DEMOGRAPHY© Volume 18, Number 3 August 1981

THE DETERMINANTS OF BREAST-FEEDING IN SRI LANKA

John Akin
Richard Bilsborrow
David Guilkey
Barry M. Popkin
Carolina Population Center, The University of North Carolina, Chapel Hill, NC 27514

Daniel Benoit
Pierre Cantrelle
Michele Garenne
Pierre Levi
ORSTOM, 24, Rue Bayard, 75008 Paris, France

Abstract—Breast-feeding is the focus of rapidly growing interest. Research on the determinants of breast-feeding is only beginning. The research in this paper is based on World Fertility Survey data for Sri Lanka. We develop what we believe to be an appropriate probit model and find that there are significant socioeconomic factors that influence breast-feeding, in addition to the demographic factors focused upon in the literature. Moreover, some of them have clear policy implications, which are elaborated herein with respect to labor force, education, family planning and internal migration policies. In the course of the paper we also address a number of generally neglected statistical issues that should be considered in analyzing the determinants of breast-feeding, including problems resulting from digit preference or age heaping, the need to use dichotomous dependent variables, unavoidable truncation biases in the basic data, and structural shifts in the determinants of breast-feeding at different durations.

INTRODUCTION

There has been considerable research on the potential benefits of breast-feeding, particularly those related to the health of the infant. These effects include prolongation of the period of post-partum amenorrhea (Osteria, 1978; Van Ginneken, 1978), provision of immunological protection to the infant (Chandra, 1978), provision of an appropriate and inexpensive source of nutrients for the infant (Jelliffe and Jelliffe, 1978), and stimulation of a strong emotional relationship between mother and child (Sosa et al., 1976). Moreover, while the exact pathways by which breast-feeding affects fecundity have not been clarified (Tindal, 1974; Tyson et al., 1975), it is also known that breast-feeding suppresses the ovulatory cycle of the mother and is a major source of protection against pregnancy in most low-income nations (Knodel, 1977; Rosa, 1975, 1976; Jain and Bongaarts, 1980). This occurs not only because of direct hormonal and other biological effects, but also because in some cultures breast-feeding is associated with taboos which discourage sexual intercourse (Singarimbun and Manning, 1974). Despite these major benefits associated with breast-feeding, little research has been conducted in low-income countries on existing patterns of breast-feeding or on the factors which influence these patterns, let alone on some of the methodological issues which must be considered in such research.

The purpose of this paper is to evaluate the determinants of breast-feeding for Sri Lanka, a country for which a particularly

good set of data is available through the World Fertility Survey (WFS). Our analysis is based on a data set that merges information from the WFS Standard Recode Tapes and raw data tapes. Sri Lanka was one of the few countries that included an economic module in the questionnaire, which, as will be seen below, was important since it allowed us to specify a much richer model.

An important corollary to our substantive findings is the development of what we feel to be an effective method of dealing with three methodological problems that typically occur whenever researchers must rely upon survey data collected at one point in time to analyze the determinants of the duration of a time-dependent variable.

The first problem—common in all studies on breast-feeding—is the fact that respondents prefer certain digits which results in a strong concentration of responses on the reported duration of breast-feeding at six-month intervals. This digit preference problem exists to a greater or lesser degree whenever dates are obtained retrospectively (Bachi, 1951, 1954; Carrier, 1959; Eubank, 1980; Myers, 1940; Shryock and Siegel, 1976, pp. 114–29; U.N., 1976).[1] A variety of techniques have been developed to "smooth" data heaped on particular ages or digits. However, these techniques are of little use for our purposes because we are interested primarily in analyzing the *determinants* of breast-feeding, where breast-feeding is the dependent variable in a functional relationship.

The second problem is that the duration of breast-feeding is truncated (a) in the closed birth interval by the birth of another child, or (b) in the open birth interval by the date of the interview. What this means statistically is that the dependent variable "completed duration of breast-feeding," is not actually observed for a large part of the sample.

The final issue is the general belief (but not yet empirically observed) that certain influences on breast-feeding become more important the longer the duration, while others become less important. If true, this implies that at some point in time a structural shift in the model takes place. As is shown below, the empirical results here support the structural shift hypothesis. Nevertheless, our results on this should be considered very preliminary: We expect to examine them in more depth when better data allow us to use more sophisticated statistical procedures.

This paper is organized as follows: first, we describe the model, then the statistical issues that must be resolved before the model can be estimated, and finally the actual empirical results. In the concluding section we discuss some of the major policy implications.

MODEL SPECIFICATION AND SAMPLE SELECTION

Variable Selection

To analyze the factors affecting the extent and duration of breast-feeding in Sri Lanka, we develop a model of the determinants of breast-feeding behavior (essentially a model of the household demand for breast-feeding). The dependent variables chosen are whether the mothers ever breast-fed, and, if so, whether they breast-fed the child at various specified durations. Other measures of breast-feeding behavior, the frequency of feedings, whether the infant was fed separately or with others, the extent of breast milk relative to other foods (other milk, formula, solid foods, etc.), etc.—cannot be addressed with the WFS Sri Lanka data since the necessary questions were not included in questionnaires. Moreover, for reasons discussed below, the use of the number of months that a child was reported to have been breast-fed, as a measure of breast-feeding duration, is also inappropriate.

The durations used in the analysis are 3, 6, 9, 12, and 15 months. We feel that a variety of cut-offs are useful because of the different policy implications associated with them. For example, 3- and 6-month durations are often considered to

represent the range of minimum desirable durations of full breast-feeding (Jelliffe and Jelliffe, 1978; WHO, 1979). The 12-month duration represents a more traditional, longer breast-feeding duration. The 9- and 15-month durations are used as a result of statistical considerations discussed in the next section.

An earlier study reviewed in detail the various individual, household and community factors expected to affect breast-feeding behavior (Popkin et al., 1979). Based on that review, we selected a set of maternal, child, and household characteristics for detailed analysis. Table 1 lists and defines these variables, as well as providing brief justifications for each. Whenever possible, the variables are designed to relate to the specific birth intervals of the mother during the last four years before the survey. For example, pill usage refers to whether the mother used oral contraceptives at all during the interval. Unfortunately, it is not possible to determine the age of the child when use of the pill commenced. It would be preferable to know pill usage just before the time used in the measure of the dependent variable; e.g., before the infant became 9 months of age. The variables for mother's age and the numbers of other living children in various age-sex groups have been created to refer to the time of birth of the infant studied.[2]

An important improvement in model specification (beyond that possible with the Standard Recode Tape) is facilitated with the raw data tape for Sri Lanka; in the latter the woman's economic activity is available for *specific* birth intervals, including the last closed and open intervals of interest here. In the standardized tape we only know if she has worked before and after marriage, and whether it was at home or away. Unfortunately, even with the raw data we cannot link work location with a specific episode of work except for the last work experience, and are thus forced to assume the location of the last job applies to both the last closed and open birth intervals.

The family composition variables measure the number of children alive in each age-sex group. This information is not quite the same as parity, the measure most often used by demographers in such analyses. However, age-sex composition variables more directly relate to child care than does parity, and hence are likely to be much more closely related to breast-feeding.[3] An overall household size variable could be added to account for a possible independent effect of size on maternal nutrition and overall household per capita resources; but because this would be highly correlated with the other demographic variables, it is omitted.

