



## Effect of Not Breastfeeding on the Risk of Diarrheal and Respiratory Mortality in Children under 2 Years of Age in Metro Cebu, The Philippines

Paula W. Yoon,<sup>1</sup> Robert E. Black,<sup>1</sup> Lawrence H. Moulton,<sup>2</sup> and Stan Becker<sup>3</sup>

The effects of not breastfeeding on mortality due to diarrhea and acute lower respiratory infection (ALRI) in children under 2 years of age were examined using data from a 1988–1991 longitudinal study of 9,942 children in Metro Cebu, The Philippines. Cox regression methods were used to study the magnitude of the risks, possible interactions with birth weight and nutritional status, and the effect of additional confounding factors. Not breastfeeding had a greater effect on diarrheal mortality than on ALRI mortality. In the first 6 months of life, failing to initiate breastfeeding or ceasing to breastfeed resulted in an 8- to 10-fold increase in the rate of diarrheal mortality. The rate of mortality associated with both ALRI and diarrhea was increased nearly six times by not breastfeeding, but the rate of ALRI mortality alone was not increased. The data also suggested that the risk of mortality associated with not breastfeeding was greater for low birth weight infants and infants whose mothers had little formal education. After age 6 months, the protective effects of breastfeeding dropped dramatically. These findings underscore the importance of promoting breastfeeding, especially during the first 6 months of life, and of targeting high risk groups such as low birth weight babies and those of low socioeconomic status. *Am J Epidemiol* 1996;143:1142–8.

birth weight; breast feeding; diarrhea; malnutrition; mortality; nutritional status; respiratory tract infections

Breastfeeding improves child survival, reduces infectious disease morbidity, and improves infant growth and development (1–4). Less is known, however, about the protective effect of breastfeeding against specific major causes of mortality, such as diarrhea and acute lower respiratory infection (ALRI). The evidence for a protective effect of breastfeeding against diarrheal mortality is stronger than that available for ALRI. A 1984 review of nine studies found that when infants receiving no breast milk were compared with those exclusively breastfeeding, the median relative risk of death from diarrhea during the first 6 months of life was 25 (3). More recently, a case-control study conducted in Brazil by Victora et al. (5) found that infants who had been completely weaned had 14.2 times the risk of death from diarrhea as exclusively breastfed infants, while infants who were

partially weaned had a relative risk of 4.2 (5). In the same study, the protective effect of breastfeeding on ALRI mortality was much lower. Infants who were completely weaned had 3.6 times the risk of ALRI mortality as exclusively breastfed infants, and infants who were partially weaned had a relative risk of 1.6. A 1992 World Health Organization review of breastfeeding and ALRI estimated the risk of ALRI episodes or death from nine studies, and found that the risk for nonbreastfed infants was 2.5 times higher than that for infants who received breast milk (C. G. Victora, Acute Respiratory Infections Programme, World Health Organization, unpublished manuscript).

Breastfeeding is influenced by a number of factors, including maternal choice and the status of the infant at birth. Some of these factors, such as birth weight, can subsequently affect nutritional status, which in turn has an impact on mortality (6). Many prior studies of breastfeeding have not controlled for possible confounding factors, which can include age, socioeconomic factors, and child care (3). Other common methodological problems include possible reverse causality bias, where breastfeeding may be interrupted because of illness, and self-selection bias, where the mother chooses to not breastfeed or to wean the child because of illness, low birth weight, or poor growth.

These issues have been addressed in the current study, which examined the effects of low birth weight,

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Abbreviation: ALRI, acute lower respiratory infection.

<sup>1</sup> Department of International Health, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, MD.

<sup>2</sup> Departments of International Health and Biostatistics, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, MD.

<sup>3</sup> Department of Population Dynamics, School of Hygiene and Public Health, The Johns Hopkins University, Baltimore, MD.

Reprint requests to Dr. Robert Black, Department of International Health, The Johns Hopkins School of Hygiene and Public Health, 615 North Wolfe Street, Baltimore, MD 21205.

not breastfeeding, and protein calorie malnutrition on diarrheal and ALRI mortality. The main objectives of the study were 1) to measure the strength of the associations between the risk factors and mortality, 2) to investigate the interactive relations among the three risk factors, and 3) to explore additional socio-economic variables that might modify the risk of the primary independent variables of interest. The strengths of this study derive from the use of a large prospective data set with carefully enumerated deaths, where cause of death was determined using a validated verbal autopsy instrument. Additionally, the factors of primary interest—breastfeeding status and nutritional status—were characterized longitudinally, and the use of Cox regression for the survival analysis accommodated the censored nature of the data as well as these time-dependent explanatory variables.

