Lactational amenorrhea is associated with child age at the time of introduction of complementary food: a prospective cohort study in rural Senegal, West Africa[1-3]

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ABSTRACT

Background: In Africa, lactational amenorrhea is the major reason for birth spacing.

Objective: We studied whether the early introduction of complementary food to infants is associated with an increased risk of menstruation resumption in rural African women.

Design: Senegalese women ($n = 855$) were included at 2–3 mo postpartum and followed up at 4–5 and 6–7 mo in dispensaries. A subsample of 502 women were followed up at 9–10 mo and twice yearly at home thereafter. Risk factors for menstruation resumption were assessed with logistic regression, with control for maternal parity, occupation, education, postpartum body mass index, child sex and weight-for-age, and season.

Results: The risk of menstruation resumption was 4.2% (95% CI: 2.8%, 5.6%) at 6–7 mo and 6.5% (4.0%, 8.9%) at 9–10 mo. Compared with the introduction of complementary food after 6–7 mo, introduction at 2–3, 4–5, or 6–7 mo was associated with a greater odds of menstruation resumption at 6–7 mo [odds ratios (ORs): 5.08 (1.01, 25.5), 6.00 (1.29, 27.4), and 4.45 (0.96, 20.6; NS), respectively]. Introduction of food at 4–5 or 6–7 mo compared with that after 6–7 mo was associated with significantly greater odds of menstruation resumption at 6–7 mo (5.13; 1.16, 22.6) but not at 9–10 mo (3.07; 0.65, 14.4; NS) or year 2.

Conclusion: Child age at introduction of complementary food was significantly associated with the odds of menstruation resumption at 6–7 mo postpartum. *Am J Clin Nutr* 2003;78:154–61.

INTRODUCTION

Breastfeeding delays the resumption of menstruation after childbirth, and lactational amenorrhea—and the associated suppression of ovulation—is still the primary factor responsible for birth spacing in sub-Saharan Africa, where the use of modern contraception is limited by lack of access and by ideologic concerns in traditionally pronatalistic societies (1). However, preventing short birth intervals is important because pregnancy is a common reason for early cessation of breastfeeding (2–6), which is associated with an increased mortality risk in children, at least up to the age of 2 y (7).

Greater maternal age and parity are associated with prolonged amenorrhea (8–10) as are various characteristics of breastfeeding, such as a high number of feedings per 24 h, nighttime feedings (11), and a long duration of amenorrhea per 24 h (10). Together, these characteristics allow an estimation of the global stimulation of the nipple (12, 13). The relation of lactational amenorrhea with maternal nutritional status has been subject to debate, but most studies report a longer duration of breastfeeding among more malnourished women (8, 14), even in affluent societies (11).

The early introduction of high-calorie liquids or foods, other than breast milk, to infants has been shown to be associated with a shorter duration of amenorrhea in Bangladesh (14) and Scotland (12). However, in studies that analyzed separately cow milk fed by bottle and other types of food, only bottle-feeding was associated with a shorter duration of amenorrhea in the United States (15) and the Philippines (13). The authors of the latter study concluded that "supplements in the form of semisolids or liquids other than milks have no appreciable effect on the risk of return to menses." This statement was not validated by a randomized intervention study in Honduras. Indeed, women breastfeeding exclusively until 6 mo postpartum had a lower risk of menstruation resumption between 4.5 and 6 mo than did women who introduced semisolid, high-energy-density food to their infants at 4 mo (16). In a former similar trial, the difference between these 2 groups was not significant (17), perhaps because one-half of the partially breastfeeding women were instructed to maintain a high breastfeeding frequency.

The objective of this study was to test for an association between child age at the introduction of complementary food and the risk of menstruation resumption in a rural African setting where bottle-feeding is not practiced and the complementary foods given to infants are of local origin. The potential confounding effects of many variables, including season and nutritional status,

were considered. Because of the current interest in the effects of the introduction of complementary foods at 4 mo compared with those at 6 mo and the limited data available on this topic (18), this association was specifically investigated in subanalyses. This observational, prospective study was originally designed to investigate the association between infant feeding and maternal fertility and was later modified to also investigate the association between child growth and the duration of breastfeeding, the results of which were published previously (6, 19).

