Breast-feeding and Diarrheal Morbidity

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ABSTRACT. This study used a unique longitudinal survey of more than 3000 mother-infant pairs observed from pregnancy through infancy. The sample is representative of infants from the Cebu region of the Philippines. The sequencing of breast-feeding and diarrheal morbidity events was carefully examined in a longitudinal analysis which allowed for the examination of age-specific effects of feeding patterns. Because the work controlled for a wide range of environmental causes of diarrhea, the results can be generalized to other populations with some confidence. The addition to the breast-milk diet of even water, teas, and other nonnutritive liquids doubled or tripled the likelihood of diarrhea. Supplementation of breast-feeding with additional nutritive foods or liquids further increased significantly the risk of diarrhea; most benefits of breast-feeding alone or in combination with nutritive foods/liquids became small during the second half of infancy. Benefits of breast-feeding were slightly greater in urban environments. *Pediatrics* 1990;86:874–882; *breast-feeding, diarrheal morbidity, Philippines.*

Diarrheal disease, a major cause of infant morbidity and mortality, is the focus of extensive public health program efforts in numerous low-income countries. Most recent efforts to alleviate the problems of diarrheal disease have focused on promoting its case management primarily through the use of oral rehydration therapy. The value of preventive measures, such as the promotion of appropriate infant-feeding practices, has been little emphasized.[1] There has been extensive documentation of the protective value of breast-feeding against diarrhea in settings where poor hygiene is prevalent. Nevertheless, important issues related to the effects of types of food supplements and the risks associated with their use in different types of environments remain largely unaddressed.

The vast majority of infants who are not exclusively breast-fed consume a wide variety of other foods, including various milks used as breast-milk substitutes (commercial formulas and condensed sweetened and evaporated milk), other nutritive liquids (eg, juices), and gruels, as well as a large number of nonnutritive liquids (teas, water, broths). Furthermore, the rapid and often subtle shifts in feeding regimens occurring throughout infancy make simplistic definitions of bottle and supplemental feeding misleading.[2,3] Nonetheless, previous research has generally categorized the infant as breast-fed, mixed-fed, or bottle-fed and, therefore, has failed to address the complexity of feeding patterns at any specific time and at different ages of the infant.[4]

Effects of a given infant-feeding method almost certainly vary with the infant's age. Not only do an infant's nutritional needs vary at different ages, but so does the infant's vulnerability to the harm that can result from feeding-pattern changes. Whereas a 3-week-old neonate may suffer from being weaned completely from breast milk, a 9-month-old infant may be minimally affected.

Thus, it must be recognized that a number of possible mechanisms exist for the lower frequency of diarrhea found in breast-feeding infants and the higher risk observed when other fluids and foods are introduced. First, breast-fed infants have less exposure to enteric pathogens transmitted by contaminated fluids and foods. Second, breast-feeding may offer protection against diarrhea because of humoral and cellular antiinfective properties in human milk. Third, breast milk may promote an

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...stinal environment and microflora that inhibits ...iferation of enteric pathogens. Finally, breast-...ding can enhance the infant's nutritional status, ...reby reducing susceptibility to diarrhea.

We present a study of the dynamic relationship ...tween infant-feeding patterns and diarrheal dis-...e. Data were collected through a longitudinal ... in the Philippines, designed specifically to ...udy the relationship of diet and health. The se-...ncing of breast-feeding and diarrheal morbidity ...nts is carefully examined. Longitudinal statis-...al methods allow for the examination of the age-...cific effects of different feeding patterns on diar-...al morbidity. Because the work controls for a ...ide range of environmental causes of diarrhea, the ...ults can be generalized to other populations with ...me confidence.

MATERIALS AND METHODS

Study Design

The study site was metropolitan Cebu, which includes the cities of Cebu, Mandaue, and Lapu Lapu; coastal Cebu towns; a number of villages in mountainous and coastal areas of Cebu; and inhabited ...eas on some smaller islands. We used a stratified two-stage sampling procedure to select a random sample of 33 communities or barangays (17 urban and 16 rural).