The marital status variable is used to capture the effects of spouse availability. Households whose heads are female represent an important group in many countries; we expect mothers who live alone to be less able to breast-feed. The WFS data do not allow a precise determination of whether or not the husband or other adult is living with the mother. The measure used here is an attempt at approximating this by assuming that only women who are separated, divorced, or widowed do not have another source of support. In Sri Lanka only 1.25 percent of the women fell in this category. Consequently, there was inadequate variation and it could not be included in the multivariate analyses here, though this will not be true in many other countries.

Unfortunately it was also not possible to develop detailed occupational variables from Sri Lanka tapes: Only broadly defined occupational groups were available which only very weakly correspond to income and socioeconomic status. (These groups are professional, clerical, sales, service, farm, agricultural work, household worker, and [vaguely defined] skilled and unskilled worker categories.)

Although there was no variable adequately representing income directly, the raw data tape did contain information on various home assets, vehicles, and house/land ownership. "Producer assets" can raise productivity and alter the time allo-

Table 1.—WFS Variables Selected for the Analysis of Breast-Feeding Determinants

Variable[a]	Definition
Education	In years. Represents her modernity, her value of time, and household socioeconomic status.
Age	In years. Older women have a smaller volume of milk.
Work Now	(1 = mother works in market; 0 = does not work) Mother works in a wage, farming, or other market-oriented occupation; in combination with work away, allows interpretation of impact of maternal working status on breast-feeding.
Work Away	(1 = mother works away from home; 0 = does not work away) Work away is more likely to be incompatible with breast-feeding.
Pill Use	(1 = use of contraceptive pill in interval; 0 = not used) Pill use has been associated with decreased breast-milk production.[b]
Hindu	(1 = Hindu; 0 = Other) Breast-feeding patterns of Hindus may differ from those of Muslims in Sri Lanka.
Buddhist	(1 = Buddhist; 0 = Other) Breast-feeding patterns of Buddhists may differ from those of Muslims in Sri Lanka.
Christian	(1 = Christian; 0 = Other) Breast-feeding patterns of Christians may differ from those of Muslims in Sri Lanka.
Marital Status	(1 = married and living together; 0 = separated, widowed, or divorced) Indicates availability of spouse to provide economic and social support for each child.
Urban	(1 = urban; 0 = rural and estate) Measures influences of urban living (media, available breast-milk substitutes, less social support, more modern health professionals, less compatible work).[c]
Male Child	(1 = male; 0 = female) Measures any sex bias against female children.
Husband's Education	In years. A proxy for household socioeconomic status, husband's value of time.
Number of Other Children Aged 0-3	Number of siblings aged 0 to 41 months. Additional preschoolers can increase the value of the mother's time at home and increase her likelihood of breast-feeding. On the other hand, they also require attention (are time-intensive) and may compete with the infant for the mother's time.
Number of Other Children Aged 4-6	Number of siblings aged 42 to 77 months. They are less time-intensive than younger children but are less likely to act as mother-

Table 1.—(continued)

	substitutes than older children. In many cultures, they are left alone while older family members work.
Number of Sisters/ Brothers Aged 7 to 12	Number of sisters/brothers aged 78 to 149 months. Potential mother substitutes for infant feeding in many cultures.
Number of Sisters/ Brothers Aged $\geq$ 13	Number of sisters/brothers older than 149 months. Potential mother substitutes for infant feeding, infant care, or market production.
Refrigerator	Lowers the cost of feeding breast-milk substitutes (by permitting their storage), and generally reduces shopping time and releases women for work away from home. It also reflects standard of living of the household (1 = refrigerator ownership; 0 = none).
Toilet	Reflects standard of living in general and health conditions in particular (1 = flush or sealed toilet; 0 = other).
Landlord	Reflects socioeconomic status of household (1 = landlord; 0 = other).
Farms Own Land	Reflects general standard of living and socio-economic status (1 = farms own land; 0 = other).

a--All variables refer to the mother except as indicated.

b--See Rosa (1976), Osteria (1978) and other references cited in Popkin et al. (1979, p. 19).

c--Since we desired to use a single dummy variable here, we combined estate with rural, though we recognize there are important differences.

cation of the woman in the household: They directly influence the cost of various goods (e.g., breast-milk substitutes) and household health (i.e., a refrigerator, toilet). Perhaps most important, in the absence of direct information on household income, they reflect the (long-term) income level of the household. If breast-feeding is a "normal" good, families with higher incomes will spend more time breast-feeding, other things being equal.[4] If it is viewed as an inferior (traditional, "un-modern") good, higher income families will tend to breast-feed less. Since it is not clear a priori whether breast-feeding is generally regarded as a normal or inferior good (in Sri Lanka or elsewhere), the signs on the asset variables can only be determined empirically. Moreover, as will be seen, alternative interpretations exist for some of the other variables as well, requiring empirical evidence to settle which interpretations are dominant.

Preliminary empirical tests led us to the decision to include the four asset variables described in Table 1: Refrigerator, Toilet, Landlord, and Farms Own Land. A few further explanatory comments are necessary on the latter two variables. Most of the population in low-income countries continues to live and work in rural areas. Land tenure and land ownership are the major determinants of both socioeconomic status and the standard of living for the rural population. The variable Farms Own Land distinguishes those

farmers who own their land from the rural landless,[5] while Landlord refers to the subset of farmers who not only own land but also rent it to others. Households in the Farms Own Land category constituted 31 percent, and those in the Landlord category constituted 2 percent of all households in Sri Lanka (see footnote a in Table 4). The two variables together permit a threefold economic status differentiation within the rural population. We would expect the coefficient for Landlord to be larger in absolute value and more statistically significant than that for Farms Own Land.

Sample Selection

We wish to estimate the determinants of the extent and duration of breast-feeding for children born in a selected time period. Our sample is based on all children born in the four-year period preceding the date of interview. Often breast-feeding analyses are based on only either the open birth interval or the last closed birth interval. This procedure is incorrect and leads to biased results, since it is not based on a random sample of all children. The correct procedure is to use all birth (or breast-feeding) intervals over a specific time period as the unit of observation. But to look only at their last child (last open birth interval) biases the sample toward omitting short birth intervals. Similarly, analyzing the determinants of breast-feeding only for the next-to-last child (last closed birth interval) tends to omit long birth intervals.[6]

Consequently, it is necessary to use data for both open- and closed-birth intervals together to provide an unbiased sample of births. Note that it is not possible to examine earlier births in the four-year period prior to the next-to-last child because breast-feeding information was obtained in WFS only for the last two children. In the case of Sri Lanka, this omission fortunately causes us to lose only an estimated 3.6 percent of the births in the last four years. (This omission will be more serious in other countries where fertility is higher.) Moreover, information on the behavior of the *mothers* of these omitted children is already available from their last two births.[7]

The reason we constrained ourselves to a four-year interval is that it is desirable to examine a sample whose breast-feeding decision occurred as recently as possible, to ensure that the (current status) variables hypothesized as influencing breast-feeding refer to a time period as close as possible to the decision. Most socioeconomic variables are measured only at the time of the survey (that is, there is an absence of retrospective information for important independent variables). Moreover the further back respondents are asked to recall, the less accurate the information (cf. Som, 1968). Four years is selected as a compromise in the belief that it is a sufficient time period to obtain an adequate number of births. Nor is it so long as to result in low quality data or too many births in the interval not having breast-feeding data because of the absence of such data for births prior to the last two.

