Working Paper WP98-4 **December 1998**

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The Effects of Breastfeeding on Health and the Need for Medical Assistance among Children in Brazil

Ben Senauer and Ana Kassouf

INTRODUCTION

The beneficial effects of breastfeeding on child health have been widely established.[1] Breastfeeding confers both nutritional and immunological benefits. Breastfeeding is also more sanitary than bottle feeding in most developing country situations. Medical and public health organizations strongly encourage breastfeeding. The World Health Organization (WHO) of the United Nations recommends exclusive (unsupplemented) breastfeeding for the first 4-6 months and continued breastfeeding for up to two years or beyond, appropriately supplemented.[2]

Tragically, the AIDS pandemic has created a dilemma concerning breastfeeding. The AIDS virus can be transmitted at a significant rate through breast milk. Estimates are that one-third of all infants with HIV were infected by their mother's milk.[3] In a controversial decision, the United Nations recently recommended that HIV-positive mothers not breastfeed.[4] This paper does not address the link between HIV and breastfeeding directly. However, because of this link it is even more important to establish the substantial health benefits of breastfeeding and the potential health care savings for the general population (not HIV-positive) resulting from increased breastfeeding.

This study contains several unique features that add to the literature documenting the health benefits of breastfeeding. The underlying theoretical framework for this study is the household economics model of Gary Becker.[5] In particular, health production functions are

specified and estimated. Data from the 1989 Brazilian National Health and Nutrition Survey are used to analyze the effects of breastfeeding on child morbidity (the absence of health). Binomial probit equations are estimated in which the dependent variable is whether the child required medical assistance during the previous two weeks for any of eight illness symptoms: fever, sore throat, loss of appetite, stomach ache, vomiting, diarrhea, respiratory problem, or a problem sleeping.

The analysis is structured to be consistent with the WHO breastfeeding recommendations. For children 0-23 months, the impact of current breastfeeding on the need for medical care is analyzed and for infants 0-5 months, the effect of exclusive breastfeeding. Although the focus is on the impact of breastfeeding, the analysis is multivariate. Other possible determinants, which if excluded could bias the results, are included as additional explanatory variables. Several of the explanatory variables, including breastfeeding, are appropriately treated as endogenously determined and estimated with instrumental variables. Many studies end with a discussion of the econometric results. In this paper, the results of the probit analysis are used to simulate the possible reduction in the need for medical care if all children in Brazil were breastfed according to the WHO recommendations.

There are two previous economic studies particularly relevant to this research.[6] The Cebu Study Team estimated child health production functions for diarrhea, febrile respiratory infection, and weight with data from Cebu in the Philippines for children up to two years old. Individual, household, and community variables were found to affect child health. The infant feeding variables were treated as endogenous and the data allowed them to distinguish between exclusive breastfeeding, breastfeeding supplemented with non-nutritive liquids and with

nutritive foods. Breastfeeding reduced the incidence of diarrhea, but appeared to have little effect on respiratory infections. They did find that children in any of the breastfed categories weighed more than those not breastfed. The other study by Barrera estimated a health production function for child height-for-age with survey data from Bicol in the Philippines. The endogeneity of breastfeeding was addressed here also. The results showed that the growth benefits from exclusive breastfeeding differed by mother's education. Children with less-educated mothers had the most gains.

ANALYTICAL FRAMEWORK

This section covers the theoretical model and estimation issues. The analysis is based on a standard economic model of the household in which a joint utility function is maximized subject to a household production function and a full income constraint.[7] Household utility is a function of the goods and services consumed, health status of the children and other household members, and leisure.

The health production function is used by economists to analyze health behavior and outcomes. It provides a framework for specifying and estimating the determinants of child health. The production function for child health is specified as:

$$h = \beta' \mathbf{x} + \epsilon$$

where h is an unobserved health variable which depends on a vector **x** of inputs which include the feeding technique (whether breastfed or not), plus other variables for the characteristics of the child, the parents, the household and the community.[8] We assume that ϵ has a normal distribution.