## MATERIALS AND METHODS

### Study design

A longitudinal study of child survival was carried out between July 1988 and January 1991 in Metro Cebu, The Philippines, to assess levels of morbidity and mortality among infants and children under 2 years of age in both rural and urban areas. About 1.25 million people live in Metro Cebu, which is divided into 253 barangays (administrative units). A stratified random sample of seven urban and 26 rural barangays was selected which provided an equal proportion of mothers from rural and urban areas. A household census was conducted to identify children under 2 years of age, followed by a baseline survey to collect socioeconomic, health, and environmental data. Periodic surveys were repeated at 6-month intervals to monitor morbidity, nutritional status, and health-related activities of the children. New births and in-migrants to the study area were added during the periodic surveys. Mortality surveillance was carried out by key informants who were traditional midwives or health workers living in the sample barangays. When a death was identified among the children, a postmortem interview was conducted with the mother or caretaker using a validated verbal autopsy instrument to determine the cause of death and treatment history (7). Additional details on the study design and baseline characteristics of the population are given elsewhere (8).

### Variables

The analysis presented here was based on data from the 9,942 children who were born during the prospective study period (July 1, 1988–January 15, 1991). All of these children entered the study at birth and were

followed until they reached 24 months of age, were lost to follow-up, or died, or until the study ended. Deaths among the children were due to a number of causes, but the current analysis was limited to diarrhea, ALRI, and diarrhea and ALRI combined. Additionally, because deaths of newborn infants are largely attributable to congenital causes and conditions of delivery, only deaths that occurred on or after the fourth day of life were included in this analysis. The causes of death, as defined by the illness episode which led to the death, were: 1) diarrhea alone—three or more loose stools on the worst day of illness and no evidence of ALRI; 2) ALRI alone—cough and fever, difficulty breathing for 2 or more days, and no evidence of diarrhea; and 3) combined ALRI and diarrhea—three or more loose stools on the worst day of illness, cough and fever, and difficulty breathing for 2 or more days.

Birth weight data were obtained by maternal recall. Mothers were asked the actual weight of the infant in grams and whether the infant was smaller than average, average, or larger than average at birth. Actual weights were obtained for 65.5 percent of the infants, and mother's description of birth size was available for 98.6 percent of the infants. For the analysis, available weights were converted to weight-for-age *Z* scores based on the National Center for Health Statistics reference population (9). Birth weights less than or equal to 2,500 g were considered low, and birth weights over 2,500 g were considered normal. When no weight information was available, the following criterion was used: infants described as smaller than average were given a *Z* score of  $-2.52$ , which was the mean *Z* score for all available birth weights less than or equal to 2,500 g; infants described as average or larger than average were given a *Z* score of  $-0.09$ , which was the mean *Z* score for all available weights over 2,500 g. To validate the methodology used here to assign birth weight-for-age *Z* scores, the mothers' descriptions of birth size were examined for the 6,511 infants with actual birth weights. The weight-for-age *Z* score of the infants described as smaller than average was  $-2.62$ . The relatively small difference between  $-2.52$  and  $-2.62$  supports the notion that the mothers' descriptions of birth size may have been reasonably accurate for the purpose of these analyses.

Breastfeeding status was determined by asking the mother whether the infant had been breastfed at birth. If the infant had been breastfed but had already stopped, the mother was asked to report the child's age to the nearest month when breastfeeding stopped. For infants who continued breastfeeding, breastfeeding status was determined at each survey round. For children who died, mothers were asked whether the child

had been breastfeeding immediately prior to the illness that led to death. In the analyses, three measures of breastfeeding were studied: 1) total number of months breastfed, 2) breastfeeding status immediately prior to the illness that led to the death or prior to the interview, and 3) breastfeeding status during the 2 months before death or the interview.

Nutritional status was determined at each survey round. Body weight was measured to the nearest 100 g on 25-kg Salter scales, and length was measured to the nearest 0.10 cm on length boards. From these measurements, three anthropometric indices were created—height-for-age, weight-for-age, and weight-for-height—and expressed as Z scores (10).