SUBJECTS AND METHODS

Study design

The study was nested into a randomized infant vaccine trial in rural Senegal (20) for enrollment and the first part of data collection. A cohort of 855 women and their suckling infants, born from January 1995 to July 1996, were enrolled at 2–3 mo postpartum, at the time of their first vaccination, and were followed up prospectively during subsequent visits to dispensaries to receive DTP (diphtheria, tetanus, pertussis) vaccines at 4–5 and 6–7 mo. A subsample of 502 women who had given birth between January and October 1995 were selected for a longer follow-up: they were evaluated in dispensaries at 9–10 mo postpartum and in their homes 4 times at 6-mo intervals during the second and third years postpartum (6, 19).

The analysis considered the odds of resumption of ovarian activity at various times postpartum: 6–7, 9–10, 13–23, and 18–22 mo. The onset of ovarian activity was defined as either the onset of menstruation or as a new pregnancy, whichever came first. The main dependent variable of interest was child age at introduction of complementary food, which was analyzed first as a categorical variable with 4 groups and secondarily as a binary variable (at ≈4 mo compared with ≈6 mo).

Study population

The study population was described previously (6, 19). Between 1994 and 1999, the total fertility rate was 7.0 live born children per woman (21). No prolonged postpartum sex taboos exist in this population. The proportion of women aged 15–49 y who use modern contraception is < 2% (22).

Mothers of singletons and of first-born twins were included if they had given birth between January 1995 and July 1996 and if their infants had received at least the first 3 recommended vaccinations (at 2.0–3.9, 4.0–5.9, and 6.0–7.9 mo postpartum, respectively).

A total of 1783 women had given birth during the period of inclusion and were still residing in the study area at 2 mo postpartum together with their lastborn child. Twenty-four children died between the first and the third sessions, 26 women out-migrated from the area, and 652 women did not attend all 3 vaccination sessions with their child. Because of logistic difficulties during a cholera epidemic, anthropometric or infant-feeding data were missing for an additional 221 woman-infant pairs, occupational data were missing for 1 woman, and data on quality of housing were missing for 4 women. Therefore, 855 women and their suckling infants were included in the study.

The longer follow-up included a subsample of the cohort of 855 women, ie, the 502 who had given birth from January to October 1995. Of these women, 387 had complete data at the dispensary visit at 9–10 mo postpartum and 396 were present at the first home visit in November 1996 (at 13–23 mo postpartum).

The study was approved by the Ministry of Health, Senegal, and was conducted in accordance with the Declaration of Helsinki. The women gave oral informed consent at inclusion.

Data collection

At each visit to the dispensary, a female fieldworker administered a questionnaire to the mother. The main food items consumed during the day preceding the survey and the occurrence of any genital bleeding indicating the resumption of menstruation were recorded. No problems of acceptability were encountered.

Anthropometric data were collected routinely during the trial. Women's heights were measured to the nearest millimeter, and the women were weighed while fully dressed to the nearest 0.1 kg with a Seca 769 electronic scale (Seca, Hamburg, Germany). The infants were weighed while naked to the nearest 0.01 kg with a Seca baby scale.

For the subsample of women selected for the longer follow-up, 4 sets of data were collected in their homes (in November 1996, May and November 1997, and April 1998).

Because sociodemographic data were available for all subjects residing in the study area (6, 19), the maternal year of birth, degree of formal education, professional activity, parity, religious and ethnic groups, and the child's sex and birth date were extracted from the relevant data files for all women eligible for the study to make comparisons between the women who were and were not included in the study.

Variables

Child age at introduction of complementary food was defined as a categorical variable according to 4 categories based on data from 24-h dietary recalls performed during the visits to the dispensaries: *1*) by 2–3 mo, *2*) after 2–3 mo but by 4–5 mo, *3*) after 4–5 mo but by 6–7 mo, and *4*) later than 6–7 mo.

Infant nutritional status was assessed by using weight-for-age data relative to the growth reference data of the National Center for Health Statistics and the World Health Organization (WHO), computed by Anthro1 (Centers for Disease Control and Prevention, Atlanta). The mother's nutritional status was assessed on the basis of body mass index [BMI; weight (kg)/height^2 (m)]. Both were translated into categorical variables (malnourished or not malnourished). Cutoffs were -1 z score (during the first year postpartum) or -2 z scores (beyond the first year) for child weight-for-age and a maternal BMI of 20 (measured at 2–3 mo postpartum).