The health variable (h) is not directly observed, only whether the child required medical assistance in the previous two weeks for any one of eight illness symptoms. Therefore, the observation is

$$y = 1 \text{ if } h < h^*$$

$$y = 0 \text{ if } h \geq h^*$$

The child required medical assistance ($y = 1$) if health was below some threshold level (h^*) and did not ($y = 0$) if health was at or above the threshold. Therefore, a binomial probit model is appropriate for estimation with

$$\text{Prob}[y = 1] = F(\beta' \mathbf{x})$$

$$\text{Prob}[y = 0] = 1 - F'(\beta' \mathbf{x})$$

The parameters in β' reflect the effect of changes in $\mathbf{x}$ on the probability of the need for medical assistance. Maximum likelihood was used to estimate the probit model.[9]

Several of the determinants in $\mathbf{x}$ clearly should be treated as endogenously determined.[10] First and foremost is whether the child was breastfed. The decision of how to feed her child is made by each mother. Moreover, the health status of the child may influence the choice of feeding technique, which would lead to correlation between the explanatory variables and the error term. A two-stage estimation procedure was used to control for unobserved heterogeneity and endogeneity. In the first stage, an instrumental variable probit equation was estimated with breastfeeding as the dependent variable and the predicted values for breastfeeding were then used in the health production function.

There were other explanatory variables which were also treated as endogenous, which are discussed in the next section. Probit or least-squares instrumental variable regressions were

used depending on whether they were binary or continuous. The variables used as instruments are also discussed in the next section. Identification was not a problem since there were several instrumental variables which were not included as explanatory variables in the health production function.

SURVEY DATA AND VARIABLES

The data used were from the 1989 National Health and Nutrition Survey collected by the Brazilian Geographical and Statistical Institute (IBGE). The data were collected between July and September of 1989. The Northern region of Brazil was excluded from the survey. Approximately 63,000 individuals from 17,920 households were interviewed. This analysis covers infants 0-5 months old with a sample of 496 and children 0-23 months with 2,081 observations.

Dependent Variable

The questionnaire asked whether the child had suffered from eight different illness symptoms during the two weeks preceding the survey. The symptoms included whether the child had a fever, a sore throat, a loss of appetite, a stomach ache, vomiting, diarrhea, respiratory problems or problems sleeping. The answers to these questions reflect the mother's or other caregiver's personal evaluation of whether the infant showed any of these symptoms, which means there is a high degree of subjectivity in these responses. However, the respondent was next asked whether because of these illness symptoms medical assistance was sought for the child from a doctor, clinic or other health care provider. More objectivity is added to the illness evaluation if the mother or other caregiver felt the symptoms required

medical treatment. The problem would need to be considered sufficiently serious to spend the time and possibly also money to get medical assistance.[11] The dependent variable, therefore, is whether the child required medical assistance for any one of the symptoms. This variable does not reflect whether more than one symptom was involved or more than one visit for medical assistance in the two-week period.

Explanatory Variables

The key explanatory variable of interest is whether infants 0-5 months were exclusively breastfed and whether children 0-23 months were currently breastfed (either exclusively or supplemented). Table 1 gives the percent of infants 0-5 months exclusively breastfed by age in months. For newborns less than one month old 60.6% were exclusively breastfed. Table 2 shows the percent of children 0-23 months who were currently breastfed by age. Some 91.5% of newborns were breastfed, exclusively or supplemented. At 23 months, only 11.3% were still breastfed. Presumably in the population the percentage of breastfed infants declines continuously as age increases. However, the number of children became small enough when the sample was segmented by age in months, that there are some anomalies from a smooth decline in Tables 1 and 2.

Table 3 provides a detailed description of each variable and the means and standard deviations (in parentheses) for 0-5 month and 0-23 month old children. Some 21.1% of infants 0-5 months and 20.5% of infants 0-23 months required medical assistance in the two weeks preceding the survey for one or more of the eight illness symptoms. On average, 29.5% of the infants 0-5 months were exclusively breastfed and 36.3% of the children 0-23

months were currently breastfed. In addition to breastfeeding, the other variables treated as endogenous were the number of cigarettes smoked by the mother, the number of hours she worked in the labor force, and whether the household filtered its water. Each of these variables reflects a choice by the mother or the household. A two-stage procedure was used, using least squares regression in the first stage for number of cigarettes and hours worked and probit for water filtration.

Breastfeeding is, of course, assumed to have a positive effect on child health, and hence decrease the probability of needing medical assistance. Smoking by the mother exposes the child to second-hand smoke and suggests the mother probably also smoked while she was pregnant. Both would be assumed to have a negative effect on child health and increase the probability of requiring medical assistance. Since the care of young children is very time-intensive, especially of the mother's time, an increase in hours worked might have a negative impact on health and increase the probability of needing medical assistance. Filtration might help improve water sanitation and reduce water-borne illnesses.