A major problem for the children in the closed interval for the Sri Lanka WFS data is that the breast-feeding duration variable was arbitrarily recoded as "not breast-feeding" in the month when the mother became pregnant. This imputation, on both the standardized and raw data tapes, is, alas, often incorrect: In Sri Lanka, earlier data showed that 27 percent of the currently pregnant women were still breast-feeding at the time of interview; in Senegal the proportion was even higher at 30 percent (Cantrelle and Leridon, 1971). Moreover, in Senegal 10 percent continued to be breast-fed through the fourth month of pregnancy and 1.5 percent up to the last month of pregnancy.[8] Thus while a new pregnancy is often an important determinant of the time of weaning—and therefore of the duration of breast-feeding—the two are often not mutually exclusive.[9]

STATISTICAL ISSUES

There are several statistical problems that should be resolved in an analysis of the determinants of breast-feeding. The

analysis of the binary choice decision variable, to breast-feed or not to breast-feed, can be handled within a standard discrete dependent variable framework. The method that we have chosen is the probit technique, a procedure that has been widely applied in diverse disciplines (for a textbook explanation see Pindyck and Rubinfeld, 1976, chapter 8). The analysis of the factors that influence the *duration* of breast-feeding is more difficult. Under ideal conditions, ordinary least squares would be the optional choice for method of estimation. Unfortunately, two problems that frequently occur with duration data do not allow its use. First, the duration of breast-feeding may be truncated either by the birth of another child, or the date of the interview. Second, as can be seen from Table 2, there is a strong tendency for respondents to round toward half-year digits. As in the truncation problem, this digit preference problem means that, for some percentage of our sample, we cannot observe our true dependent variable, the duration of breast-feeding.

One solution to both of these problems involves categorizing the continuous variable, duration of breast-feeding, into a discrete variable. As a result, in our analysis we will be concerned with whether or not a child was breast-fed to some chosen cut-off value. The cut-offs used are the half-year points that are frequently considered important for health and policy reasons, and also 9 and 15 months because they are not digit preference points.

Once a cut-off is chosen, the dependent variable in our analysis will be assigned a value of zero if the child was breast-fed fewer months than the cut-off and a value of one if the child was breast-fed longer than the cut-off. Then, the method of estimation is the probit technique.

The final statistical issue discussed here is how to model the possibility of a structural shift in the model as the duration of breast-feeding lengthens. If we could use the continuous data, this complication could be handled within the framework of a switching regression model (see, for example, Goldfeld and Quandt, 1976) where the actual point in time that the switch takes place would be estimated. Unfortunately, the existence of the problems discussed above precludes the use of the continuous data and hence the use of continuous data methods. Thus, what we actually do is pick a switch point based on what we consider reasonable time intervals. While our method is somewhat arbitrary, there is no alternative. We believe that our approach is useful, especially in light of the empirical results obtained below.

EMPIRICAL RESULTS

General Model

Our empirical results are presented in Tables 3 through 7. Table 3 presents the results of estimating the model by the probit method, assuming no structural shift. It is clear from the χ^2 statistic presented at the bottom of the table that the explanatory variables, as a group, are significantly related to the probability of breast-feeding at various times.

The individual effects of the independent variables vary somewhat depending upon the cut-off chosen in the definition of the dependent variable. Some patterns, nevertheless, are quite clear. First, religion does not appear to have much effect *except* in the decision to breast-feed at all or not. For this decision, women in all 3 religions are more likely to breast-feed than others.

With regard to variables that specifically relate to the mother, mother's age has a clear negative impact on breast-feeding as does pill usage, both as expected and observed by others. Mother's education also has a negative association except for the ever/never decision. The effect of the work variables is somewhat more complex and quite interesting. It appears that the major impact on breast-feeding is not work per se, but the *location* of the work: note the very strong negative impact on breast-feeding associated with the decision to work away from home during the birth interval. Indeed, working during the interval—which, of course, includes working at home because of the

Table 2.—Frequency of Breast-Feeding for Combined Open- and Last-Closed-Birth Interval Children in Sri Lanka Born in the Four Years Preceding the 1975 World Fertility Survey

Number of Months Completed	Combined Sample	
	Absolute Frequency	Relative Frequency
0	230	5.339
1	181	4.201
2	168	3.900
3	245	5.687
4	146	3.389
5	151	3.505
6	238	5.525
7	149	3.459
8	174	4.039
9	120	2.786
10	140	3.250
11	59	1.370
12	491	11.397
13	76	1.764
14	94	2.182
15	76	1.764
16	82	1.903
17	63	1.462
18	306	7.103
19	56	1.300
20	96	2.228
21	39	0.905
22	44	1.021
23	35	0.812
24	347	8.055
25	31	0.720
26	23	0.534
27	37	0.859
28	35	0.812
29	22	0.511
30	71	1.648
31	25	0.580
32	32	0.743
33	19	0.441
34	10	0.232
35	11	0.255
36	75	1.741

way the dummy variables are defined—actually has a significantly positive impact for some durations of breast-feeding.

With regard to the income and asset variables, there appears to be a negative effect associated with higher levels of husband's education. While husband's education is not, strictly speaking, the same as income, it is highly correlated and probably represents it, as well as picking up the modernization or taste effect typically associated with attaining higher education levels. The four asset variables have a very clear negative impact on the decision to breast-feed, except for the Farms Own Land variable that is never significant.[10] The presence of a refrigerator has the largest negative impact on

Table 3.—Determinants of the Probability that Children in Sri Lanka were Breast-Fed at Specified Ages[a]