Pregnancy was defined as either a pregnancy declared by the woman herself or by a birth occurring within 9 mo. The mother's education and professional activity were binary variables (any or none), whereas 4 classes of increasing maternal parity were created. Because of the strong correlation between women's age and parity ($r = 0.86$), only parity was used in the multivariate analyses. The material used for construction of the walls of the mother's hut (cement or mud bricks) was used to construct a binary indicator of economic status.

Statistical analysis

The mean age at resumption of ovarian activity was estimated for the subsample of women with a long follow-up by fitting Weibull distribution to the data with the use of maximum likelihood (23). A 95% CI was obtained by simulation (24).

Logistic regression analysis was used to predict the odds of having resumed ovarian activity at 6–7, 9–10, and 13–23 mo (in November 1996). A fourth analysis of data from women with children aged 18–22 mo in either November 1996 ($n = 200$) or May 1997 ($n = 179$) was conducted and the data were pooled into one sample. Thus, data from the 200 women seen at 18–22 mo

Variable and grouping	Short follow-up ($n = 855$)	Long follow-up ($n = 502$)
	%	
Age		
15–24 y	35.9	36.5
25–29 y	21.9	19.7
30–34 y	18.1	19.1
35–49 y	24.1	24.7
Parity		
1	17.2	17.5
2–3	20.9	20.1
4–6	32.6	32.1
7–13	29.2	30.3
Education		
None	91.9	91.0
Any	8.1	9.0
Occupation		
None	90.9	90.6
Any	9.1	9.4
Housing quality		
Mud bricks	76.3	78.5
Cement	23.7	21.5
Child age at introduction of complementary food		
By 2–3 mo	19.8	19.7
By 4–5 mo	23.9	25.1
By 6–7 mo	33.2	32.5
After 6–7 mo	23.2	22.7

postpartum in November 1996 were included with the same data in both analyses for the second year postpartum.

One set of regression analyses compared the odds of resumption of ovarian activity among the 4 age groups at the time of introduction of complementary food; the last category (after 6–7 mo) was used as the group of reference.

A second set estimated the odds ratio (OR) of menstruation resumption associated with an introduction at ≈4 mo compared with an introduction at ≈6 mo. The analytic strategy was taken from a recent systematic review of the literature about the optimal duration of exclusive breastfeeding, which included data on child age at introduction of complementary food collected in the same Senegalese population and according to the same time schedule as in the present study (18). However, the results in that study related to infant growth, not to the duration of postpartum amenorrhea (25). In this review, women who had introduced complementary food to their infants by 4–5 or by 6–7 were termed the 4-mo group and were compared with women who had introduced food to their infants later than 6–7 mo, who were termed the 6-mo group. Thus, in these analyses, the women who had introduced complementary food by 2–3 mo were excluded. All tests were two-tailed and significance was set at $P < 0.05$. BMDP (version 7.0; BMDP Statistical Software Inc, Berkeley, CA) and S-PLUS (version 3.3; Mathsoft Inc, Seattle) were used for the analyses.

RESULTS

Characteristics of the sample

The 855 included women had low levels of education, occupation outside the household, and quality of housing (Table 1).

About one-fifth (18.8%) of the women had access to pit latrines. Most women (76.0%) declared themselves to be Muslims. Parity was high: the mean ($\pm$ SD) was 4.9 ± 3.0, and the first and second tertiles were 3 and 6. Mean maternal age at childbirth was 28.8 ± 7.5 y, and mean height was 161.1 ± 5.7 cm.

Compared with the women included in the study, a significantly higher proportion of the 928 women not included in the study had an occupation (15.7% compared with 9.1%; $P < 0.01$), had some education (11.3% compared with 8.1%; $P < 0.05$), and had a parity <4 (42.5% compared with 38.1%; $P < 0.05$). No significant differences in maternal age, religion, child sex ratio, or duration of breastfeeding were found between the 2 groups.

The nutritional status of the included women, assessed on the basis of the BMIs of nonpregnant subjects only, varied significantly by season: it was low at the end of the rainy season (mean: 19.7 ± 2.0 in November 1996; $n = 356$) and higher during the dry season (21.1 ± 2.2 in May 1997; $n = 253$). The mean weight loss of nonpregnant women was 4.2 kg over 6 mo (95% CI: 3.8, 4.6 kg; $n = 231$) between March–May and November 1996, whereas the mean weight gain was 3.7 kg over 6 mo (95% CI: 3.3, 4.1 kg; $n = 221$) between November 1996 and May 1997.