Households were surveyed to collect data on all births between May 1, 1983, and April 30, 1984. Baseline pregnancy surveys were obtained for 3327 pregnant women who gave birth during this 12-month period. Of these women, 1.1% had stillbirths, 0.4% had miscarriages, 0.8% had twin births, 4.6% either migrated before the infant's birth or refused birth interviews, and 0.7% represented observations whose data files had faulty information (such as baseline interview data obtained after birth). For this analysis of infant health, the sample consisted initially of the 3080 women who had single live births and for whom baseline and birth information were available. An additional 57 women in the sample communities gave birth during the 12-month period but either did not live in the communities during pregnancy or were somehow missed during the screening for pregnant women.

Data on the mothers and infants came from baseline surveys of the mothers in their sixth or seventh month of pregnancy, from anthropometric and gestational age information obtained at birth and in the birth information survey, and from longitudinal surveys repeated bimonthly. Community price and health facility data came from a set of health personnel, health facility, and food market surveys. Additional details on the survey design and data appear elsewhere.[5-7]

Variables

Diarrheal morbidity is represented by a set of time-varying dichotomous variables that reflect the mother's report of whether her infant had an episode of diarrhea in the 7 days before each longitudinal survey. This variable is responsive to the independent variables of interest, was measured with a high degree of reliability, occurs with sufficient frequency in the sample, and is commonly used in the literature. The percentages of infants with diarrhea in the 7 days before each survey were 7, 12, 20, 24, 24, and 23 for ages 2, 4, 6, 8, 10, and 12 months, respectively. The percentage of study children who experienced at least one diarrheal episode at some point during the first year was 60.3, a number comparable with the rate of 52.9% reported for the whole nation of the Philippines for 1983.[8]

Infant feeding data were obtained by trained interviewers using survey instruments designed to gather precise information on patterns of feeding and food processing. Interobserver reliability studies, preceded by a 2-week dietary data collection training course, were used to ensure high-quality data. Additional training and reliability tests were conducted several times during the survey period. Using food models and measuring aids, trained interviewers recorded the frequency of breast-feeding and the types, amounts, and feeding frequencies of all liquids, semisolids, and solids fed to the infant on the day preceding the survey. Information was also obtained on the frequency of breast-feeding and whether infants were given foods in specified categories (eg, water, breast milk substitutes, semisolid or solid foods, etc) 7 days before each survey.

For this analysis, infants were grouped into a set of mutually exclusive feeding categories, reflecting breast-feeding and consumption of other foods and liquids. An infant was considered to be "exclusively breast-fed" if its entire intake consisted only of breast milk from its own mother. This definition excluded consumption of any foods or liquids that could potentially introduce pathogens to the infant. A second category included breast-feeding in combination with nonnutritive liquids such as water and herbal teas. More than 95% of the infants in this category were fed water. A third category encompassed breast-feeding in combination with nutritive liquids (eg, juices, milks) or foods (semisolids or solids). The fourth category represented no breast-feeding at all.

In Table 1 we present the prevalence of infant-

TABLE 1. Breast-feeding Patterns During Infancy, Metropolitan Cebu Area, Philippines, 1983–1985*

