EFFECT OF MATERNAL NUTRITION ON FERTILITY IN RURAL BANGLADESH

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INTRODUCTION

The Cholera Research Laboratory (CRL) has maintained demographic surveillance of a rural population of approximately 260,000 persons in Matlab Thana and adjacent areas in Comilla District, Bangladesh, since 1966. During this period of time, the year 1974 was marked by severe economic hardship in Bangladesh. In Matlab Thana, rice prices increased early in 1974 and remained high until late 1975. Many people in the area could not afford to buy a minimally adequate amount of food, and famine conditions prevailed (1).

The CRL found in this population between 1973 and 1974 that the crude death rate climbed from 14 to 21 per 1000; in 1975, the rate fell somewhat to 18 per 1000. The infant mortality rate followed a similar pattern; 125 per 1000 in 1973, 175 per 1000 in 1974, and 152 per 1000 in 1975. During this period, the decline in fertility was even more dramatic. For these three successive years the crude birth rate fell from 47.8 to 40.1 to 27.6, a drop of nearly 45% from 1973 to 1975. These fluctuations in fertility and mortality reduced the rate of natural increase to 0.9% in 1975 compared with 3% per year between 1966 and 1970.

A reported contraceptive use rate in October 1975 of only 2.4% for married women aged 15-44 suggests that modern contraceptives could not play a major role in the fertility decline. The famine conditions can be related to the drastic decline in fertility, although the variables involved have only been partially explored

(1,2). It is known that the food shortage beginning in 1974 caused a threefold increase in net out-migration from the area. The shortage was also probably linked to the decline in marriages and increase in divorces and separations observed in 1974, and these undoubtedly affected the fertility rates in 1975. Biologically, the food shortage probably decreased the nutritional status of women, a decrease which may have reduced fecundity, lengthened the period of temporary infertility and increased fetal deaths.

This paper will present a preliminary analysis of maternal nutrition and its relationship to two components of fertility: 1) length of postpartum amenorrhea (amenorrhea segment), and 2) length of time to conception after resumption of menses (menstruating segment). Information was collected in the Matlab area over a 12 month period beginning in November, 1975.

THE STUDY AREA

Matlab Thana is an administrative unit in Comilla District, Bangladesh. Like much of the nation, Matlab is situated on a flat deltaic plain intersected by numerous rivers and canals. The region has no roads. Internal communication is accomplished by foot or country boat. The climate is subtropical with three seasons. Most of the average annual rainfall of 85 inches falls during the monsoon which extends from June till September. During this season, it rains almost daily, and most of the low-lying fields are flooded. The monsoon is followed by the cool-dry season which lasts until February. The hot-dry season begins in March and ends with the beginning of the monsoon. Agriculture is the dominant economic activity, with rice as the major staple and jute the main cash crop. Fishing is the second most common occupation. The remainder of the labor force is involved in service-related or labor-intensive activities. There are three harvests annually; the _aman_ crop, a flood crop, which yields over half of the annual rice production, is harvested in November. Smaller rice crops are harvested at the end of the _boro_ season (February) and the _aus_ season (June).

The people are nearly all indigenous Bengalis; over 85 percent are Muslim and most of the remainder are Hindu. The population density exceeds 2,000 persons per square mile, making Matlab one of the most densely settled rural regions in the world. Villages have an average population of 1,000 persons. Each village is divided into many _baris_, each consisting of two or more patrilineally-related families. A family averages approximately six persons and usually has its own one-or two-room house with a mud floor, jute stick walls, and a thatched grass or galvanized iron roof. The houses of a _bari_ are arranged around a central courtyard

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METHODS

The study began in November 1975 and will continue through October, 1978. Twelve villages within a five-mile radius of the CRL Matlab Treatment Center were selected for study. These villages contained approximately 2,200 married women aged 15-49 years. An initial interview and existing CRL records provided basic information about the women including age, parity, number of living children, education, religion, husband's occupation and date of last pregnancy termination. Follow-up information is collected by trained female workers who visit each woman once a month to inquire about pregnancy, pregnancy termination, menstrual status, breast-feeding practices, family planning practice, child mortality, and morbidity, and the absence of either the woman or her husband. The height of each woman was measured once and weight and arm circumference are measured each month. Every two months, fingertip blood samples are collected for hematocrit determinations.

DEFINITIONS

The length of postpartum amenorrhea is defined as the number of full calendar months from the date of a pregnancy termination to the date of onset of the first menses. The waiting time for conception (menstruating segment) is defined as the number of full calendar months from the first postpartum menses to the month of conception.

For the purpose of analysis, amenorrhea and menstruating segments were divided into closed-interval and open-interval segments based on cut-off or termination during this period. A closed amenorrhea segment is one which started with pregnancy termination and ended with the onset of menses during the period of the study. An open amenorrhea segment also started with pregnancy termination but continued to the cut-off date without the onset of menses. A closed menstruating segment is one which started with the onset of menses and ended at conception occurring during the study period. An open menstruating segment continued until cut-off date without conception. Any of these segments may have started either before or during the study period. If a woman had more than one amenorrhea or menstruating segment during the year, only the most recent of each kind was included.

