, 100)	26		NA	

*, †, ‡: As Table 4.

Table 6. Mean breast-feeding frequencies (and range) at first ovulation by time of first ovulation (minimal criterion for ovulation)

Time of first ovulation	*N*	Per day	Per night	Per 24 hr
Months				
1–3	7	5·6 (0–9)	3·3 (0–6)	8·9 (0–15)
4–6	8	6·5 (1–9)	3·3 (1–5)	9·8 (2–14)
7–9	6	8·7 (6–12)	4·7 (4–5)	13·3 (10–17)
10–12	3	7·0 (5–8)	2·7 (0–4)	9·7 (5–12)
Total	24	6·8 (0–12)	3·5 (0–6)	10·4 (0–17)

follow-up visit, and the remaining two started supplements when the baby was 1 month old. In these mothers, follicular development began very early and three of the six conceived during the study. Weaning did not occur particularly early among these mothers, but ovulations did, and in each case, supplementation preceded ovulation regardless of ovulation criteria.

Breast-feeding frequency at the first ovulation

For the 24 breast-feeding women who ovulated during the study, the mean frequencies of breast-feeding per day, night and 24 hours at the time of ovulation were 7, 4 and 10, respectively (Table 6). Some women ovulated while breast-feeding 17 times per day while others did not ovulate until after breast-feeding had totally ceased. In other words, the frequency of breast-feeding was not consistently related to the onset of fertility. Breast-feeding women who ovulated were observed in the study for a significantly shorter period than non-ovulators (Table 7) suggesting that an evaluation of breast-feeding frequency at the time of first ovulation should be controlled for time. The breast-feeding frequency at first ovulation (using the minimal criterion for ovulation, for the greatest *N*), showed great variability regardless of the relative time postpartum when the first ovulation occurred. Breast-feeding frequency was significantly positively correlated with time, whether the women ovulated or not, but attrition of the mothers who ovulated no doubt influences this association. The ovulatory and non-ovulatory groups did not differ in breast-feeding frequency at the end of the study.

Maternal weight or Quetelet's Index and ovulation

The breast-feeding ovulators and non-ovulators had similar body weights and Quetelet's Index (weight for height squared) at the end of the study, suggesting that, in this sample, maternal body composition was not related to the return of ovulation. Quetelet's Index was associated in a consistently negative direction with time, although this association was not significant.

Discussion

The extent to which these findings can be generalized to other rural Egyptian women is unknown. Only a small number of mothers could be studied because of the

Table 7. Time to endpoint event*, breast-feeding frequency (BF), maternal weight and Quetelet's Index (QI)† at endpoint event and Pearson product-moment correlation coefficients of time to endpoint event with BF and QI

		Time (days) from delivery to endpoint event		BF/24 hr		Maternal weight (kg)		QI		Pearson coefficient			
										BF with days		QI with days	
	N	Mean	Range	Mean	Range	Mean	Range	Mean	Range	r	p	r	p
Ovulators	15	153	36–305	9	0–13	59	52–73	24·7	21·4–33·8	+0·526	0·022	−0·330	0·115
Non-ovulators	11	326	151–500	10	5–17	63	50–87	25·8	21·8–33·2	+0·568	0·043	−0·355	0·142
Total	26	226	36–500	9	0–17	61	50–87	25·2	21·4–33·8	+0·545	0·002	−0·022	0·458
t-test‡		t = 4·80, *P* = 0·00		t = 1·24, *P* = 0·12		t = 1·26, *P* = 0·11		t = 0·81, *P* = 0·21					

* For ovulators, estimated day of ovulation by the strict criteria; for non-ovulators, day of removal from the study.
† QI calculated as (kg/cm^2 × 100,000), where kg = maternal weight at endpoint event and cm^2 is mother's height, in cm, squared.
‡ Ovulators versus non-ovulators, 24 df, 1-tailed test of significance. When either minimal or strict criteria were used, the only test achieving significance was for time to endpoint event.

constraints of very frequent and intensive follow-up and the expense of conducting thousands of radioimmunoassays.