Infants by Age and Residence	Breast-feeding Patterns				
	Breast Milk Only	Breast Milk + Nonnutritive Liquids Only	Breast Milk + Nutritive foods,† Maybe Nonnutritive Liquids	No Breast Milk	n
2 mo					
Rural	53.3	17.3	23.1	6.3	698
Urban	24.0	19.4	38.0	18.7	2186
Both	31.1	18.9	34.4	15.7	2886
4 mo					
Rural	31.7	19.3	40.4	8.6	688
Urban	16.3	18.9	40.6	24.2	2118
Both	20.1	19.0	40.4	20.3	2806
6 mo					
Rural	4.6	6.3	79.2	9.9	668
Urban	2.8	4.7	63.9	28.6	2052
Both	3.2	5.1	65.6	24.0	2720
8 mo					
Rural	0.2	0.8	86.9	12.2	662
Urban	0.2	0.9	66.4	32.5	2007
Both	0.2	0.9	71.4	27.5	2669
10 mo					
Rural	0.0	0.6	84.1	15.3	654
Urban	0.2	0.5	62.2	37.1	1976
Both	0.1	0.5	87.7	31.7	2630
12 mo					
Rural	0.2	0.2	78.0	21.7	650
Urban	0.1	0.1	56.4	43.5	1950
Both	0.1	0.1	61.8	38.0	2600

* Based on feeding behavior on the day preceding the survey. Horizontal columns total 100%.
† Nutritive liquids including other milks or semisolid and solid foods.

feeding patterns for urban and rural infants from birth to 12 months. Urban and rural patterns were examined separately because previous analyses of the Cebu data have found important differences in health-related behaviors and their determinants between these samples, justifying their separate consideration.[6,7] Even though many continued to breast-feed, infants were introduced to other foods and liquids, particularly nonnutritive ones, very early. At 2 months, approximately 19% of infants were fed breast milk in combination with nonnutritive liquids and 34% were fed breast milk and nutritive foods or liquids (possibly in combination with nonnutritive liquids). Expressed in another way, approximately 63% of breast-fed infants had their diets supplemented with some other liquid or food by the age of 2 months. By 8 months essentially all breast-fed infants were receiving other liquids and foods.

We note several points related to the measurement of breast-feeding in this study. First, mothers may move in and out of exclusive breast-feeding. They may exclusively breast-feed their infants at one age, add foods at a later age, and then, even later, return to exclusive breast-feeding. For example, 116 urban (5.3%) and 25 rural infants (3.6%) made transitions from more complex feeding patterns at 2 months back to exclusive breast-feeding at 4 months (Bisgrove EZ, Popkin BM, Barba C., 1988. Unpublished manuscript). Most infants received teas, water, and other nonnutritive broths, or some gruels, juices, or other foods or liquids with nutritional value at an early age. However, many infants received these non-breast-milk items only on a sporadic basis, and in those cases the consumption is not likely to have a long-term effect on infant morbidity.

Second, some infants were fed by a wet nurse. At each 2-month interval, 2% to 4% of the infants were nursed at least once in the day preceding the survey by a woman other than their mother. In no case in the data, however, did an infant receive breast milk from a wet nurse without also receiving breast milk four or more times that day from its own mother. The possible effects of wet nursing are not considered in this study. Third, most breast-feeding is initiated in the third to fifth day after birth. Before this, the liquids fed to newborns are boiled, and no effect on neonatal health seems to result from their consumption; thus prelacteal feeding is not considered in the definition of feeding patterns.[9]

Statistical Controls

To understand the precise relationship between feeding and infant morbidity, it is necessary to control for various biologic and behavioral variables that affect susceptibility to illness and exposure to pathogens. We used longitudinal multivariate methods designed for analysis of behaviors in human populations. These methods are appropriate in cases where either it is not possible (for ethical and financial reasons) to conduct experimental studies, or the research must be conducted in natural settings to observe behaviors in a realistic context. These methods allow for the evaluation of a number of important susceptibility and exposure factors considered to be significantly related to diarrhea during the first year of the infant's life. Susceptibility variables capture information about the infant's biologic endowments, including health status at birth (measured by gestational age and birth weight) and subsequent "healthiness" (measured by weight velocity and weight velocity interacted with weight). Sex of the infant is an exogenous variable that may represent susceptibility differences because of genetic endowments of the infant or the effects of different health-related behaviors of the mother when dealing with males vs females.