### Statistical analysis

Descriptive analyses were carried out for the three main risk factors—low birth weight, not breastfeeding, and malnutrition—and some of the socioeconomic and environmental data collected during the survey rounds. Separate Cox proportional hazards regression models were constructed to analyze the effects of the risk factors on mortality due to diarrhea, ALRI, and combined ALRI and diarrhea. Since one of the aims of this study was to see whether the magnitude of the risks changed during the first 2 years of life, the models were analyzed for three age groups: 0–5 months, 6–11 months, and 12–23 months. This was done by defining three survival time variables for each child which expressed his/her duration of observation in each of the age groups.

The covariates used in the models were: 1) birth weight-for-age Z score, 2) duration of breastfeeding in months, 3) breastfeeding immediately prior to the illness that led to death or prior to the interview (yes/no), 4) breastfeeding (yes/no) during the 2 months prior to death or interview, and 5) weight-for-age Z score. Birth weight was examined in two ways, first as an independent risk factor and second as the initial measurement in the nutritional status risk factor (as measured by weight-for-age). The weight-for-age Z score used in the analysis was the most recent determination for each child, which was not differentially distributed in time between those who died and those who did not die. Weights of living children at ages later than the reference death were not used. Breastfeeding was quantified in three ways, but only one expression of breastfeeding was included in each regression model. For each child, the month of cessation of breastfeeding was determined and was fixed so that children were not recorded as subsequently resuming breastfeeding. The “not breastfed” and “not breastfed in the prior 2 months” covariates in the Cox models were coded as time-dependent using the flexible facility implemented

in SPSS 6.0 for Windows. For example, for the “not breastfed in the prior 2 months” variable, if a child was initially breastfed the binary variable was 0; at each event (age at a death), this variable was recalculated by checking to see whether the age of the child was more than 2 months greater than the determined age at cessation of breastfeeding; if it was, the variable was coded 1 at that instant.

Potentially confounding variables that were shown to be associated with both mortality and the main risk factors were also included in the models. These additional variables were mother’s education in years, type of toilet facility, and length of previous birth interval. Lastly, the effect of a number of interaction terms was evaluated, and the models of breastfeeding were stratified by birth weight (low birth weight vs. normal birth weight) and by maternal education ( $\leq 6$  years vs.  $> 6$  years). Partial likelihood ratio tests were used as tests of hypotheses that the model coefficients were 0. Children that migrated out of the study area or were lost to follow-up were included in the analysis until lost.

### RESULTS

Of the 9,942 children included in the study, 63.4 percent were still being followed at the end of the study period; 4.3 percent had died, 21 percent had reached 24 months of age and were no longer being followed, 9.9 percent had migrated out of the study area, and 1.5 percent had been lost to follow-up for unknown reasons. Of the 425 children who had died, 140 were less than 4 days old at death, 145 were reported to have died from diarrhea and/or ALRI, and 140 were reported to have died from other causes. The actual numbers of diarrhea and ALRI deaths in the three age groups are shown in table 1.

#### Breastfeeding prevalence

Ninety percent of the children were breastfed immediately after birth. Women who never breastfed (including mothers whose infants died before the age of 4 days) differed from the women who did breastfeed in terms of average age (27.5 years vs. 26.2 years,  $p < 0.001$ ), mean number of years of education (9.1

TABLE 1. Numbers of deaths due to diarrhea and acute lower respiratory infection (ALRI) among children under 2 years of age, Cebu Longitudinal Study, 1988–1991

Age group (months)	Cause of death		
	Diarrhea	ALRI	Both diarrhea and ALRI
0–5.9	24	18	14
6–11.9	27	14	19
12–23.9	11	7	11

vs. 7.9,  $p < 0.001$ ), and working outside the home (40 percent vs. 23 percent,  $p < 0.001$ ); 10.5 percent of urban mothers did not breastfeed compared with 9.0 percent of rural mothers ( $p < 0.02$ ). Mothers who did not breastfeed received the same amount of prenatal care as all other mothers and delivered their babies at home and in hospitals in the same proportions. A very striking difference was found regarding the previous birth interval. Children who were born 18 months or less after a sibling were much less likely to be breastfed. Only 84 percent of these children were breastfed, and the median duration was about 5 months. Of the infants who were never breastfed, 25 percent were born  $\leq 18$  months after a sibling, whereas only 14 percent of breastfed babies had a previous birth interval of  $\leq 18$  months ( $p < 0.001$ ).