	Ever/Never Breast-Fed (1)	3 Months (2)	6 Months (3)	9 Months (4)	12 Months (5)	15 Months (6)
1. Constant	1.6936	2.3141	1.8811	2.0230	1.8193	1.9383
	(7.359)	(9.800)	(8.102)	(9.993)	(9.146)	(9.184)
2. Mother's Education	0.0967	-0.0033	-0.0636	-0.1230	-0.1798	-0.1193
	(2.214)	(-0.082)	(-1.822)	(-3.548)	(-5.312)	(-3.359)
3. Mother's Age	-0.0179	-0.0118	-0.0051	-0.0165	-0.0132	-0.0273
	(-2.274)	(-1.435)	(-0.711)	(-2.342)	(-1.931)	(-3.879)
4. Work during Breast-Feeding Interval	0.1053	0.1639	0.3085	0.2887	0.1781	0.1400
	(0.951)	(1.402)	(3.035)	(2.961)	(2.028)	(1.613)
5. Work Away	-0.2420	-0.4733	-0.6350	-0.5072	-0.3516	-0.2589
	(-1.956)	(-3.759)	(-5.770)	(-4.717)	(-3.508)	(-2.565)
6. Pill Use	---	-0.4885	-0.2049	-0.2933	-0.2637	-0.2893
		(-3.583)	(-1.517)	(-2.259)	(-2.052)	(-0.2082)
7. Hindu	0.1708	0.1389	0.1830	0.1683	0.0007	-0.0222
	(1.498)	(1.041)	(1.585)	(1.488)	(0.006)	(-0.195)
8. Buddhist	0.2708	-0.0503	-0.0172	0.0100	0.0704	0.0412
	(2.513)	(-0.423)	(-0.165)	(0.097)	(0.698)	(0.387)
9. Christian	0.2957	0.2098	0.0618	-0.0355	-0.1685	-0.1051
	(1.866)	(1.256)	(0.449)	(-0.265)	(-1.273)	(-0.743)
10. Urban	-0.1760	-0.2010	-0.2643	-0.2279	-0.2555	-0.1897
	(-1.938)	(-2.240)	(-3.403)	(-3.018)	(-3.444)	(-2.442)
11. Male Child	0.0103	-0.0795	-0.0220	-0.0391	0.0040	-0.0294
	(0.150)	(-1.121)	(-0.360)	(-0.656)	(0.070)	(-0.494)
12. Husband's Education	-0.0139	-0.0704	-0.0861	-0.0712	-0.0639	-0.1005
	(-0.339)	(-1.862)	(-2.645)	(-2.202)	(-1.982)	(-2.994)
13. No. of Children 0-3	0.0555	-0.0310	-0.0188	-0.0664	-0.1175	-0.1542
	(1.037)	(-0.571)	(-0.399)	(-1.451)	(-2.625)	(-3.294)
14. No. of Children 4-6	0.0670	0.0770	0.0783	0.0802	0.0019	-0.0106
	(1.259)	(1.357)	(1.617)	(1.715)	(0.042)	(-0.235)
15. No. of Sisters 7-12	0.0774	0.0653	0.0972	0.1094	0.1044	0.1560
	(1.352)	(1.043)	(1.762)	(2.098)	(2.181)	(3.239)
16. No. of Brothers 7-12	0.1253	0.0095	0.0805	0.1009	0.1078	0.1378
	(2.116)	(0.167)	(1.555)	(2.010)	(2.288)	(2.944)
17. No. of Sisters 13+	-0.0411	0.1487	0.0859	0.2060	0.1312	0.1422
	(-0.610)	(1.638)	(1.120)	(2.640)	(2.051)	(2.327)
18. No. of Brothers 13+	0.0542	0.0278	-0.0197	0.0781	0.0970	0.1329
	(0.794)	(0.363)	(-0.298)	(1.150)	(1.578)	(2.252)
19. Refrigerator	-0.1715	-0.5719	-0.4869	-0.8465	-0.6838	-1.1165
	(-0.720)	(-3.216)	(-2.830)	(-4.264)	(-3.119)	(-3.768)
20. Toilet	0.2425	-0.2334	-0.3561	-0.3555	-0.2714	-0.2480
	(2.279)	(2.563)	(-4.581)	(-4.669)	(-3.522)	(-3.059)
21. Landlord	-0.1431	-0.4798	-0.4265	-0.4664	-0.1603	-0.1715
	(-0.698)	(-2.433)	(-2.322)	(-2.562)	(-0.861)	(-0.860)
22. Farms Own Land	0.0420	0.0818	0.0225	0.0840	-0.0498	0.0831
	(0.480)	(0.905)	(0.290)	(1.124)	(-0.695)	(1.119)
Number of Cases	4308	3724	3303	2901	2526	2139
χ^2 Statistic[b]	42.07	144.60	268.03	368.78	319.49	290.29

a--These are probit coefficients estimated using an iterative maximum likelihood estimation technique; the "t-statistic" follows an asymptotically normal distribution (t values are in parentheses).

b--The chi-squared is used for a joint test of significance for all the coefficients except the constant term. The critical value for a 1% level of significance is 37.57.

breast-feeding of the asset variables. But since only 2 percent of the sample had refrigerators, the overall impact of refrigerator ownership is limited. There are at least three possible interpretations of the negative coefficient for refrigerator ownership, but since the other explanatory variables capture the work and income effects, we believe the large negative "refrigerator effect" largely reflects the lowering of the cost of substitutes for breast-milk (by permitting safe milk storage and therefore less frequent purchases in the market).

These results for the asset and income related variables strongly suggest that, in Sri Lanka, breast-feeding is generally considered an inferior good—as families become richer, one of the things purchased with added resources is substitutes for breast milk. Why this is the case is not clear, and certainly warrants further research, given its implications for future trends in breast-feeding in developing countries as income rises.

The family composition variables have very mixed and interesting results. We will discuss the effects of these variables in greater detail later. For now, it is sufficient to point out that the effect of young children is generally negative while the effect of older children is generally positive.

An important specification question relates to the role of urban residence. There are two issues to be considered. First, what is the marginal impact of living in urban (versus rural) areas on breast-feeding; and second, what are the differences, if any, in the impact of the various determinants of breast-feeding in urban and rural areas. To distinguish the two issues, we initially specified a model that had, along with the dichotomous urban-rural variable, interaction terms between urban-rural and all other variables. The coefficients of the interaction terms indicate whether the structures of the urban and rural models differ. A likelihood ratio test was then used to test the joint significance of the coefficients of the 16 interaction terms. Because the interaction terms were not statistically significant at the 5 percent level in any of our estimated equations, we conclude that urban and rural differences can be accounted for adequately by the single intercept shift dummy variable, Urban. Thus the underlying structures of the urban and rural models are essentially the same; i.e., the various explanatory variables have similar effects in both urban and rural areas. Therefore a single regression equation is sufficient, and stratification by urban-rural residence is not needed for Sri Lanka.[11]

Effects of Simulated Changes in Selected Variables on Breast-Feeding

In order to better interpret our results we calculated the probability that a woman with a certain set of characteristics would breast-feed up to at least a specified duration. Tables 4 and 5 present the predicted probabilities of ever breast-feeding and of breast-feeding at 3, 6, 9, 12, and 15 months. These are, in sequence: .954, .941, .868, .859, .612, and .694.[12] In these tables the effects on breast-feeding of changes in some of the key determinants are indicated. The impact of changes in the mother's work status on whether or not she ever breast-feeds is statistically significant but small. However, the impact is very significant on the duration decisions, rising as the child ages until 12 months and then falling again. Having a job at home increases the probability of ever breast-feeding by less than 1 percent, but this rises to 1.6 percent at 3 months and reaches a maximum of 6.6 percent at 12 months. Very similar results are found for the effect of working away from home, except that the effect is negative, as expected. It is intriguing that women who work at home are more likely to breast-feed than women who do not work (other than housework). It may be that they constitute a selected group of women who have chosen work at home (usually lower paying and with more irregular hours) precisely in order to care for their infants (Popkin et al., 1979). (It is *not* likely that women's working at home is associated with higher family income

Table 4.—Effects of Simulated Changes in Selected Explanatory Variables on the Probability of Ever Breast-Feeding Children, Sri Lanka

A. Predicted Values[a]	Total Sample
Average Household	0.954
B. Marginal Changes in the Probability of Breast Feeding[b]	Marginal Probability
1. Work status changes (from not working):	
Works at home	+.009**
Works away from home	-.014**
2. Education level increases by one level[c] for:	
Woman	+0.009**
Husband	-0.001
3. Residence changes from rural to urban	-0.018***

*** t-value significant at .01 level
** t-value significant at .05 level

a--The average household is calculated at the mean for each independent variable and the urban and rural poor and rich households, at values specified below. They are:

	Average Household	
	Mean	Standard Deviation
Mother's Education	2.41	(.04)
Husband's Education	2.72	(.04)
Works now	0.29	(.11)
Works away	0.18	(.12)
Mother's Age	29.41	(.01)
Male	0.51	(.07)
Urban	0.24	(.09)
Hindu	0.24	(.11)
Buddhist	0.56	(.11)
Christian	0.08	(.16)
Number of Children by Age/Sex:		
0-3	0.67	(.05)
4-6	0.63	(.05)
7-12 male	0.42	(.06)
7-12 female	0.41	(.06)
13+ male	0.22	(.07)
13+ female	0.21	(.07)
Refrigerator	0.02	(.24)
Good toilet	0.21	(.14)
Farms own land	0.31	(.09)
Landlord	0.02	(.21)

b--Changes in the predicted probability of ever breast-feeding based on changes in the value of one variable for the basic probit regressions used for this table.

c--Changes in formal education groups as defined by WFS. Groups are no schooling, 1-5 years, 6-9 years, 10-11 years, university and other advanced studies.