Patterns of infant feeding

All infants were breastfed until at least 9–10 mo of age, although not exclusively because they all drank water daily by 2–3 mo of age. The main types of complementary foods introduced were family foods based on millet and rice and a liquid millet gruel prepared especially for some infants. Younger infants were more likely to eat infant gruel. No bottle-feeding was reported, and, when animal milk was consumed by the infants, it was fermented and semisolid.

The children were almost equally distributed among the 4 age groups at introduction of complementary food (Table 1). By 9–10 mo of age, the proportions of children who had received at least 3 meals of complementary food during the preceding day were 26.6%, 17.4%, 19.1%, and 9.7% for children introduced to such foods by 2–3 mo, 4–5 mo, 6–7 mo, and later than 6–7 mo, respectively (P for linear trend < 0.05). The proportions of children who had eaten ≥ 1 meal at 9–10 mo of age were 93.4%, 94.9%, 90.6%, and 63.5% for the same 4 groups, respectively ($P < 0.001$).

Mean child weight-for-age differed significantly by age at introduction of complementary food. At 6–7 mo of age, mean z scores were -1.44, -1.04, -0.81, and -0.68 for introductions by 2–3 mo, by 4–5 mo, by 6–7 mo, and later than 6–7 mo, respectively ($P < 0.001$).

Resumption of ovarian activity

Resumption of ovarian activity seldom occurred during the first year postpartum (4.2% at 6–7 mo and 6.5% at 9–10 mo postpartum; Table 2). A few women declared resumption of menstruation at 2–3 or 4–5 mo and no resumption at 6–7 mo, probably because of nonmenstrual, early postpartum bleeding. During the second year postpartum, the risk of resumption of ovarian activity increased (≈35% at 13–23 mo and ≈55% at 18–22 mo postpartum). A few women had ceased breastfeeding at that time: 8.1% at 13–23 mo and 14.8% at 18–22 mo. The mean postpartum duration at the time of resumption of ovarian activity was 19.7 mo (95% CI: 19.1, 20.2 mo). Some women became pregnant before the resumption of menstruation (13.5% of those with resumption of ovarian activity at 13–23 mo). The number of

TABLE 2
Type of resumption of ovarian activity, by time postpartum[1]

	4–5 mo (n = 855)	6–7 mo (n = 855)	9–10 mo (n = 387)	Subsample[2] 13–23 mo (n = 396)	18–22 mo[3] (n = 379)
Menstruation [n (%)]	23 (2.7)	36 (4.2)	24 (6.2)	122 (30.8)	179 (47.2)
Pregnancy [n (%)]					
Declared	—[4]	—[4]	—[4]	24 (6.1)	35 (9.2)
Birth within 9 mo	0	0	1 (0.3)	40 (10.1)	88 (23.2)
New birth [n (%)]	0	0	0	1 (0.3)	2 (0.5)
Any sign of ovarian activity [n (%)]	23 (2.7)	36 (4.2)	25 (6.5)	141 (35.6)	208 (54.9)
95% CI (%)	1.6, 3.8	2.8, 5.6	4.0, 8.9	30.9, 40.3	49.9, 59.9

[1] Ovarian activity defined as the resumption of menstruation, occurrence of miscarriage or a new birth, or birth within 9 mo after the survey.

[2] Consisted of 502 women selected for follow-up beyond 6–7 mo postpartum. At 13–23 mo, data were collected at home visits; at 9–10 mo, data were collected during vaccination sessions; attendance was ≈80%.

[3] Some of the women included had the same data as at 13–23 mo postpartum (n = 200).

[4] The women's perception of current pregnancy was not investigated at 4–5, 6–7, and 9–10 mo postpartum.

women who declared pregnancy was lower than the number of women who gave birth during the following 9 mo, probably because some women still ignored their state and others were reluctant to declare an early pregnancy.

In bivariate analyses, the proportion of women who had resumed ovarian activity was not significantly associated with child age at the introduction of complementary food at any time, although a later introduction of food tended to be associated with a lower proportion at 6–7 mo postpartum ($P = 0.055$; **Table 3**).