Exposure variables reflect an infant's chances of coming into contact with pathogens. These include measures of personal hygiene (use of soap), water quality, excreta disposal practices, food hygiene, and the mother's concern with preventive measures (evidenced by use of preventive health care). Diarrhea tends to follow distinct seasonal patterns as a result of varying exposures to the contaminated environment. In this case study, seasonality was represented by a measure of rainfall in the 14 days before each survey because this varies more seasonally than temperature or other variables. Other control variables represent crowding in the community or within the household, either of which may affect the probability of person-to-person contacts, and the resultant transmission of pathogens. The presence of animals (chickens, livestock, pets) in or under the house also represents exposure to additional pathogens that can be transmitted from animals to humans.

Modeling Methods

The model presents the probability that an infant will have diarrhea as the result of feeding practices and of the full set of susceptibility and control variables described above. To understand the precise total effect of breast-feeding on diarrhea, when it is and is not combined with various other foods, a number of relationships must be considered. The analysis of the relationships in this study was based on a coherent behavioral and biomedical model, discussed in detail elsewhere.[10] In general the model disaggregates a set of health-affecting processes into a series of logical relationships, beginning with a set of community and household socioeconomic conditions and progressing through their effects on a set of intermediate behavioral and biologic variables (eg, food processing and birth weight) to health outcomes.

Inasmuch as breast-feeding may not only directly reduce the incidence of diarrhea, but also increase the infant's nutritional status, in turn reducing the severity and incidence of diarrhea,[11-13] these indirect effects must also be considered. Prior growth velocity (grams per day during each measurement period) and growth velocity interacted with prior nutritional status (the interaction term is included because a given growth velocity may have different effects on health according to the child's nutritional status when the growth began) are included in the diarrhea analysis to capture the indirect nutritional effect of breast-feeding on diarrheal morbidity. It is also possible that exclusive breast-feeding could have direct and indirect effects in opposite directions, particularly at older ages when exclusive breast-feeding may be associated with growth faltering.

The procedure we used for estimation of the diarrhea model is a longitudinal probit. This multivariate procedure allowed us to calculate the net effect of each independent variable in the model on the probability of diarrhea can be accounted for. Because it is a longitudinal model, the timing and sequencing of the biologic and behavioral processes affecting each diarrhea can be accounted for. For example, infant feeding is recorded and modeled for a time period just before the observation of the presence or absence of diarrhea. The other biologic and behavioral controls also are modeled with consideration of the likely timing of their effects (Cebu Study Team. 1989. Unpublished manuscript).[10]

The longitudinal probit procedure also accounts for several normally encountered statistical problems, in particular the endogenity of certain behaviors and outcomes (mothers may recognize threats to their infant's health and take measures to reduce them), and the effects of correlation of unobserved factors over time, (Cebu Study Team. 1989. Unpublished manuscript).[14,15]

RESULTS

Results are derived from the model represented in detail in the Appendix. The coefficients are maximum likelihood estimates of the effect of each variable on the probability of having diarrhea. A negative coefficient means that the probability is reduced by that variable, with the T statistic indicating the statistical significance of the effect.

Diarrhea was strongly affected by mode of feeding. For both the urban and rural samples, exclusive breast-feeding (no other liquids or foods given) 7 days before a survey significantly decreased the probability that an infant would have diarrhea during the week from that date to the survey date. Similarly, infants fed breast milk in combination with nonnutritive liquids 7 days before a survey had decreased probability of diarrhea, relative to all except fully breast-fed infants. Infants fed breast-milk in combination with nutritive foods and/or liquids, however, were not found to be significantly less likely to have diarrhea than infants who were not breast-fed. The combined impact of the three breast-feeding variables is statistically significant for the urban and rural samples.

In Figs 1 and 2 we present information on the responsiveness of diarrhea to changes in breast-feeding for the urban and rural samples. The estimated relationships reflect the direct effect of breast-feeding on diarrhea and the indirect effects of breast-feeding on growth and, in turn, of growth on diarrhea. If each infant has all other characteristics controlled so that only the infant-feeding pattern varies, the prevalence of diarrheal morbidity associated with each feeding pattern is presented. In other words, these figures represent the adjusted diarrheal morbidity probabilities.