Overall, the median duration of breastfeeding was 9 months, with rural women breastfeeding for about 10 months and urban women for 7 months. Women of higher socioeconomic status breastfed for a shorter duration. In households with four or more people per room, women breastfed for a median of 11 months, whereas in households with less than two people per room, women breastfed for a median of only 6 months. The greatest differentials were found for women's educational level (figure 1). Women with no formal education breastfed for a median of almost 12 months, whereas women with some college education breastfed for a median of only 3 months. Women who delivered at home breastfed for a median duration of almost 11 months, more than three times longer than women who delivered at a private facility.

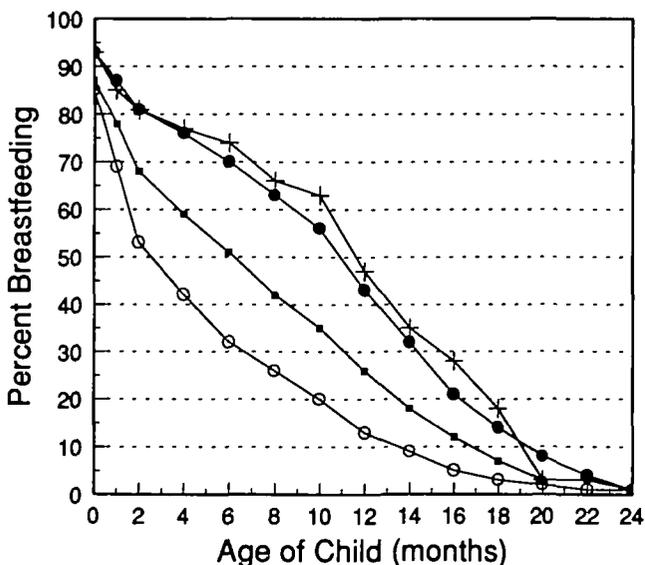


FIGURE 1. Percentage of mothers breastfeeding, by mother's education and age of the child, Cebu Longitudinal Study, 1988-1991. Levels of maternal education are as follows: +, none; ●, primary school; ■, secondary school; ○, college.

## Relations among the risk factors

A smaller percentage of low birth weight infants were initially breastfed in comparison with normal birth weight infants (87 percent vs. 91 percent,  $p < 0.001$ ). The median duration of breastfeeding was slightly less than 8 months for low birth weight infants and nearly 9 months for normal birth weight infants.

There were statistically significant differences ( $p < 0.05$ ) between breastfed and nonbreastfed babies with regard to mean Z scores for all three anthropometric indices through the first 6 months of life (table 2). Breastfed babies had a higher nutritional status according to all three measures. After 6 months of age, however, the pattern changed. Beginning in the 6- to 8-month age group, the children who were initially breastfed had lower mean Z scores than the nonbreastfed children for all three anthropometric indices. In fact, between 9 months and 15 months, the breastfed children had significantly lower Z scores on all but one index—the mean height-for-age Z score between 9 and 12 months, where the significance level was  $p = 0.14$ .

## Breastfeeding and mortality

Of the children who died, 42 percent were never breastfed, but when deaths occurring at  $< 4$  days were excluded, 19 percent of these children were never breastfed (versus 10 percent of all children). The proportion of children who were never breastfed, by cause of death, was 18 percent for diarrhea, 10 percent for ALRI, and 19 percent for ALRI and diarrhea combined.

Based on the results of the proportional hazards modeling, there was a strong association between not breastfeeding and diarrheal mortality (table 3). Of the three age groups studied—0-5 months, 6-11 months, and 12-23 months—the risk of diarrheal mortality associated with not breastfeeding was greatest in the 0- to 5-month age group. The estimated crude rate of dying from diarrhea in the first 6 months of life was 1.6 times greater for each month the child was not breastfed. Children who were not breastfeeding during the first 6 months, compared with those who were breastfeeding, were 7.7 times more likely to die of diarrhea. In addition, compared with children who were still breastfeeding or had stopped less than 2 months before, children who had never breastfed or had stopped more than 2 months prior to the point of comparison were 7.5 times more likely to die of diarrhea. When adjusted for nutritional status, mother's education, socioeconomic status (as measured by household toilet facilities), and previous birth interval, the estimated rate ratio for diarrheal mortality associated with not breastfeeding in the first 6 months was

**TABLE 2. Mean Z scores for height-for-age, weight-for-age, and weight-for-height according to anthropometric measurements, by age group and breastfeeding status at birth, Cebu Longitudinal Study, 1988–1991**