This paper covers only the first 12 months of observation and includes only closed intervals, that is, only those amenorrhea and menstruating segments which terminated in the study period. The nutritional status of the woman is based on the measurements taken in the month the interval is closed, i.e., in the month of first menstruation for the amenorrhea segment, and in the month of conception for the menstruating segment. It is recognized that this analysis will be biased because of a selection for short intervals; however, this bias should not substantially affect comparisons of interval lengths by age, nutritional status, or other variables.

RESULTS

Two thousand two hundred eighteen women were studied. Table 1 compares the age distribution of the study population with the total Matlab population. Forty-one of these women were menopausal and 204 had no previous pregnancy termination; 1,395 women had menstruating segments terminating or cut off during the study period. One hundred forty seven of these had been menstruating for at least 60 months without pregnancy occurring and were assumed to be sterile. Of the remainder, 483 had closed menstruating segments and 766 had open menstruating segments; 643 women had closed amenorrhea segments and 562 had open amenorrhea segments.

Table 2(a) shows the length of postpartum amenorrhea and waiting time for conception by age of the women studied. Age is positively related to length of both the amenorrhea and menstruating segments. The mean length of amenorrhea for women of less than 25 years of age was 13.7 months compared to 19.3 months for the age group 25-34, and 20.6 months for the age group 35 and over. The differences in mean waiting time for conception by age are not great - 12.2 months in age group below 25 versus 14.0 in age group 35 and over.

Table 2(b) shows the length of amenorrhea and menstruating segment by parity. The pattern closely parallels that by age and is probably due to the age/parity correlation (see below).

Table 2(c) provides the segment lengths by education of the women. Education shows a negative relationship with length of postpartum amenorrhea. No evidence exists of any association between education and waiting time for conception. Again, because of education and age relationships, any interpretation of this table may be difficult.

Table 2(d) shows the waiting time for conception by period of absence of the husbands. As expected, the absence of husbands is directly related to the duration of the menstruating segments.

Table 2(e) shows the length of postpartum amenorrhea and waiting time for conception as related to the death of children. The

Table 1

Comparison of Study Population with Matlab Population in 1974 by Age Group

Age Group	Study Women	Married Women in Matlab
10-14	1.7	1.8
15-19	16.4	17.0
20-24	17.6	17.8
25-29	15.2	15.4
30-34	18.7	18.0
35-39	14.0	12.9
40-44	11.0	10.8
45-49	5.4	6.3
	100.0	100.0

average length of postpartum amenorrhea is shorter by at least six months for mothers experiencing child death during the segment. This, of course, reflects the earlier interruption of breastfeeding. The waiting time for conception was found higher among mothers who had a child death since her last pregnancy; however, this cannot be interpreted because of small numbers and no adjustment for age in this tabulation.

The length of amenorrhea and length of menstruating interval by height of the women is presented in Table 3(a). Height showed no effect on the menstruating segment or on amenorrhea segment.

Table 3(b) presents the length of amenorrhea and length of menstruating intervals by weight of the mother. Weight showed only a slight negative relationship both to waiting time for conception and to the length of postpartum amenorrhea. The arm circumference, another index of nutritional status, also failed to show any consistent relationship with the fertility variables (Table 3(c). Hematocrit level showed some positive correlation with fecundity, but none with postpartum amenorrhea (Table 3(d).

Because of interrelationships between variables in the previous tables, a correlation matrix is presented in Table 4 which shows the extent of interrelationship between nutritional, demographic, and socioeconomic factors affecting fertility. In the table, age-parity correlation was found to be 0.84, age-education correlation was -0.16. Age-weight correlation was found -.12, height-weight correlation was 0.42, and weight-arm circumference was 0.73.

Table 2

Mean Duration of Postpartum Amenorrhea and of Menstruating Interval by Mother's Age, Parity and Education, Husband's Absence, and Infant Death
Matlab 1975-1976

		Postpartum Amenorrhea		Menstruating Interval	
		No.	Mean Months	No.	Mean Months
(a)	All	643	17.9	482	10.9
	Age				
	< 25	189	13.7	173	12.2
	25-34	304	19.3	226	8.8
	35 +	150	20.6	83	14.0
(b)	Parity				
	1-3	266	16.5	249	12.2
	4-6	197	20.6	151	8.5
	7 +	155	19.0	77	11.8
(c)	Education (Yrs.)				
	None	467	18.6	385	11.1
	1-4	62	17.1	44	8.9
	5 +	74	14.1	53	11.4
(d)	Husband's Absence (Mo.)				
	< 1	-	-	347	8.6
	1-4	-	-	71	11.8
	5 +	-	-	20	15.3
(e)	Infant Death				
	No	600	18.2	430	10.6
	Yes	49	12.9	46	13.6

Multiple regression analyses were done, considering separately as the dependent variable: 1) the closed interval of postpartum amenorrhea, and 2) the closed interval of waiting time to conception to assess the effects of each of the independent variables.