Exclusively breast-fed infants tended to have a low likelihood of developing diarrhea; the likelihood for infants fed both breast milk and nonnutritive liquids was higher. Diarrheal morbidity was increased even more for infants fed breast milk plus nutritive foods or liquids, and the highest probability of diarrhea was found in infants who were not breast-fed at all. Between one fifth and one third of all infants who were not breast-fed 7 days before a survey can be expected to have diarrhea in the 7 days between that date and the survey day.

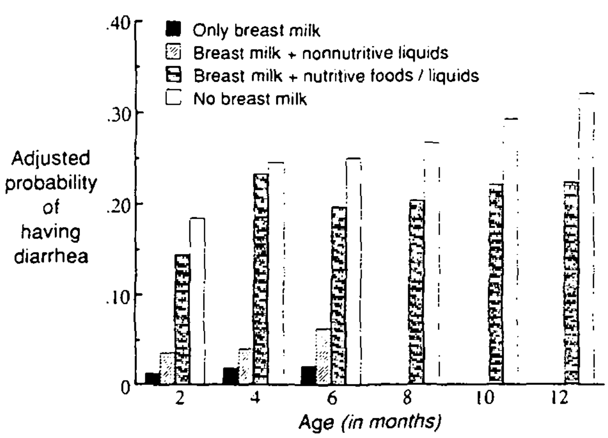

Fig 1. Breast-feeding and diarrheal morbidity, Cebu, Philippines, 1983 to 1985: urban sample.

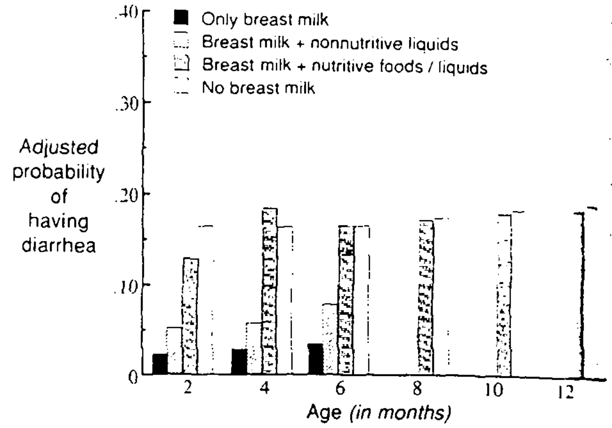

Fig 2. Breast-feeding and diarrheal morbidity, Cebu, Philippines, 1983 to 1985: rural sample.

The relative risks of diarrheal morbidity for infants who were not exclusively breast-fed, presented in comparisons with infants who were exclusively breast-fed, appear in Table 2. From those results, it can be seen that the feeding of nonnutritive liquids had important effects on diarrheal morbidity. Depending on age, the infant was 2.0 to 3.2 times as likely to have diarrhea if nonnutritive liquids were fed in addition to breast milk than if he or she was only fed breast milk. When nutritive foods and/or liquids were added to the breast milk diet, the infant became 4.7 to 13.1 times as likely to have diarrheal morbidity. At given times during the first 6 months, the infant who was not breast-fed was from 4.7 to 16.8 times as likely to have diarrhea as was the exclusively breast-fed infant.

By 8 months of age, when all breast-feeding infants in the sample were fed a mixed diet of breast milk and other nutritive foods and liquids, the relative benefits of breast-feeding fell considerably. Only in urban areas was the probability of diarrhea for breast-fed infants at this age lower than it was for infants who were not breast-fed and, even there, the difference was small. The results indicate a clear inverse relationship between age and the protective effects of breast-feeding on diarrheal morbidity.