Multivariate analysis of the risk of resumption of ovarian activity

Age at introduction of complementary food

At 6–7 mo postpartum, the analysis of risk factors for the resumption of ovarian activity had low statistical power because of the very low absolute risk at that time. Introduction of complementary food by 2–3, 4–5, or 6–7 mo was associated with a 5-fold greater odds than was an introduction later than 6–7 mo, but the ORs were significantly > 1 for introductions by 2–3 and 4–5 mo only (**Table 4**). The difference among the 4 groups was significant ($P = 0.0488$).

At 9–10 mo postpartum, introduction of complementary food by 2–3, 4–5, or 6–7 mo was associated with nonsignificantly increased odds of menstruation resumption. At 13–23 and 18–22 mo postpartum, the ORs for resumption of ovarian

activity associated with introductions of complementary food by 2–3, 4–5, or 6–7 mo postpartum were only slightly and nonsignificantly > 1.

When child age at introduction of complementary food was analyzed as a binary variable (excluding women who had introduced complementary food already by 2–3 mo), introduction by 4–5 or 6–7 mo was associated with a significantly increased odds of resumption of menstruation at 6–7 mo compared with an introduction later than 6–7 mo (OR: 5.13; 95% CI: 1.16, 22.6; $P = 0.008$; **Table 5**). At 9–10 mo postpartum, the adjusted OR of menstruation resumption was 3.07, which was not significantly > 1 (95% CI: 0.65, 14.4; $P = 0.11$).

Other variables

Parity was significantly associated with the odds of resuming ovarian activity during the second year postpartum; multiparous women had lower odds than did their primiparous counterparts ($P < 0.001$; **Table 4**).

A maternal BMI ≥ 20 in the early postpartum period was associated with 2-fold greater odds of resumption of ovarian activity at 6–7, 9–10, and 13–23 mo postpartum, but the OR was significantly > 1 at 13–23 mo only ($P < 0.01$; **Table 4**). When maternal BMI was entered as a continuous variable, no association with the odds of menstruation resumption was observed at any time postpartum (data not shown).

TABLE 3
Resumption of ovarian activity at 4–5, 6–7, 9–10, 13–23, and 18–22 mo postpartum, by child age at introduction of complementary food

Age at introduction of complementary food	4–5 mo (n = 855)	6–7 mo (n = 855)	Subsample[1] 9–10 mo (n = 387)	13–23 mo (n = 396)	18–22 mo[2] (n = 379)
	n (%)	n (%)	n (%)		
By 2–3 mo	3 of 169 (1.8)	8 of 169 (4.7)	4 of 76 (5.3)	24 of 74 (32.4)	34 of 65 (52.3)
By 4–5 mo	8 of 204 (3.9)	13 of 204 (6.4)	8 of 99 (8.1)	40 of 99 (40.4)	54 of 93 (58.1)
By 6–7 mo	9 of 284 (3.2)	13 of 284 (4.6)	9 of 127 (7.1)	54 of 141 (38.3)	79 of 138 (57.2)
After 6–7 mo	3 of 198 (1.5)	2 of 198 (1.0)[3]	2 of 85 (2.4)	20 of 82 (24.4)	41 of 83 (49.4)
P[4]	>0.10	0.055	>0.10	>0.10	>0.10

[1] Consisted of 502 women selected for follow-up beyond 6–7 mo postpartum. At 13–23 mo, data were collected at home visits; at 9–10 mo, data were collected during vaccination sessions; attendance was ≈80%.

[2] Some of the women included had the same data as at 13–23 mo postpartum (n = 200).

[3] A few women reported resumption of menses at 4–5 mo postpartum and amenorrhea during the subsequent visits.

[4] P value of chi-square tests for comparisons among the 4 groups of age at introduction of complementary food.