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Table 3

Mean Duration of Postpartum Amenorrhea and the Menstruating Interval by Maternal Height, Weight, Arm Circumference, and Hematocrit
Matlab 1975-1976

	Postpartum Amenorrhea		Menstruating Interval	
	No.	Mean Months	No.	Mean Months
(a) <u>Height (cm)</u>				
< 145	169	18.2	110	10.9
145-149	255	17.5	206	11.4
150 +	210	18.5	160	10.5
(b) <u>Weight (Kg)</u>				
< 38.5	137	17.9	120	11.3
38.5-42.4	191	17.5	138	10.7
42.5 +	174	16.8	161	10.0
(c) <u>Arm Circumference (cm)</u>				
< 21	153	18.7	115	10.7
21-22	302	17.8	219	9.9
23 +	160	17.6	130	12.1
(d) <u>Hematocrit (%)</u>				
< 34	161	17.3	134	9.3
35-39	222	19.9	185	11.9
40 +	44	18.6	28	12.7

Table 5 presents the regression analysis where the independent variables are age, parity, weight, arm circumference, height and hematocrit, and the dependent variable is the length of postpartum amenorrhea. Here, after controlling other factors, only age, parity, and the hematocrit are significantly related to the duration of postpartum amenorrhea. The relationships are in the expected directions: increasing age is associated with longer amenorrhea; higher parity is associated with shorter amenorrhea, possibly because short birth intervals are required to reach higher parity; similarly, a higher hematocrit is logically associated with longer amenorrhea since the hematocrit was measured at the <u>end</u> of the period of amenorrhea and higher levels must be related to the

Table 4

Correlation Matrix

Variables	Variable Number							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Age (1)	1.00							
Parity (2)	0.84	1.00						
Education (3)	-0.16	-0.14	1.00					
Height (4)	-0.04	-0.08	0.05	1.00				
Arm Cir. (5)	-0.01	-0.01	-0.02	0.16	1.00			
Weight (6)	-0.12	-0.15	-0.02	0.42	0.73	1.00		
Hematocrit (7)	-0.11	-0.08	0.05	0.08	-0.07	-0.08	1.00	
Husband Absence (8)	0.06	0.08	0.02	-0.01	-0.01	0.00	0.00	1.00

Sample size 568

sparing of blood loss. The nutrition variables, height, weight, and arm circumference, were not significantly associated with the length of amenorrhea.

Table 6 presents the second regression analysis, putting the menstruating segment as the dependent variable, and age, parity, weight, height, arm circumference, length of husband's absence, and hematocrit level as the independent variables. Not surprisingly, age and husband's absence were positively associated with the menstruating interval, and higher parity was associated with shorter intervals. Again, there were no significant relationships with the nutrition variables.

CONCLUSIONS

A preliminary analysis of the birth interval components, based on prospective observations in rural Bangladesh leads to the following conclusions:

1. Age of women is positively related to both the length of postpartum amenorrhea and waiting time for conception.
2. After eliminating the age effect, parity is negatively related to the length of both the amenorrhea and the menstruating intervals.

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Table 5

Relationship of Length of Postpartum Amenorrhea to Age, Parity and Nutrition Variables

Simple and Partial Correlation Coefficients

Independent Variable	Simple Correlation	Partial R	Partial F
Age	0.283	0.234	36.93*
Hematocrit	0.113	0.119	9.18*
Parity	0.190	-0.097	5.98*
Arm Circumference	-0.043	-0.029	0.53
Height	-0.003	0.016	0.16
Weight	-0.049	0.005	0.02

Multiple $R^2 = 0.104$
$F = 12.28^*$
$N = 641$ women

$^* \ p < 0.05$

Table 6

Relationship of Menstruating Interval to Age, Parity, Husband's Absence, and Nutrition Variables

Simple and Partial Correlation Coefficients

Independent Variable	Simple Correlation	Partial R	Partial F
Age	0.076	0.205	21.67*
Parity	-0.057	-0.183	17.04*
Husband's Absence	0.117	0.120	7.17*
Weight	0.070	0.074	2.75
Hematocrit	0.068	0.074	2.73
Height	0.002	-0.034	0.58
Arm Circumference	0.021	-0.028	0.38

Multiple $R^2 = 0.067$
$F = 5.03^*$
$N = 512$ women

$^* \ p < 0.05$

3. The nutritional indicators - height, weight, and arm circumference - were not significantly associated with either the length of postpartum amenorrhea or the waiting time to conception.

4. Longer amenorrhea is associated with a higher hematocrit, probably due to sparing of blood loss.

5. Husband's absences are associated with conception delays.

It should be noted that though this longitudinal study was carried out over the year of a famine and falling fertility, the data presented here does not begin to explain the fertility decline. This is in part because this analysis deals only with closed intervals, that is, intervals which terminate in the observation period. While this may not be a serious problem with reference to postpartum amenorrhea, it may be presenting a bias in measuring fecundability. Specifically, women who cannot conceive, that is, who have long conception times did not appear in the study group.

There is some evidence that this may be a factor. Preliminary analysis indicates that among women in the lowest weight group (less than 38.5 kg) 17.6% had not conceived in five years, as compared to only 6.7% and 8.4% in the higher weight groups. Further analysis, adjusting for age for example, is required before any definitive conclusions can be reached in this area.

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