The exogenous variables include the child's gender, race, and age. The omitted racial category is parda, which is a racial mix, and accounts for the largest proportion of the Brazilian population. Average education levels in Brazil are strikingly low. The mothers on average completed less than five years of school. Previous studies have found maternal education to positively impact child health.[12] Piped water, a sewer connection, electricity and being on a paved street should all help to create a healthier, more sanitary environment. Finally, urbanization could reflect a number of factors such as proximity to medical assistance, infrastructure in addition to piped water, a sewer and paved street, or population density and

pollution which might have a negative impact on health.

The data used in this analyses were clearly not experimentally generated by random placement in either a breastfed or a control group. Even if the primary interest is in the impact of breastfeeding, the other explanatory variables are needed as "controls," serving the role of a control group in an experiment, albeit imperfectly.[13] The omission of variables that affect child health and which are correlated with breastfeeding would bias the estimated impact of breastfeeding on child health and the probability of requiring medical assistance.

Instrumental Variables

In addition to the exogenous variables in Table 3, included in the health production functions, additional exogenous variables were available to use as instruments in the first stage estimation for the endogenous variables and assure identification of the health production function. The additional variables included region (Southeast, South and Central with Northeast omitted), the z-scores for the mother's and father's heights, the father's age, the father's education, whether the mother and father were literate, the estimated wages for the mother and father and household nonlabor income per capita. The estimated wages were from a previous study with the same data, in which the Heckman technique was used. More detailed information can be found in Kassouf and Senauer and the first-stage results are available from the authors on request.[14]

EMPIRICAL RESULTS

Probit Results

The maximum-likelihood probit results for the health production functions for requiring

medical assistance are reported in Table 4 for infants 0-5 months and children 0-23 months. The partial derivatives (marginal effects), probit coefficients and t-statistics are given. The LIMDEP program was used for estimation.

The parameters of the probit model do not indicate the marginal effects of an explanatory variable on the dependent variable, as in a typical linear regression.[15] LIMDEP calculates the partial derivatives $\partial E[y|\mathbf{x}]/\partial x$, which are derived at the mean values of **x**. The partial derivatives are not the appropriate marginal effects for binary variables, such as breastfeeding. Taking the derivative with respect to a binary variable as if it were continuous provides a good approximation of the marginal effect in many cases, though.[16] Therefore, the derivatives are reported in Table 4 for all variables. In the next section, the marginal effects of breastfeeding, appropriately calculated, are reported.

In the results for infants 0-5 months in Table 4, exclusive breastfeeding is statistically significant at a high level. The partial derivative suggests that the probability of needing medical assistance for at least one of the symptoms is 22.42 percentage points lower for infants exclusively breastfed, than those who were not. Somewhat surprisingly, the only other significant effect is the mother's age. The probability of the infant requiring medical care increases with the mother's age at a rate of 0.75% per year. There are a number of factors that might be related to this trend. As the mother's age increases, the number of older siblings which the infant has is likely to also increase. Other studies have found that birth order is an important factor in determining child health. Being later in the birth order (having more older siblings) has been found to negatively affect health outcomes.[17]

For children 0-23 months, breastfeeding is significant at the 5% level. The partial

derivative indicates that the probability of requiring medical care was on average 5.97 percentage points lower for breastfed children, evaluated at the means of the regressors. The child's age also has a statistically significant effect. The probability of needing medical assistance declines 0.79% per month. In the next section, the marginal effects of breastfeeding are reported across the range of child's age (0-23 months).

The effect of piped water is also significant. The probability of the child needing medical assistance is higher in households with piped water, the opposite of the effect expected. This effect might reflect the lack of proper sanitary treatment of the water supply in many areas. In addition, this variable may be reflecting the proximity of medical assistance and its affordability in terms of household income, both of which are probably correlated with the household having piped water. That in both results (0-5 and 0-23 months) more factors, such as mother's education or race, are not significant is unexpected. However, the lack of significance of many other factors makes the role of breastfeeding in improving child health and reducing the need for medical care stand out.