DISCUSSION

The Cebu, Philippines, case study reaffirms the general finding of a large body of research that breast-feeding protects against diarrheal morbidity.[1,4] In particular, the results indicate that adding either nonnutritive liquids or nutritive foods or

TABLE 2. Adjusted Relative Risk and 95% Confidence Interval of Diarrheal Morbidity by Child's Age and Infant-Feeding Patterns, Metropolitan Cebu, Philippines, 1983–1985*

Infants by Age and Residence†	Breast Milk Only	Breast Milk + Nonnutritive Liquids			Breast Milk + Nutritive Foods/Solids			No Breast Milk		
		Relative Risk	95% CI		Relative Risk	95% CI		Relative Risk	95% CI	
			Lower Limit	Upper Limit		Lower Limit	Upper Limit		Lower Limit	Upper Limit
Age group: 2–6 mo										
Urban sample										
2 mo	1.00	3.17	2.50	3.83	13.30	6.15	20.44	17.32	6.74	27.89
4 mo	1.00	2.12	1.77	2.46	12.93	6.04	19.81	13.72	6.14	21.30
6 mo	1.00	3.18	2.53	3.84	10.61	4.63	16.60	13.45	5.24	21.66
Rural sample										
2 mo	1.00	2.24	2.01	2.47	5.67	4.31	7.03	5.68	4.31	7.05
4 mo	1.00	1.97	1.80	2.13	6.30	4.93	7.66	5.64	4.52	6.76
6 mo	1.00	2.21	2.07	2.35	4.73	3.95	5.52	4.73	3.97	5.49
Age group: 8–12 mo										
Urban sample										
8 mo			1.00			1.32	1.22	1.42		
10 mo			1.00			1.32	1.23	1.42		
12 mo			1.00			1.32	1.23	1.42		
Rural sample										
8 mo			1.00			1.02	1.02	1.03		
10 mo			1.00			1.03	1.02	1.03		
12 mo			1.00			1.04	1.03	1.04		

* The relative risk reported here is the mean of individual-level risks, each of which is the ratio of individual probabilities. The individual-level probabilities are estimated as in Figs. 1 and 2. The standard deviation of the individual relative risk is multiplied by 1.96 and the product is added and subtracted to the mean relative risk to obtain the 95% confidence interval (CI).

† The relative risk is the ratio of the risk of diarrheal morbidity or respiratory infection for infants in each age-feeding category compared with exclusively breast-fed infants for 2 to 6 months and for those breast-fed plus fed nutritive foods and liquids for ages 8 to 12 months. Risks are adjusted for a set of exposure and susceptibility factors mentioned in the text.

liquids to the breast-milk diet is associated with a large increase in the occurrence of diarrhea and that the protective effect of breast-feeding decreases with age. It is important to note that if the classification procedure used in this study causes infants to be placed into a breast-feeding category to which they do not continuously belong, that category is likely to be either the only-breast-milk or breast-milk-plus-nonnutritive-liquids category, because both represent feeding patterns that for short lengths of time occur periodically, probably because of such factors as illness or shortage of foods. If the assertion is correct, we are creating a conservative test of the hypotheses about the positive health effects of breast-feeding. Benefits of breast-feeding would be underestimated because some infants who are classified as being exclusively breast-fed actually periodically receive other liquids or foods, and some infants classified as breast-fed with the addition of only nonnutritive liquids actually periodically receive nutritive liquids or foods.

A major conclusion based on the case study is of the benefit, during the first 6 months of life, of exclusive breast-feeding relative to being fed breast milk and nonnutritive liquids such as water, teas, and herbal broths. Consumpion of these nonnutritive liquids seems to have a large adverse effect on diarrheal morbidity. The results also suggest that earlier research that misclassified infants fed nonnutritive liquids as being exclusively breast-fed probably reported a smaller protective effect of exclusive breast-feeding than actually existed in the samples analysed. The relationship found in the Cebu study is statistically strong and large in magnitude, and it holds true when a wide range of exposure and susceptibility factors are controlled in the analysis. Eliminating nonnutritive liquids from the infant's diet should pose no health risks under most climatic conditions because infants can maintain adequate hydration status while exclusively breast-feeding even in warm climates[16] and could be expected to substantially reduce diarrhea in this age group.