Table 5.—Effects of Simulated Changes in Selected Explanatory Variables on the Probability of Breast-Feeding Children at 3, 6, 9, 12 and 15 Months in Sri Lanka

	3 Months	6 Months	9 Months	12 Months	15 Months
A. Predicted Probabilities[a]					
Average Household	.941	.868	.859	.612	.694[c]
B. Simulated Marginal Change[b]					
1. Work status changes from not working to:					
Working at home	+.016***	+.054***	+.055***	+.066***	+.049**
Working away from home	-.044***	-.081***	-.054***	-.068***	-.041**
2. Education increases by one level					
Woman	-.000	-.014*	-.029***	-.070***	-.043***
Husband	-.009*	-.019**	-.016**	-.025**	-.036***
3. Mother changes from no pill use to pill use	-.080***	-.049	-.072**	-.104**	-.103**
4. Residence changes from rural to urban	-.026**	-.061***	-.042***	-.099***	-.052**

* t-value significant at .10 level
** t-value significant at .05 level
*** t-value significant at .01 level

a--Using the values presented in Table 4, footnote 1. In addition, the pill was used by women in 4.1 percent of the birth intervals.

b--Changes in the probabilities of breast-feeding in row (1).

c--See footnote 12 in the text.

and hence a (positive) income effect on breast-feeding: The results and discussion earlier suggest the income effect is negative.)

The effect of higher education is also complex, varying with the sex of the parent and the duration of breast-feeding. Women with more education are *more* likely to *ever* breast-feed (but only 1 percent more likely), but *less* likely to breast-feed as the child ages. For example, those with one level more of education (see footnote 3, Table 3) were found to be on the average 7 percent less likely to breast-feed a 12-month-old child. This may indicate that better educated women are more aware of the need to provide weaning foods at this age, or it may relate to their perceived value of time (higher opportunity cost).[13] Husband's education has little effect on whether the wife ever breast-feeds, but a small depressing effect on the duration which increases with the age of the child. This supports our belief that it largely reflects more modern tastes, when asset variables are included in the multivariate analysis to capture income influences.

Persons who live in urban areas are significantly less likely to ever breast-feed, or to breast-feed at any age of the child. The negative effect increases with age of the child but somewhat inconsistently. Thus, the probabilities of *ever* breast-feeding are

only 3 percent less for urban residents, but the differences at various ages from 3 to 15 months are 4 to 10 percent less. These differences are not as large as generally assumed or observed in other studies. We believe this may reflect the omission of important socioeconomic variables in the other studies of breast-feeding.

Finally, given its potential importance for policy, we examine the impact of the use of birth control pills in the interval on breast-feeding the child in the same interval. We find that pill use seems to have a powerful negative effect on the probability of breast-feeding, especially at the older ages of 12 and 15 months. However, some caution must be exercised in interpreting this result because the month of initiation of pill use is not known from WFS data. Therefore, it is not known whether it began before or after weaning, or how long and continuously pills were taken in the interval.

Structural Shifts in the Determinants of Breast-feeding at Different Durations

The final set of results deals with the identification of those factors influencing breast-feeding decisions which are different at different ages of the child—that is, whether there are structural shifts in the factors influencing women's decisions to continue breast-feeding because of changes in the composition of the sample, i.e., eligible to continue breast-feeding or not. For example, the factors influencing decisions to (continue to) breast-feed for women who have breast-fed for a year may be quite different from those that influence women who breast-feed for less than a year.

As a first attempt to obtain empirical evidence about structural shifts, we divided the data into a short duration sample (1 to 9 months, with a 4.5 month cut-off) and a long duration sample (10 to 21 months with a 15 month cut-off). (Note that women who do not breast-feed at all are excluded a priori.) The two separate samples of women were then used to estimate two different equations examining factors influencing the duration of breast-feeding. One equation examines the factors influencing whether (relatively) short-duration breast-feeders continue to a moderate duration or not. The other equation examines whether long-duration breast-feeders continue to a very long duration or not.

The results are reported in Tables 6 and 7. While a casual reading of Table 6 might suggest there are only a few differences in the variables influencing breast-feeding decisions of the two separate samples of women, the results in Table 7 provide the basis for a more conclusive comparison of the results.[14] A number of the variables are indeed observed to have quite different results. The work status and women's education variables seem to have (the expected) effects only among women with relatively short durations of breast-feeding, while the household composition variables (presence of children by age and sex) significantly influence decisions of longer-duration women to continue or not. With respect to household composition, the presence of other very young children (aged 0–3) seems to interfere with very long breast-feeding but does not have differential effects among the short-duration breast-feeders—as would be expected in a society with strong breast-feeding norms such as Sri Lanka. Somewhat older children (aged 7–12), particularly females, who can substitute for the mother and help care for other young children (0–6) have positive effects on long duration. Males 13 and older, who perhaps substitute for the mother in working to support the household, also positively affect breast-feeding duration.

We conclude that these results do in fact provide support for the structural shift hypothesis: the factors that influence breast-feeding (continuation) differ at different durations of breast-feeding.

SUMMARY AND POLICY IMPLICATIONS

Given the now well-known important consequences of breast-feeding on postpartum amenorrhea and birth intervals,

Table 6.—Effect of Duration on the Determinants of Breast-Feeding[a]

		1 to 9 Month Duration with a 4.5 Month Cut-off	10 to 21 Month Duration with a 15 Month Cut-off
1.	Constant	1.3604*** (4.932)	1.9008*** (6.072)
2.	Mother's Education	0.0767 (1.682)	-0.0310 (-0.551)
3.	Mother's Age	-0.0290*** (-3.013)	-0.0441*** (-4.132)
4.	Work during Breast-Feeding Interval	0.3607** (2.390)	-0.0477 (-0.377)
5.	Work Away	-0.6392*** (-3.895)	0.1172 (0.743)
6.	Pill Use	-0.4459** (-2.385)	-0.4769** (-2.002)
7.	Hindu	0.2546 (1.585)	-0.1012 (-0.612)
8.	Buddhist	0.1550 (1.098)	0.0223 (0.142)
9.	Christian	0.3136* (1.679)	0.1080 (0.518)
10.	Urban	-0.1215 (-1.134)	-0.1543 (-1.280)
11.	Male Child	-0.0780 (-0.931)	-0.0083 (-0.092)
12.	Husband's Education	-0.0422 (-0.952)	-0.0399 (-0.796)
13.	No. of Children 0-3	-0.0447 (-0.709)	-0.2158*** (-2.958)
14.	No. of Children 4-6	0.0921 (1.346)	-0.0403 (-0.599)
15.	No. of Females 7-12	0.1338 (1.712)	0.2022*** (2.873)
16.	No. of Males 7-12	0.0693 (1.009)	0.1409 (1.929)
17.	No. of Females 13+	0.1646 (1.416)	0.0804 (0.910)
18.	No. of Males 13+	-0.0356 (-0.362)	0.1896** (2.326)
19.	Refrigerator	-0.4961** (-2.538)	---[b]
20.	Toilet	-0.2934*** (-2.765)	-0.0836 (-0.654)
21.	Landlord	0.0380 (0.150)	0.0825 (0.243)