Calculated Marginal Effect

The correct marginal effect for a binary variable, such as breastfeeding is

$$\text{Prob}\,[y=1 \mid \bar{\mathbf{x}}_*, d=1] - \text{Prob}\,[y=1 \mid \bar{\mathbf{x}}_*, d=0]$$

where $\bar{\mathbf{x}}_*$ equals the means of all the other variables and d is the binary explanatory variable.[18] Based on the coefficients in Table 4 for infants 0-5 months, the marginal effect of exclusive breastfeeding is –.1762, the difference between the probability of needing medical assistance when breastfed of .0660 and when not breastfed of .2422, with other explanatory variables at

their mean values. In this case, the partial derivative of –.2242 is not a good approximation of the marginal effect. Exclusive breastfeeding actually reduces the probability of needing medical assistance by 17.62 percentage points. The partial derivatives can not automatically be assumed to closely approximate the correct marginal effects for binary explanatory variables in a probit model. If the sample of observations on the dependent variable deviates greatly from an even split, the approximation may degrade, for example. The relationship is an empirical regularity and not guaranteed.[19]

The marginal effect of breastfeeding for children 0-23 months is –.0575, the difference between the probability of needing medical assistance of .1558 when breastfed and of .2133 when not. The partial derivative of –.0597 in this case is a very good approximation of the actual marginal effect.

The benefits of breastfeeding are greatest early in life and decline with the child's age. This age effect is particularly important to account for with children 0-23 months, given the broad age range and the statistical significance of the child's age in the probit model (Table 4). Therefore, the marginal effect of breastfeeding was calculated across the range of age. Using the coefficients from the probit model in Table 4, probabilities of needing medical assistance were derived for breastfed (d=1) and non-breastfed (d=0) children as a function of the child's age, with all other variables at their mean values.

Figure 1 shows these two functions over the range 0-23 months for the child's age. The marginal effect of breastfeeding is the difference between the two functions. The probability of needing medical assistance declines substantially as the child grows older. Although the benefits of breastfeeding decline somewhat as a child grows older, they remain

even for older children. At less than one month of age the marginal effect of breastfeeding is -.0733 and at 23 months it is -.0404.

Figure 2 shows the probability of needing medical assistance for 0-5 month old infants who were exclusively breastfed (d=1) and those not (d=0) across a range of the mother's age, which was also a statistically significant factor in Table 4. Interestingly, the gap between the two probabilities widens for older mothers. Not only are children with older mothers not as healthy as those born to younger women, but the benefits of breastfeeding for child health increase with the mother's age. The marginal effect of exclusive breastfeeding is -.1234 for 16 year old mothers and is -.2486 for 42 year old mothers. The probability of 0-5 month old infants not exclusively breastfed with 42 year old mothers needing medical care is .3835 (38.35%), whereas it is only .1348 (13.48%) for those exclusively breastfed.

The probabilities at the ends of this age range should perhaps be viewed with some caution since the number of very young or older mothers in the sample is limited. Only five mothers were 16 years old and only five were 42. Nevertheless, this pattern does suggest the importance of exclusively breastfeeding infants for the first 4-6 months is even more important for older mothers.

Policy Simulations

The marginal effects can be used to estimate the total reduction in visits for medical assistance if all infants in Brazil were breastfed according to the WHO recommendations. For weighting purposes the data set provides the estimated number in the Brazilian population represented by the sample results. The data indicate that there were an estimated 1,278,057

infants 0-5 months old in Brazil and 888,971 were not exclusively breastfed. An estimated 196,556 medical visits were made in the two-week period by the population of infants 0-5 months old who were not exclusively breastfed. If all these infants had been exclusively breastfed and we assume a resulting 17.62% reduction in medical visits needed, there would have been a reduction of 34,633 visits. The annual reduction in medical visits would be 900,462, obtained by multiplying the two-week figure by 26 such periods in a year.

There were indicated to be 5,019,597 children 0-23 months in the Brazilian population and an estimated 3,199,708 were not breastfed. Of those not breastfed, 674,299 required medical assistance in the two weeks prior to the survey. If breastfeeding reduced the probability of needing medical assistance by 5.75%, there would have been 38,772 fewer medical visits, 1,008,077 on an annual basis.

There would be some overcounting if the two estimated reductions in medical visits are combined. The infants 0-5 months are included among the sample of children 0-23 months. On the other hand, total medical visits are probably substantially undercounted. If medical assistance was sought for more than one symptom during the two weeks, it was counted as only one visit since many illnesses have multiple symptoms, such as stomach ache, vomiting and loss of appetite combined, or fever, sore throat, and respiratory problem together. Many of the children who required medical assistance may have had more than a single visit for the same symptoms or for different symptoms. Above all, the estimated reduction in visits for medical assistance, although only an approximation, suggests some of the substantial savings to the health care system from wider adoption of the WHO breastfeeding guidelines.