This study also indicates that supplementation of breast-feeding with nutritive foods or liquids further increases the risk of diarrhea above that which results when only nonnutritive liquids are added to the breast-milk diet. As a consequence, it can be inferred that it is important to promote exclusive breast-feeding up to the age at which the breast-fed infant requires complementary foods to promote adequate growth and development. The dilemma created because the weanling is protected from diarrhea by delaying supplementation, but needs relatively early supplementation for adequate growth, leads to a certain ambiguity in this age-of-supplementation recommendation. The need for supplemental foods almost certainly occurs before 5 to 6 months of age but could come as early as 3 to 4 months.

The benefits of receiving breast milk alone or in combination with other foods or nutritive liquids become significantly smaller during the second half of infancy. At these later ages when the infant's immunologic system is more mature, the quantitative effect of passive immune factors is diminished, and essentially all infants are exposed to pathogens in the diet, so the benefits of breast-feeding as a protection against diarrhea become relatively small.

Because of the extensive controls for other environmental and seasonal exposure and susceptibility variables used in this empirical study, the results can be taken to indicate that exclusive breast-feeding will be associated with reduced diarrheal morbidity in a wide range of environments. The study has used more precise categorizations of infant feeding than past work related to diarrhea, has considered carefully the sequencing of feeding and diarrheal morbidity, and has controlled for a complete set of confounding variables. That the estimated impacts of breast-feeding in diarrhea reduction are so robust, given the statistical care taken, is strong evidence of the positive value of breast-feeding on infant health.

The case study has found differences in the protective effects of breast-feeding in urban and rural environments. Infants in urban areas appear to receive a slightly greater benefit from exclusive breast-feeding. This may reflect a greater probability of exposure to diarrheal pathogens in the urban environment, perhaps through some pathway left unmeasured in this study. Urban infants in the Philippine sample are exposed to a more crowded environment with poorer excreta disposal practices. Water quality, which generally is better in rural areas, seems to have a smaller effect on diarrhea (Cebu Study Team. 1989. Unpublished manuscript)[10] than excreta disposal practices. In general, studies based in low-income countries where the infant is exposed to high levels of pathogens have estimated a greater benefit from breast-feeding than have studies from less contaminated environments.

It has been estimated elsewhere that the effective global promotion of breast-feeding could reduce diarrheal morbidity rates 8% to 20% for infants up to the age of 6 months.[1] Using 1982 estimates of global diarrheal morbidity rates of 2.3 episodes per year for this age group, and an estimated 1988 global population size of 70.7 million infants, these authors estimated that 6.5 to 16.3 million episodes of diarrheal illness per year could be averted worldwide. Although these calculations are only crude estimates, they show the magnitude of what might be achieved through even modestly positive results from the promotion of breast-feeding. While breast-feeding promotion, particularly the encouragement of exclusive breast-feeding, will reduce only a portion of the world's episodes of diarrhea, it will almost certainly reduce the risk of diarrhea during the age at which infant growth is most rapid and in which weanling diarrhea is believed to pose the greatest threat to survival.

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ENDIX

[...]dinal Analysis: Structural Equation for Diarrhea Incidence in Week Preceding Survey by Urban-Rural [...]nce in Metropolitan Cebu, 1983–1985*