Table 6.—(Continued)

22. Own Land	-0.0582 (-0.541)	0.0813 (0.744)
Number of Cases	1112	885
χ^2 Statistic[c]	97.31	70.65

* t-value significant at .10 level
** t-value significant at .05 level
*** t-value significant at .01 level

a--These are probit coefficients estimated using an iterative maximum likelihood estimation technique; the t-statistic follows an asymptotically normal distribution (t values are in parentheses).

b--Insufficient variation (cases) to include this variable here.

c--The chi-squared is used for a joint test of significance on all coefficients except the constant term. The critical value for a 1% level of significance is 37.57.

on the one hand, and infant mortality, on the other, the subject of the determinants of breast-feeding is receiving increasing interest. The potential policy implications of research on these determinants are legion. Most existing data in developing countries on breast-feeding patterns (whether women breast-feed and the duration) are derived from retrospective household surveys of women of childbearing age. Much of this has been collected recently through the program of the World Fertility Survey. The present paper attempts to investigate the factors influencing breast-feeding in one of the WFS countries. While our interest was to explore the effects of a wide variety of socioeconomic factors, relating to the household as well as the mother, limitations imposed by WFS data restricted our analysis in ways described above.

The fact that potentially important variables were not available must be borne in mind in recognizing the substantive limitations of the analysis reported herein, and thereby in deriving policy inferences.[15] Nevertheless, since previous studies of breast-feeding have been even more limited in this respect, and, moreover, have also been limited by the use of inappropriate statistical estimation procedures, it is important to examine the results of our analyses here for possible, tentative policy recommendations. In the situation of Sri Lanka where over 95 percent of the children are breast-fed, the policy implications will refer mainly to factors influencing the *duration* of breast-feeding. In other countries, and in urban areas where breast-feeding is not so nearly universal, policy implications from studies using the methodology developed here can refer to both the decision to breast-feed and its duration. Finally, by way of introduction to a discussion of policy implications, we note that the policy inferences here are likely to have relevance for other countries only to the extent that relevant cultural and socioeconomic conditions are similar to

Table 7.—Effects of Duration on the Determinants of Breast-Feeding: Simulated Changes in Explanatory Variables

Variable	1-9 month duration sample with 4.5 month cutoff	10-21 month duration sample with 15 month cutoff
A. Predicted Probabilities for the Average Household[a]	0.733***	0.625***
B. Simulated Marginal Change[b]		
1. Work Status changes from no work to:		
Works at home	+.111**	-.021
Works away from home	-.088**	+.024
2. Education Level increases 1 S.D.[c]		
Mother	+.030*	-.012
Husband	-.020	-.016
3. Mother changes from No Pill to Pill	-.060**	-.208**
4. Residence changes from Rural to Urban	-.041	-.060
5. Child changes from Female to Male	-.026	-.003
6. Mother's Age increases 1 S.D.[c]	-.060***	-.208***
7. Religion changes from Muslim to:		
Hindu	+.027	-.037
Buddhist	-.005	+.010
Christian	+.055	+.042
8. No. of Children increases 1 S.D.[c]		
Age 0-3	-.007	-.053***
Age 4-6	+.020	-.012
Age 7-12 females	+.028	+.056***
Age 7-12 males	+.016	+.037*
Age 13 plus females	+.024	+.018
Age 13 plus males	-.006	+.048**
9. Addition of asset/position		
Add a refrigerator	-.182**	Not available
Add a toilet	-.099***	-.032
Own a farm	-.019	+.030
Become a landlord	+.013	+.031

* t-value significant at .10 level
** t-value significant at .05 level
*** t-value significant at .01 level

a--Using the mean values for these variables for specified population group and the coefficients from Table 9.

b--Changes in the marginal probability of breast-feeding. For continuous variables, this represents an increase of 1 standard deviation and for dichotomous variables, a change in the value as specified in this table.

c--S.D. = standard deviation.

those of Sri Lanka. This will generally be more true of countries in South and Southeast Asia than those in Africa or Latin America.

While the substantive results in Tables 3, 4, and 5 have policy implications some of the most insightful policy suggestions follow from consideration of structural shifts in the short-duration and long-duration analyses (Tables 6 and 7). Factors which influence the extension of breast-feeding from a short to a moderate duration are particularly important since most nutrition and health policy is concerned with extending breast-feeding for short-duration breast-feeders. This is because infants fed foods other than breast-milk before 4–6 months of age are considered to be at much greater risk of death. Significant nutritional, emotional, and other benefits are thought to also accrue from at least partial breast-feeding beyond that age, particularly through the first year. Therefore, the results of the short-duration analysis in Tables 6 and 7—of the factors influencing extending breast-feeding from 1–4 to 5–9 months—have the strongest health policy implications. Nevertheless, there are known to be important immunological and family planning benefits of prolonged breast-feeding, as well as economic benefits (since purchased milk is much more expensive) that are not negligible for most families in low-income countries, so the results of the long-duration determinants in Tables 6 and 7 are also of interest.

Our discussion here focuses on four possible policy issues.

1. *Labor force policies.* Women's work, per se, does not appear to reduce breast-feeding. Rather it is work away from home which seems to often interfere with breast-feeding, especially for extending breast-feeding for the short-duration woman. It is this group, the mothers who may only breast-feed for 1–4 months, for whom the "weanling diarrhea" and the associated infant supplementation, growth, and mortality problems are greatest. At present, work away from home reduces the probability of their extending breast-feeding from 1–4 to at least 5 months by almost 9 percent. This is one of the largest effects observed. For policy purposes it is important to determine who the women are that work away from home, why they work away, what are the working conditions, what are the implications for breast-feeding, child care, and time allocation within the household, and what in turn are the effects on the health and development of infants and children, and general family welfare. Answers to most of these questions require far more detailed information than is available from WFS data (for Sri Lanka or other countries).

For example, if the women working away from home are generally better off and more educated, and can afford and actually provide good food supplements, resulting in satisfactory child health and development, there would be much less reason for concern than if these were poorer, less educated, women working because their families needed the income, who did not have adequate knowledge of nutrition, resulting in infant-child morbidity and mortality because of the use of inadequate, unhealthy substitute foods for young infants. If the location of work tends to be close to home and the nature of work does not preclude breaks to breast-feed, a far stronger case can be made for legislation requiring infant day-care facilities at places of (women's) work than in other circumstances. The *size* of the place of employment of women will also be relevant here since larger firms can much more easily provide such special facilities for women.