CONCLUSIONS

In this study data from a 1989 Brazilian survey were used to estimate the impact of breastfeeding on the need for medical assistance among children. Separate health production functions were specified and estimated for 0-5 month old and 0-23 month old children. Several explanatory factors, including breastfeeding, were treated as endogenous. A probit model was utilized since the health outcome analyzed was whether the child required medical assistance for at least one of eight illness symptoms in the two weeks prior to the survey.

Based on the calculated marginal effects, exclusive (unsupplemented) breastfeeding reduced the probability of needing medical assistance by 17.62% among infants 0-5 months. In addition, the probability of requiring medical care was 5.75% lower among breastfed children 0-23 months than those not breastfed. Although the benefits of breastfeeding declined for older babies, even at 23 months there was a positive impact on child health, with a reduced need for medical assistance. Infants 0-5 months required more medical care as their mother's age increased. However, breastfeeding reduced the need for medical assistance even more among infants with older mothers, as indicated by its marginal effect.

The marginal effects were used to simulate the potential reduction in medical assistance needed if all Brazilian children were breastfed in accordance with World Health Organization recommendations. If all infants 0-5 months old had been exclusively breastfed, there would have been an estimated annual reduction in visits for medical assistance of 900,462. There would have been 1,008,077 fewer medical visits if all children 0-23 had been breastfed. There are elements of both overcounting and undercounting in these calculations. These estimates should be treated as rough approximations. Moreover, they relate to only one measure of the

total possible health care savings due to breastfeeding.

Nevertheless, the simulations suggest the potential concrete savings in health care that could result from an increase in breastfeeding. Greater public expenditures on breastfeeding promotion can be economically justified. If promotion programs increase appropriate breastfeeding, they can have a real economic pay back in reduced health care needs and costs. Moreover, given the tragic link between AIDS and breast milk and the limited resources for health care in developing countries, increased breastfeeding among the general (non-HIV positive) population would free up health care resources that could be directed towards combating AIDS.[20]

ENDNOTES

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[10]Cebu Study Team and Barrera.

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[20]This would require an inexpensive test for HIV and the willingness of pregnant women to be tested and identified.

Table 1. Percent of Infants Exclusively Breastfed by Age in Months (0-5)

Age	< 1	1	2	3	4	5
Percent	60.6	48.2	36.7	24.7	8.9	11.7

Table 2. Percent of Infants Breastfed by Age in Months (0-23)

Age	< 1	1	2	3	4	5	6
Percent	91.5	84.7	73.4	62.3	56.7	51.1	48.1

Age	7	8	9	10	11	12	13
Percent	45.1	45.8	37.9	43.5	41.7	24.5	36.3

Age	14	15	16	17	18	19	20
Percent	25.3	33.8	21.2	23.1	21.8	12.9	15.1

Age	21	22	23
Percent	14.8	19.0	11.3

Table 3. Description of Variables

Variables	Means and (Standard Deviations) 0-5 Months	0-23 Months
Dependent Variable		
Child needed medical assistance for at least one of 8 illness symptoms in the previous 2 weeks; yes = 1.	.211 (.405)	.205 (.398)
Endogenous Variables		
Infant is exclusively breastfed; yes = 1	.295 (.461)	
Child is currently breastfed, yes = 1		.363 (.485)
Number of cigarettes smoked by the mother per day	2.97 (5.51)	2.93 (5.69)
Number of hours the mother works in the labor force per week	6.76 (15.54)	7.94 (16.36)
Household water is filtered; yes = 1	.461 (.496)	.484 (.496)
Exogenous Variables		
Child is male = 1; or female = 0	.481 (.500)	.491 (.500)
Child is black; yes = 1	.049 (.160)	.038 (.183)
Child is white or Asian; yes = 1	.478 (.500)	.490 (.500)
Child's age in months	2.61 (1.71)	11.53 (6.83)
Mother's age in years	27.09 (6.68)	27.54 (6.57)
Mother's number of years in school	4.93 (3.78)	4.92 (3.76)
Residence has piped water; yes = 1	.592 (.500)	.585 (.500)
Residence is connected to a sewer; yes = 1	.370 (.425)	.398 (.430)
Residence has electricity; yes = 1	.776 (.474)	.752 (.481)
Residence is on a paved street; yes = 1	.296 (.405)	.307 (.410)
Residence is in an urban area; yes = 1	.678 (.496)	.648 (.491)

Table 4. Infant and Child Health Production Functions for Needing Medical Assistance