Explanatory Variables	Urban		Rural	
	Coefficient	T Statistics	Coefficient	T Statistics
[...]ous				
Susceptibility				
Lagged weight velocity (g)	-7.57×10^{-3}	−1.19	-7.33×10^{-3}	−0.64
Lagged weight velocity interacted with weight (g × g/d)	2.65×10^{-6}	2.18‡	2.08×10^{-6}	0.91
Gestational age (wk)	0.12	2.98§	−0.03	−0.64
Gestational age interacted with age (wk × d)	9.32×10^{-6}	1.62	-6.30×10^{-7}	−0.06
Susceptibility/exposure				
Feeding practices				
Exclusive breast-feeding (prob)	1.39	−4.87§	−0.87	−2.49‡
Breast-feeding with nonnutritive liquids (prob)	−0.91	−3.20§	−0.50	−1.32
Breast-feeding with nutritive foods and liquids (prob)	−0.17	−1.13	-8.88×10^{-4}	−0.01
Total calories (cal)	-3.35×10^{-4}	−1.40	3.42×10^{-4}	0.79
Health service use: preventive health care	−0.23	−1.25	0.44	1.65†
Exposure				
Personal and environmental health practice				
Good quality water source (prob)	−0.30	−3.20§	−0.23	−1.31
Soap purchases/capita/week (g)	-4.43×10^{-5}	−0.07	-1.27×10^{-3}	−0.95
Pathogenic food processing (prob)	0.82	1.69†	0.20	0.43
Exposure				
Personal and environmental health practice				
Poor excreta disposal (prob)	0.80	4.85§	0.45	2.08‡
Poor excreta disposal interacted with age (prob × d)	-1.24×10^{-3}	−1.94†	-1.58×10^{-3}	−1.93†
Exogenous				
Susceptibility				
Child's age (d)	1.28×10^{-3}	2.25‡	2.05×10^{-3}	1.96‡
Child's sex (0–1)	−0.04	−0.49	−0.11	−0.78
Child's sex interacted with age (0–1 × d)	6.26×10^{-4}	2.31‡	5.23×10^{-4}	1.01
Exposure				
Animals in house (0–1)	-3.95×10^{-3}	−0.09	0.06	0.72
Animals under house (0–1)	−0.01	−0.44	−0.02	−0.22
Baby crawling interacted with animals in house (0–1)	0.04	0.77	0.02	0.22
Crowding				
No. of preschoolers (0–6)	−0.04	−2.31‡	0.02	0.79
No. of people/room (0–9.5)	0.01	1.10	1.42×10^{-3}	0.08
Community density (people/km^2)	6.20×10^{-6}	6.80§	4.62×10^{-6}	2.86§
Cumulative rainfall in last 2 wk before survey (in)	7.13×10^{-5}	0.16	1.83×10^{-3}	2.73§
Cumulative rainfall interacted with age (in × d)	1.45×10^{-6}	0.81	-3.25×10^{-6}	−1.26
Others				
Constant	−6.01	−3.67§	−0.55	−0.30
ρ	0.11	6.86§	0.15	4.42§
Log likelihood ratio	−5294.7	−1609.9		

*The units for the explanatory variables are in parentheses. Prob is the predicted probability of the explanatory varia[...]e. The significance levels for testing whether the coefficient is zero is indicated by † for 10%, ‡ for 5%, and § for [...]

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FAMILY (PRIMARY CARE?) DOCTORS LOSE FAVOR - WHEN IT PAYS

The popular labor-relations image at a time of exploding medical expenses is that of employers trying to shift costs to workers, who in turn fight to keep as many benefits as possible. But a new study by National Research Corp., a health-care research firm in Lincoln, Neb., suggests that many employees may be more flexible than previously thought.

In a nationwide survey of 1,000 adults, National Research found 41% would be willing to choose a doctor from a list approved by their employer in exchange for a lower insurance premium. That's up from 28% just two years ago. In response to a similar question, 32% said they would be willing to select a physician from a list supplied by a hospital if they could save 10% on the cost of an office visit.

"Health costs are starting to hit people's pocketbooks," says. . .a senior vice president at National Research. "Their premiums and deductibles are going up." While many patients still take a money-is-no-object attitude toward specialists or surgeons, she says, they are growing more receptive to saving money at the general-practitioner level.

In effect, . . ."they're telling their family doctors, 'You're good, but you're not that good.'"

Ruffenach G. Family doctors lose favor - when it pays. *The Wall Street Journal.* January 2, 1990. Health Costs.