2. *Education policies.* Mothers with more education are generally considered to breast-feed less in developing countries. Of course, using such cross-sectional differentials to infer that increasing women's education reduces their subsequent breast-feeding is fraught with risk: Women who have obtained more education are a self-selected sample who might have chosen to breast-feed less in

any case. If we eschew these omnipresent concerns, we will see that in the situation of Sri Lanka there are some fascinating findings about the apparent effects of education on breast-feeding. These findings are made possible by separately examining the determinants of decisions (a) to ever/never breast-feed, (b) to breast-feed at various specific durations, and (c) to breast-feed beyond certain key ages for separate samples of short and long duration breast-feeders. Tables 3 and 5 show that, in the case of Sri Lanka, the usual assumption that more educated women breast-feed less is *only* true for relatively *long* (9 months plus) durations of breast-feeding. Table 3 and column (1) of Table 4 show that more educated women are *more* likely to ever breast-feed; and Tables 6 and 7 show that those who do breast-feed are more likely to continue breast-feeding to recommended ages if they are more educated. More educated women in Sri Lanka thus appear to better understand the value of breast-feeding for five or more months of the infant's life. An evident policy recommendation would be to strengthen this understanding for all women irrespective of education by special mini-courses or other means (e.g., mass media promotion).

3. *Family planning policies.* Mothers who use birth control pills are significantly less likely to breast-feed their children in Sri Lanka. This negative effect seems to increase at higher durations, as would be expected. Nevertheless, the effect even on short-duration breast-feeders is substantial. This may provide evidence in support of the belief that pill use suppresses breast-milk production. It is possible, therefore, that some considerations should be given to altering the types of contraceptive pills used in Sri Lanka, or to stressing alternative means of birth control (I.U.D., sterilization, etc.).[16]

4. *Urban residence and migration policies.* There does appear to be some effect of urban residence on reducing the probability of breast-feeding, but residence location was not found to interact with other factors influencing breast-feeding: The common expectation that the effects of these other factors are different in urban and rural areas was not supported by the evidence for Sri Lanka. But in addition, the effects of urban vs. rural residence per se, once the other factors are controlled, are not very large—certainly not as important as the other three variables discussed above. Therefore, continuing rural-urban migration should not in itself have much effect on reducing breast-feeding in Sri Lanka. However, there may be some urban factors (e.g., greater availability of food markets, mass media, electricity, media, modern health professionals) that influence breast-feeding which could be used to more advantageously search for additional policy suggestions. This again requires a much richer information base than is available to us from WFS data.

Certain other significant effects on breast-feeding are also observed for Sri Lanka, e.g., the woman's age, having refrigerators, and the presence of other young children depress it, while having older children to substitute for the mother in child care or marketwork to earn income facilitates it. On the other hand, we observe no effect of the child's sex on its probability of being breast-fed or the duration, nor of the mother's religion (except for a small effect on ever/never).

We should reiterate, in concluding, that our ability to formulate a sufficiently complex and realistic model was constrained by the data available. This makes any policy inferences definitely tentative. Moreover, there remain incompletely resolved issues with respect to model specification accounting for sample composition effects, and structural shifts that require further investigation. Examination of the determinants of breast-feeding for other countries—in different cultures and stages of socioeconomic development—will help determine the extent to which the results found here for Sri Lanka are generalizable.

NOTES

[1] Of course, in some cultures, there may be a tendency for breast-feeding to cease exactly at six-month or 12-month intervals because of deeply rooted societal norms, but we are unaware of research which has firmly established such a pattern. In a recent paper, Knodel and Debavalya (1980) observe that there is even greater age heaping in Thailand (60 percent of observations heaped on multiples of six months, versus 43 percent in our Sri Lanka data). They believe this does "not seem to reflect actual behavior in Thailand as indicated by the fact that current status data do not reveal sharp drops in the proportion of women breast-feeding at durations following multiples of whole or half years." (p. 5).

[2] Data are unavailable on WFS tapes for the creation of family composition variables to determine whether the children are living at home. Consequently, there is some measurement error in the variables for male and female siblings, particularly in the age 13 and over groups. It is impossible to predict how these errors will affect the results, except that they might confound the effect of the mother's age somewhat.

[3] In a well-known paper Henry (1961) hypothesized that, to the extent breast-feeding is used to control family size, its duration should be (positively) influenced by children already born. While a few earlier studies have found such a positive relationship, more recent evidence based on an analysis of data from eight WFS surveys supports the null hypothesis: See references cited in Jain and Bongaarts (1980, p. 7) and their own empirical results. The lack of a consistent relationship between parity and breast-feeding is interpreted by these authors to imply that breast-feeding is not used to deliberately control family size or birth interval length. The biological-contraceptive relationship may be weak since breast-feeding is a means of feeding in *all* cultures. But if it is considered more broadly as a form of infant-and-child care, then it can be seen that breast-feeding may be (negatively) affected by the presence of other children who also compete for this care from the mother (see also Table 1 definitions).

[4] A "normal" good is one which people desire more of as income rises.

[5] And from the urban population (24 percent of the total in Sri Lanka—see footnote a in Table 4 below).

[6] The analysis of Jain and Bongaarts (1980) is based only on closed intervals. The desirability of using information derived from *both* open and closed intervals as units of observation in analyses of the determinants of the duration of either birth intervals or breast-feeding is made amply clear in Page et al., (1980). For example, mean duration of breast-feeding based on open interval data are biased upward, while those based on last closed-interval data are biased downward. Analyses of the determinants of the duration of breast-feeding based on either alone are also biased (see Page et al., 1980). Of course, our data still suffer from some censoring (see Sheps and Menken, 1973) but that is inevitable with our multivariate analysis. (See also the next paragraph in the text.)

[7] In other countries the percent of births omitted may be higher, varying directly with their level of fertility. For additional discussion of the possible bias caused by interval selection, see Sheps and Menken, 1973; Menken and Sheps, 1970; Sørensen, 1977; and Rindfuss and Bumpass, 1977. There is also a potential autocorrelation problem associated with analysis of the last closed and open intervals together. We know that the disturbance term in the classical regression model includes, among other factors, omitted variables. These omitted variables are likely to be correlated for two observations from the same household. However, autocorrelation typically results only in some loss in statistical efficiency, far less serious than the sample bias introduced by separating the sample into open and closed intervals.

[8] In our standard recode tape analysis, all births were assumed to have been carried to a full term of nine months, so nine months was subtracted from the birth data of the *last* child to estimate the time (century month) at which breast-feeding ceased for the next-to-last (closed interval) child. By comparing the raw and Standard Recode Tapes, we found that this results in underestimating the percentages of last-closed birth children being breast-fed by 2.5, 7.5, and 20.6 percent at 3, 6, and 12 months, respectively.

[9] In the absence of (common) taboos against breast-feeding while pregnant, the two are likely to overlap (a) the longer the duration of breast-feeding and (b) the higher the pregnancy rate.

[10] The Farms Own Land variable is not significant in Sri Lanka. This may reflect the frequency of living on (public) estates, an institutional situation not found (or less prevalent) in most other developing countries. The variable may well be significant in other countries.

[11] There is a significant urban effect, as noted and to be discussed later. There is *not*, however, a statistically significant difference in the impact of mother's work, education, and the other factors between urban and rural areas. This runs contrary to a common belief that work and education, inter alia, have different effects on breast-feeding in urban and rural areas.

[12] These predicted probabilities of breast-feeding are slightly lower at 6 and 12 months than those based on a multiple-decrement life table analysis for Sri Lanka (cf. Popkin et al., 1979). Also note that the average probability for the 15-month cut-off is higher than that for the 12-month cut-off. We believe that the reason for this is that as we move to higher cut-offs, more women are excluded who did not have the opportunity to breast-feed to at least the cut-off. This is crucial in the closed interval because of the correlation between breast-feeding and

the length of time between children. The result is, in moving to longer durations, women who are very long breast-feeders constitute an increasing proportion of the sample, viz., the composition of the sample changes.