TABLE 4
Multiple logistic regression–adjusted odds ratios (ORs) for the risk of resumption of ovarian activity at different times postpartum (PP)[1]

| | Subsample[2] | | | | | | | |
| Variable and group | 6–7 mo (n = 855) | | 9–10 mo (n = 387) | | 13–23 mo (n = 396) | | 18–22 mo (n = 379)[3] | |
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Age at introduction of complementary food, compared with >6–7 mo								
By 2–3 mo	5.08	(1.01, 25.5)	2.48	(0.42, 14.9)	1.15	(0.52, 2.53)	1.24	(0.60, 2.56)
By 4–5 mo	6.00	(1.29, 27.4)	3.61	(0.71, 18.3)	1.63	(0.78, 3.41)	1.11	(0.57, 2.19)
By 6–7 mo	4.45	(0.96, 20.6)	3.31	(0.68, 16.3)	1.59	(0.80, 3.15)	1.20	(0.65, 2.20)
P	<0.05		NS		NS		NS	
Breastfeeding, no compared with yes	—[4]		—[4]		5.99	(2.10, 17.1)	7.56	(2.99, 19.1)
P	—		—		<0.001		<0.001	
BMI at 2–3 mo PP, ≥ 20 compared with <20	2.11	(0.82, 5.48)	1.97	(0.70, 5.52)	2.18	(1.24, 3.85)	1.31	(0.78, 2.19)
P	NS		NS		<0.01		NS	
Parity, compared with 1								
2–3	1.17	(0.43, 3.16)	0.65	(0.21, 1.97)	0.36	(0.16, 0.78)	0.53	(0.24, 1.17)
4–6	0.36	(0.12, 1.09)	0.14	(0.03, 0.58)	0.21	(0.10, 0.44)	0.31	(0.15, 0.64)
7–13	0.74	(0.27, 2.00)	0.35	(0.11, 1.14)	0.43	(0.21, 0.87)	0.68	(0.33, 1.41)
P	NS		NS		<0.001		<0.001	
Education, any compared with none	3.75	(1.58, 8.94)	2.27	(0.70, 7.34)	0.86	(0.38, 1.95)	2.45	(0.99, 6.06)
P	<0.01		NS		NS		NS	
Occupation, any compared with none	2.65	(1.07, 6.54)	0.96	(0.24, 3.80)	1.18	(0.50, 2.79)	1.42	(0.62, 3.26)
P	<0.05		NS		NS		NS	
House quality, high compared with low	1.55	(0.75, 3.21)	1.08	(0.38, 3.07)	1.41	(0.80, 2.51)	1.95	(1.10, 3.47)
P	NS		NS		NS		<0.05	
Season, compared with Jan–May								
Jun–Sep	0.97	(0.43, 2.17)	1.11	(0.43, 2.86)	—[5]		—[6]	
Oct–Dec	0.60	(0.24, 1.52)	0.52	(0.13, 2.11)	—		0.44	(0.27, 0.70)
P	NS		NS		—		<0.001	

[1] Analyses also included PP duration and child sex and weight-for-age.

[2] Consisted of 502 women selected for follow-up beyond 6–7 mo PP. At 13–23 mo, the data were collected at a home visit (November 1996); at 9–10 mo, data were collected during vaccination sessions; attendance was ≈80%.

[3] At 18–22 mo PP, the data were collected at 2 home visits (200 subjects seen in November 1996 and 179 seen in May 1997).

[4] All children were breastfed.

[5] All women were seen in the same season (November).

[6] Women were seen in November or in May.

Maternal education and occupation outside the household were independently associated with significantly increased odds at 6–7 mo postpartum ($P < 0.01$ and $P < 0.05$, respectively), but not later on (Table 4). House quality, an indicator of economic status, was significantly associated with the odds of menstruation resumption by 18–22 mo postpartum only: women living in huts made from cement had 2-fold higher odds ($P < 0.05$; Table 4).

The last trimester of the year (October to December) was consistently associated with a decrease in the odds of resumption of ovarian activity. However, this decrease was significant at 18–22 mo postpartum only (OR: 0.44; 95% CI: 0.27, 0.70; $P < 0.001$; Table 4). Child sex and weight-for-age were not significantly associated with the odds of resumption of ovarian activity at any time postpartum (data not shown).

DISCUSSION

This study provided evidence that child age at introduction of complementary food is a predictor of a mother's risk of early menstruation resumption in rural West Africa. Although the study was prospective and the duration of follow-up was long (for one-half of the women), we were not able to determine precise dates for menstruation resumption because data collection was not done frequently enough beyond the first year postpartum. Therefore, multivariate analyses used logistic regression on status quo data at different postpartum durations. This approach is less powerful than are hazard models that use individual data for amenorrhea duration. The strengths of this approach are that it allowed for the examination of variables associated with menstruation resumption at different postpartum durations independently and for the assessment of the short-term effects of season.