To our knowledge, this is the first longitudinal study to assess the serum levels of ovarian (and gonadatropin) hormones during breast-feeding. Previous studies measured the urinary metabolites of the ovarian hormones. Since urinary pregnanediol does not always reliably assess the endogenous production of progesterone, the current study represents an improvement over earlier protocols, although weekly blood drawing was more taxing for both staff and volunteers.

The frequency of breast-feeding among ovulating women in this study (as well as in non-ovulating women) increased with time until ovulation. This observation is in direct contradiction to the notion that ovulation occurs in the face of decreasing levels of breast-feeding. Throughout the study breast-feeding was maintained at night, so the absence of night feedings does not explain this contradiction. Breast-feeding frequency may not have been as valid a reflection of the 'amount' of breast-feeding—or more appropriately, nipple stimulation—as some other measures. Other ways to measure the breast-feeding stimulus (e.g. number of minutes of suckling per day or longest interval of time between episodes) may be better correlates of stimulation but are less easy for women to observe in their busy lives. Other studies have reported that breast-feeding frequency is not related to the time that lactational amenorrhoea ended (Elias *et al.*, 1986; Huffman *et al.*, 1987; Rivera *et al.*, 1988; Israngkura *et al.*, 1989), and the current study confirms this conclusion. Studies of western styles of breast-feeding have suggested that supplementation causes breast-feeding to decline, and that the decrease in breast-feeding heralds ovulation (e.g. Howie *et al.*, 1981). These different conclusions are probably all accurate because western infant feeding patterns are quite different from those in rural developing country settings. For example, supplements are generally replacements for breast-feeding in the developed countries whereas in traditional settings supplements are commonly non-breast-milk foods with far less dietary effect, that are not substitutes for breast-feeding. This point is emphasized by Gray and colleagues (1988, unpublished) who found that the best correlate of ovulation is the proportion of the baby's feeds that are not breast-feedings. Persistence in putting the baby to the breast in spite of supplementation may be a way of rendering kindness where traditional infant feeding patterns are maintained. Perhaps if comfort feedings were excluded from the frequencies, the results would have been different.

Whether minimal (possible) criteria for ovulation are preferred or more strict (definite) criteria are used, certain milestones could be employed, either alone or in combination, to predict an appreciable proportion of first postpartum ovulations in this sample of breast-feeding Egyptian women. This confirms the suggestion of other investigators (Rivera *et al.*, 1988; Israngkura *et al.*, 1989) that certain predicting events may be viable as signals to breast-feeding mothers and to health workers as to when family planning methods should be initiated if child spacing is desired.

Other studies have also evaluated variables observable to the mother as predictors of ovulation. The variables chosen in this analysis may not be as precise as those in formulae involving minutes of suckling (McNeilly, Glasier & Howie, 1985) or percentage of all feedings that are breast-feedings (Gray *et al.*, 1988, unpublished) but

the present variables are simpler for the mother. When used in combination, they can inform the mother with a great deal of certainty that she remains in the period of lactational infertility. By the strict criteria for ovulation, the women in this study could have postponed contraception for 6 months postpartum and experienced 100% protection from ovulation unless they had bled or supplemented before 6 months. Had they been advised to start a family planning method at the onset of either of these signs (bleeding or supplementation), none would have ovulated without warning. By the minimal criterion, 85% of the women would have been so protected, and it is assumed that some portion of the complementary 15% would not have become pregnant or sustained their pregnancy even if exposed. It is acknowledged that the denominators of these percentages are indeed small, and it is hoped that these findings will inspire larger studies of the efficacy of the guidelines.