[13] Cross-tabulations of mother's education and breast-feeding probabilities at various ages revealed pronounced inverse associations at all ages. The different results in the text indicate the value of multivariate analyses which control for other factors.

[14] For example, Table 7 illustrates the (expected) differences in the effects of pill use, mother's age, and husband's education much better than Table 6.

[15] The WFS survey represents a great improvement over most previously available data sets. Nevertheless, it is possible that the effects of some variables included here may not be correctly estimated because of the absence of potentially important individual, household and community variables in the available WFS data (e.g., infant formula prices, activities of health professionals, maternal health and nutritional status, and further labor force and economic variables).

[16] Some caution is needed here because pill users may constitute a special socioeconomic group, in which case the pill use effect may partly reflect sample composition rather than a physiological effect.

ACKNOWLEDGMENTS

We are grateful to Ronald R. Rindfuss and Ron Lesthaeghe for their invaluable advice and comments. We thank the Office of Nutrition, U.S. Agency for International Development, especially Tina Sanghvi, for providing financial support and comments on an earlier draft, the Carolina Population Center for logistic support, Jeff Bass for computational and statistical advice, and Jim Wyckoff for research assistance. The ORSTOM (France) contribution is part of a broader agreement between WHO's Division of Family Health and ORSTOM for comparative analyses of WFS data on health issues. Send reprint requests to Barry M. Popkin, Carolina Population Center, University of North Carolina, University Square East 300A, Chapel Hill, North Carolina 27514.

REFERENCES

Bachi, R. 1951. The Tendency to Round Off Age Returns: Measurement and Correction. Bulletin of the International Statistical Institute (Proceedings of the 27th Session, Calcutta, 1951) 33:195–221.

———. 1954. Measurement of the Tendency to Round Off Age Returns. Bulletin of the International Statistical Institute (Proceedings of the 28th Session, Rome, 1953) 34:127–129.

Cantrell, P. and H. Leridon. 1971. Breast-Feeding, Mortality in Childhood, and Fertility in a Rural Zone in Senegal. Population Studies 25:505–533.

Carrier, N. H. 1959. A Note on the Measurement of Digital Preference in Age Recordings. Journal of the Institute of Actuaries 85:71–85.

Chandra, R. K. 1978. Immunological Aspects of Human Milk. Nutrition Review 36:265–272.

Eubank, Douglas C. 1970. A Review of the Evidence on the Sources and Patterns of Age Misreporting in Less Developed Countries. Paper presented at the Annual Meetings of the Population Association of America, April 10–12, Denver, Colorado.

Goldfeld, Steven M. and Richard E. Quandt. 1976. Studies in Non-Linear Estimation. Cambridge, Mass.: Ballinger.

Henry, L. 1961. Some Data on Natural Fertility. Eugenics Quarterly 8:81–91.

Jain, Anrudh K. and John Bongaarts. 1980. Socio-Biological Factors in Exposure to Childbearing: Breast-feeding and Its Fertility Effects. Paper presented at the World Fertility Survey Conference, London, July 7–11.

Jelliffe, Derrick B. and E. F. Patrice Jelliffe. 1978. Human Milk in the Modern World. New York: Oxford University Press.

Knodel, J. 1977. Breast-Feeding and Population Growth. Science 198:1111–1115.

Knodel, J. and N. Debavalya, 1980. Breast-Feeding in Thailand: Trends and Differentials, 1969–1979. University of Michigan and Chulalongkorn University, mimeo.

Menken, J. A. and M. C. Sheps. 1970. On Relationships Between Longitudinal Characteristics and Cross-Sectional Data. American Journal of Public Health 60:1506–1514.

Myers, Robert J. 1940. Errors and Bias in the Reporting of Ages in Census Data. Transactions of the Actuarial Society of America 41, Part 2(104):395–415. Reproduced in U.S. Bureau of the Census (1951), Handbook of Statistical Methods for Demographers, pp. 115–125.

Osteria, Trinidad S. 1978. The Effects of Breast-feeding and Contraception on the Interpregnancy Interval of Urban Filipino Women. In: Nutrition and Reproduction, ed. by W. Henry Mosley, New York: Plenum.

Page, Hilary J., B. Ferry, I. H. Shah and R. Lesthaeghe. 1980. The Most Recent Births: Analytical Potential and Some Underlying Problems. Paper presented at Seminar on the Analysis of Maternity Histories. London: IUSSP, World Fertility Survey, and London School of Hygiene and Tropical Medicine.

Pindyck, D. S. and D. L. Rubinfeld. 1976. Econometric Models and Economic Forecasts. New York: McGraw Hill.

Popkin, Barry M., Richard Bilsborrow, Monica Yamamoto and John Akin. 1979. Breast-Feeding in Low Income Countries: Patterns and Determinants. Carolina Population Center Papers, No. 11. Chapel Hill: Carolina Population Center, The University of North Carolina at Chapel Hill.

Rindfuss, R. R. and L. L. Bumpass. 1977. Fertility During Marital Disruption. Journal of Marriage and the Family 39:517–527.

Rosa, F. W. 1975. Breast-Feeding in Family Planning. PAG Bulletin 5:5–10.

———. 1976. Breast-Feeding. A Motive for Family Planning. People 3:10–13.

Sheps, Mindel C. and Jane A. Menken. 1973. Mathematical Models of Conception and Birth. Chicago: University of Chicago Press.

Shryock, Henry S. and Jacob S. Siegel. 1976. The Methods and Materials of Demography. Condensed ed. by E. G. Stockwell. New York: Academic.

Singarimbun, Masri and Chris Manning. 1974. Fertility and Family Planning in Mogolama. Jogjakarta, Indonesia: Institute of Population Studies, Gadjah Mada University.

Som, R. K. 1968. Recall Lapse in Demographic Enquiries. Bombay: Asia Publishing House.

Sørensen, Aage B. 1977. Estimating Rates from Retrospective Questions or How the Present Affects the Past. In: Sociological Methodology, ed. by David R. Heise. San Francisco: Jossey-Bass.

Sosa, Robert, John H. Kennel, Marshall H. Klaus and Juan J. Urrutia. 1976. The Effect of Early Mother-Infant Contact on Breast-Feeding, Infection and Growth. In: Breast-feeding and the Mother. Ciba Foundation Symposium No. 45. Amsterdam: Elsevier North-Holland.

Tindal, J. S. 1974. Hypothalmic Control of Secretion and Release of Prolactin. Journal of Reproduction and Fertility 39:437–461.

Tyson, J. E., M. Khojandi, J. Huber, B. Smith and P. Thomas. 1975. The Inhibition of Cyclic Gonadotropin Secretion by Endogenous Human Prolactin. American Journal of Obstetrics and Gynecology 121:375–379.

United Nations, Department of Economics and Social Affairs. 1976. Manual IV: Methods of Estimating Basic Demographic Measures from Incomplete Data. Population Studies No. 42. New York: United Nations.

Van Ginneken, Jerome K. 1978. The Impact of Prolonged Breast-Feeding on Birth Intervals and on Post Partum Amenorrhoea. In: Nutrition and Reproduction, ed. by W. Henry Mosley, New York: Plenum.

World Health Organization. 1979. WHO Collaborative Study on Breast-Feeding. Geneva: WHO.