Another limitation of the study was the use of large age ranges for the introduction of complementary food. For a child seen for one vaccination at 4.1 mo and for another vaccination at 6.9 mo, introduction of food by 6–7 mo may have occurred at any time between 4.1 and 6.9 mo. Furthermore, about one-third of the children not introduced to complementary food yet at 6–7 mo had not eaten any food during the preceding day at 9–10 mo either; therefore, these children may not yet have been introduced to such foods at that time. However, such large age intervals are difficult to avoid in observational studies unless large proportions of women are excluded from the analysis.

Finally, because the time of introduction of complementary foods was defined on the basis of data from 24-h dietary recalls, some of the children may actually have consumed such foods occasionally at younger ages (26). However, modest differences in the timing of introduction of complementary food were found in an earlier study that compared definitions with the use of 24-h

TABLE 5
Multiple logistic regression–adjusted odds ratios (ORs) for the risk of resumption of ovarian activity at different times postpartum (PP), by age at introduction of complementary food in 2 groups (by 4–5 or 6–7 mo compared with later than 6–7 mo of age)[1]

Variable and group	6–7 mo (n = 686)[2]		9–10 mo (n = 311)[3]	
	OR	95% CI	OR	95% CI
Age at introduction of complementary food, compared with >6–7 mo				
By 4–5 or 6–7 mo	5.13	(1.16, 22.6)	3.07	(0.65, 14.4)
P	<0.01		NS	
Breastfeeding, no compared with yes	—[4]		—[4]	
BMI at 2–3 mo PP, ≥20 compared with <20	1.74	(0.64, 4.75)	1.80	(0.57, 5.74)
Parity, compared with 1				
2–3	0.81	(0.27, 2.45)	0.53	(0.15, 1.93)
4–6	0.33	(0.10, 1.07)	0.20	(0.05, 0.85)
7–13	0.62	(0.20, 1.94)	0.28	(0.07, 1.11)
Education, any compared with none	2.38	(0.82, 6.93)	0.39	(0.05, 3.31)
Occupation, any compared with none	3.65	(1.42, 9.34)	1.64	(0.41, 6.62)
P	<0.05	NS		
House quality, high compared with low	1.53	(0.66, 3.54)	0.79	(0.21, 2.99)
Season, compared with Jan–May				
Jun–Sep	0.90	(0.35, 2.29)	1.22	(0.42, 3.59)
Oct–Dec	0.61	(0.22, 1.71)	0.43	(0.08, 2.36)

[1] Analyses also included PP duration and child sex and weight-for-age.

[2] Women who had introduced complementary food to their infants by 2–3 mo PP (n = 169) were excluded from the analysis.

[3] Of the 387 women surveyed at 9–10 mo, those who had introduced complementary food to their infants by 2–3 mo PP (n = 76) were excluded from the analysis.

[4] All children were breastfed.

or 7-d dietary recalls in this community (KB Simondon, unpublished observations, 1998). In addition, any misclassification in age at introduction of complementary foods would tend to decrease differences in the risk of resumption of ovarian activity among groups (27) and could thus not be responsible for the observed differences.

The mean duration of lactational amenorrhea was 19.7 mo, considering women whose children were still alive at the time of menstruation resumption. This mean value may be slightly higher than in the community as a whole, because the women not included in the study had greater education levels and smaller parities than did those included in the study, 2 characteristics that were risk factors for early resumption of ovarian activity. Previous estimates of the mean duration of amenorrhea in the Sine area of Senegal were 17.3 and 18.2 mo, respectively (28, 29). These values are considerably greater than those observed in rural Bangladeshi women (median: 15.5 mo; 14), who had a low mean BMI ($\approx$18.5; 30) and long breastfeeding durations (median: 32 mo; 14).

The women who had introduced complementary food to their children by 2–3, 4–5, or 6–7 mo tended to resume menstruation more often by 6–7 mo than did those who had not yet introduced such foods at that time. However, only the former 2 groups had significantly increased odds of menstruation resumption.