By the strict criteria for ovulation, one can be very confident that ovulation actually occurred because the precursor to ovulation (elevated oestradiol) and two of the consequences of ovulation (elevated progesterone and menses or pregnancy) all occurred in the expected sequence with hormone concentrations at ostensibly adequate levels. Through the detailed view of ovarian function made possible by this longitudinal study, it has been possible to observe less convincing fertility events (by the minimal criterion for ovulation) which may or may not have led to sustained conceptions. Those events which were referred to as ovulation by the minimal criterion were essentially rises in progesterone followed closely, if at all, by bleeding. Some of these events could have been the reflections of luteinization of unruptured follicles, and as such presented no immediate pregnancy risk. Some may have been ovulations followed by luteal insufficiency. In this case it is more difficult to be certain of the pregnancy risk. Some true fertility events may not have achieved the strict criteria for ovulation, including adequate luteal length, but it is unknown whether pregnancy could have been sustained in these ovulations. Whether the short luteal phase represents subfertility is theoretically impossible to prove, since one can never know how short the luteal phase of a conception cycle would have been had conception not occurred. Nonetheless, many women with infertility problems present with short luteal phases. On balance, the minimal criterion for ovulation in this study probably underestimates the period of lactational protection against pregnancy and overestimates fertility. Since conception normally occurs in about 20–25% of unprotected cycles in normal, non-lactating, sexually active women, the probability of ovulation by the strict criteria is also an overestimate of the probability of pregnancy.

The median time until the initiation of supplements was slightly earlier in the current study than in the Mexican study (Rivera *et al.*, 1988) under a similar protocol (3·3 versus 4·7 months) but similar to the 3·4 months in the Thai study (Israngkura *et al.*, 1989). Similarly, the median time until the first vaginal bleeding episode (4·2 in Egypt versus 4·6 months in Mexico; the Thai study used a different definition of bleeding) and the median times until first ovulation (7·9 months in Egypt by the strict criteria, 8·5 months in Mexico and 8·2 months in Thailand) were earlier in Egypt, but not appreciably. Somewhat earlier supplementation appears to have only slightly affected the return of fertility. Earlier supplementation in Egypt necessarily resulted in supplementation being an antecedent to ovulation more often in this setting than in

the others. The Mexican and Thai studies employed somewhat different definitions of ovulation.

The six mothers who supplemented the feeding of their infants early also returned to fertility early, and half of them became pregnant again while breast-feeding in this study. Although their production of serum oestradiol began early, they did not appear to be excessively large or adipose. Among all 38 mothers, the largest mother was about 105 kg with 48% body weight as fat; the smallest was 49 kg and about 29·5% fat. The six early-supplementing women were of average body mass compared with the rest of the mothers but were strikingly similar to each other at 35%, 36%, 35%, 34·5%, 36·5% and 35% fat.

In this study, as well as in the two others with a similar protocol (Rivera *et al.*, 1988; Israngkura *et al.*, 1989), Quetelet's Index was negatively associated with time to ovulation, but in only one centre (Mexico), and then only in the mothers who ovulated during the study, did the correlation achieve significance. Again, the numbers in all three studies were small. All women who have just given birth are, theoretically, above a threshold of minimum required weight for height for ovulation, since they almost always weigh more than when they ovulated at conception, and are all of proven fertility. The totality of information on Quetelet's Index from these three studies is inconclusive. The consistently negative correlation between Quetelet's Index and time to ovulation supports the critical body composition hypothesis, yet the lack of significance of the association, plus the assumption that all lactating women lie above the theoretical threshold, suggests that body composition may not be predictive under most conditions, and that other factors are better predictors of the recovery of ovulation. Perhaps Quetelet's Index is predictive in large samples that include pronounced malnutrition. None of the women in the above studies was considered malnourished.

It is hoped that this study contributes to greater understanding of the natural contraceptive effect of breast-feeding. Whether one chooses the simple formula of the three indicators presented here or some other configuration of factors recognizable by women may depend upon local circumstances.

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