Variables	Infants 0-5 Months	Children 0-23 Months
Constant	−1.311 (3.647)	−.6827 (2.839)
Exclusively breastfed#	**−.2242** −.8075* (3.230)	
Breastfed#		**−.0597** −.2166* (2.023)
Mother smokes#	**−.0163** −.0587 (1.152)	**.0068** .0247 (.587)
Hours mother works#	**.0004** .0016 (.283)	**−.0005** −.0017 (.599)
Water filter#	**−.0821** −.2958 (1.534)	**−.0409** −.1484 (1.691)
Male	**.0049** .0175 (.127)	**.0268** .0972 (1.511)
Black	**.0552** .1990 (.575)	**.0514** .1866 (1.125)
White	**.0466** .1680 (1.098)	**.0323** .1170 (1.600)
Child's age	**−.0251** −.0904 (1.595)	**−.0079** −.0287* (4.05)

Variables	Infants 0-5 Months	Children 0-23 Months
Mother's age	**.0075** .0270* (2.386)	**−.0022** −.0081 (1.522)
Mother's education	**−.0064** −.0231 (1.040)	**−.0011** −.0038 (.323)
Piped water	**.0366** .1320 (.669)	**.0931** .3377* (3.273)
Sewer	**.0543** .1955 (.934)	**.0094** .0340 (.357)
Electricity	**.0587** .2113 (.865)	**.0359** .1302 (1.091)
Paved road	**−.0311** −.1120 (.560)	**.0007** .0025 (.029)
Urban	**.0592** .2132 (.962)	**.0202** .0732 (.661)
% correctly predicted	79.4	80.2
Restricted Log likelihood	−252.03	−1,034.09
Observations	496	2,081

Note: The bold numbers are the partial derivatives evaluated at the means followed by the probit coefficient and the absolute value of the t-statistic, respectively.
# indicates an endogenous variable for which the predicted value is used.
* denotes the coefficient is statistically significant at the 5% level.

Figure 1. Probability of Needing Medical Assistance for Children 0-23 Months.

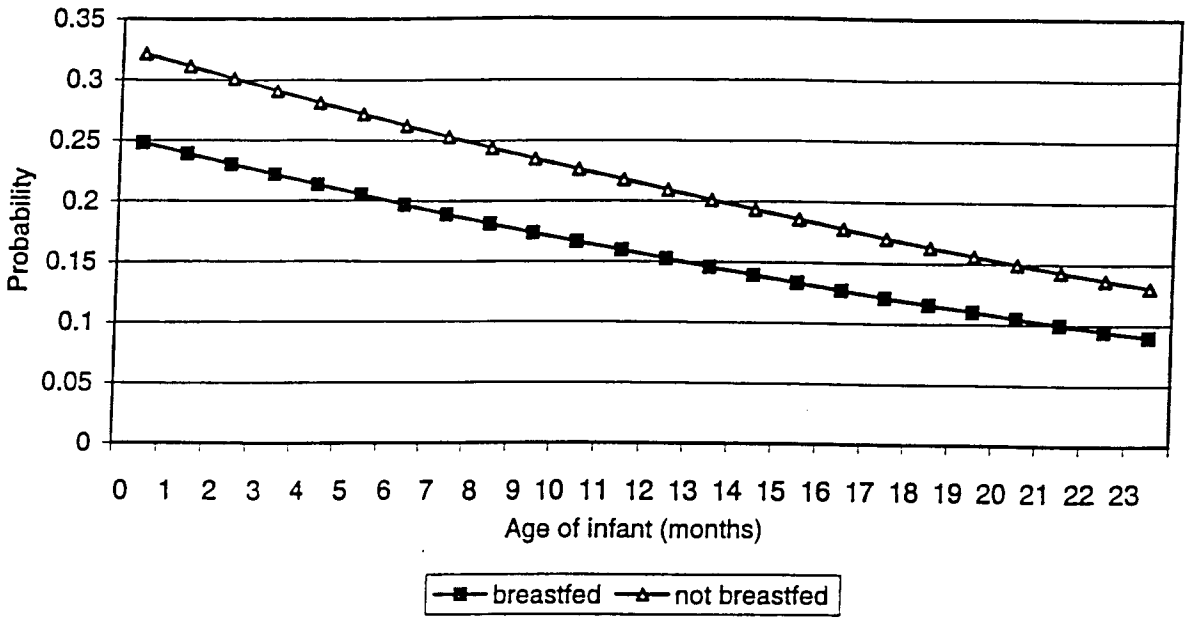

Figure 2. Probability of Needing Medical Assistance for Infants 0-5 Months.