In the subanalyses that compared women who had introduced complementary food by 4–5 mo or by 6–7 mo with those who introduced it later than 6–7 mo postpartum, significant differences were found between the 2 groups (OR: 5.13; 95% CI: 1.16, 22.6; $P = 0.008$). These analyses were conducted with the specific aim of providing additional evidence for the still ongoing controversy about the optimal duration of exclusive breastfeeding: $\approx$4 mo or $\approx$6 mo (although this study considered the duration of full rather than exclusive breastfeeding, because all infants drank water

in addition to breast milk). These analyses used the same groupings as those chosen for the analysis of growth data from this rural Senegalese population in a recent systematic review of the literature (18, 31).

In rural Bangladesh, the adjusted mean duration of postpartum amenorrhea was significantly greater for women who introduced complementary food later than 6 mo than in those who introduced such foods before 1 mo ($P < 0.01$; 14). Provided that this relation is causal, it is a remarkably long-lasting effect. This finding may be explained by the use of bottle-feeding for very early introduction of complementary food; the authors suspected that some of the children were bottle-fed (14). Unfortunately, the analysis was not designed to compare the effects of introduction of complementary food at 4 compared with that at 6 mo.

In Senegal, complementary feeding did not include any bottle-feeding but consisted of local millet gruel and family diets based on millet and rice with small amounts of fish and vegetables. Thus, the consumption of such foods also seems to have the effect of decreasing the lactation-induced inhibition of ovarian activity, but probably to a lesser extent than bottle feeding.

Although most infants consumed complementary food by 6–7 mo, the absolute risk of resumption of ovarian activity was very low compared with that observed under different conditions: 4% at 6–7 mo postpartum compared with 19–35% for exclusive breastfeeding (16, 32, 33) and 21–62% for any breastfeeding in various studies (33–35). The most likely explanation for the low risk observed in rural Africa is that the frequency of breastfeeding and the children's intake of breast milk remain high throughout infancy, regardless of the age at introduction of complementary food.

This small absolute risk also implies that delaying the introduction of complementary food until 6 mo postpartum, per recent WHO recommendations (36), would probably not increase the

mean duration of postpartum amenorrhea. Indeed, age at introduction of complementary food was not significantly associated with the risk of menstruation resumption beyond the first year postpartum, when menstruation resumption becomes more common. Therefore, mean birth intervals are not likely to be affected by an increase in the duration of full or exclusive breastfeeding in this community.

It may, however, have a positive effect by decreasing the risk of short birth intervals. Unlike in some other West African societies, the suppressive effect of breastfeeding on ovulation is crucial for the prevention of short birth intervals in this community because the duration of postpartum sexual abstinence is short (2–3 mo; 37), and modern contraceptives are rarely used (22). Nevertheless, resumption of menstruation is not a synonym of full recovery of fecundity, and there is evidence that frequent breastfeeding may depress the occurrence of and quality of ovulation even after the resumption of menstruation (38, 39). In a WHO-coordinated multicenter study of >4000 women, the risk of pregnancy by 6 or 12 mo postpartum was not significantly different between women who partially or fully breastfed their children (40).

Child weight-for-age was significantly associated with age at the introduction of complementary food: children eating such foods by 2–3 mo had lower weight-for-age values at 2–3, 4–5, and 6–7 mo postpartum. Such an association was described previously in this population, but it is unclear whether it is explained by lower birth weights or by slower-than-average growth from birth to 2–3 mo of age among children with a very early introduction of complementary food (25). Weight-for-age was adjusted for in the analyses, but it was not significantly associated with ovarian activity.

Season was a significant predictor of the risk of resumption of ovarian activity and was shown previously to be associated with the duration of breastfeeding (41) and the nutritional status of breastfed children (19) and of breastfeeding women (mean seasonal weight loss: > 4 kg in the current study). Only child age at the introduction of complementary food showed no evidence of seasonal variation, contrary to what was described in an East African setting (42). Thus, season likely did not confound the relation between the resumption of ovarian activity and child age at the introduction of complementary food; nevertheless, it was adjusted for in the analyses.

In conclusion, the risk of menstruation resumption was low at the end of the rainy season, a time during which the women have heavy workloads and a negative energy balance. The introduction of local complementary food in the infants' diets at ≈6 mo of age is associated with a significantly lower odds of menstruation resumption at 6–7 mo postpartum than is the introduction of food at ≈4 mo of age; however, the association of the timing of introduction of complementary food with the risk of short birth intervals needs to be assessed. ☒

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