Age (months)	Ever breastfed	Height-for-age Z score			Weight-for-age Z score			Weight-for-height Z score		
		No	Mean	<i>t</i> test*	No	Mean	<i>t</i> test*	No.	Mean	<i>t</i> test*
0–2	No	375	-0.99	<i>t</i> = 2.5	377	-0.62	<i>t</i> = 8.3	334	0.15	<i>t</i> = 7.2
	Yes	4,242	-0.85	<i>p</i> = 0.013	4,247	-0.21	<i>p</i> = 0.000	3,867	0.56	<i>p</i> = 0.000
3–5	No	340	-1.14	<i>t</i> = 2.7	340	-0.63	<i>t</i> = 6.2	338	0.31	<i>t</i> = 4.5
	Yes	3,837	-0.98	<i>p</i> = 0.007	3,846	-0.31	<i>p</i> = 0.000	3,836	0.57	<i>p</i> = 0.000
6–8	No	371	-1.05	<i>t</i> = -0.4	373	-0.91	<i>t</i> = -1.4	371	-0.11	<i>t</i> = -1.3
	Yes	3,559	-1.07	<i>p</i> = NS†	3,570	-0.98	<i>p</i> = NS	2,760	-0.17	<i>p</i> = NS
9–11	No	276	-1.14	<i>t</i> = -1.5	279	-1.32	<i>t</i> = -3.3	276	-0.55	<i>t</i> = -2.9
	Yes	2,760	-1.24	<i>p</i> = NS	2,772	-1.52	<i>p</i> = 0.001	2,760	-0.72	<i>p</i> = 0.004
12–14	No	241	-1.17	<i>t</i> = -2.9	242	-1.30	<i>t</i> = -6.2	241	-0.62	<i>t</i> = -6.2
	Yes	2,341	-1.40	<i>p</i> = 0.004	2,349	-1.71	<i>p</i> = 0.000	2,341	-0.99	<i>p</i> = 0.000

\* Two-sample independent-groups *t* test comparing the mean values by breastfeeding group. The *p* value represents two-tailed significance.

† NS, not significant.

9.7. After 6 months of age, the protective effects of breastfeeding dropped dramatically. In the age groups 6–11 months and 12–23 months, the rate ratios were less than 1.5 and were not statistically significant.

Not breastfeeding was not a statistically significant risk factor for ALRI mortality in any age group, although the crude rate ratio was greatest for 6- to 11-month-old infants (rate ratio = 2.2). After adjustment for nutritional status, mother's education, house-

hold toilet facilities, and previous birth interval, the estimated rate ratio for ALRI mortality for ages 6–11 months was 2.6. The effect of not breastfeeding on ALRI mortality in the 0- to 5-month age group had the opposite effect of what might be expected: An increased duration of breastfeeding increased the mortality rate and not breastfeeding decreased it, although these values had wide confidence intervals that included 1.0.

**TABLE 3. Crude and adjusted rate ratio estimates for breastfeeding covariates from Cox regression models, Cebu Longitudinal Study, 1988–1991**

Dependent variables and covariates	Age group					
	0–5 months		6–11 months		12–23 months	
	RR*	95% CI*	RR	95% CI	RR	95% CI
<b>Diarrhea mortality</b>						
Duration of breastfeeding†	1.6	1.2–2.0	1.1	1.0–1.2	1.0	0.91–1.1
Not breastfed‡	7.7	3.1–19.1	1.3	0.60–2.8	1.0	0.22–3.7
Not breastfed in the prior 2 months§	7.5	2.5–22.5	1.4	0.64–3.0	1.4	0.37–5.5
Not breastfed—adjusted	9.7	4.0–25.0	1.4	0.62–3.2	1.4	0.37–5.6
<b>ALRI* mortality</b>						
Duration of breastfeeding	0.6	0.26–1.4	1.1	1.0–1.3	1.0	0.83–1.1
Not breastfed	0.4	0.10–1.9	2.2	0.75–1.0	0.8	0.15–4.6
Not breastfed in the prior 2 months	0.5	0.06–3.8	2.7	0.94–7.8	1.3	0.24–7.2
Not breastfed—adjusted	0.4	0.09–1.9	2.6	0.84–7.8	1.0	0.18–5.8
<b>ALRI and diarrhea mortality</b>						
Duration of breastfeeding	1.5	1.1–2.1	1.1	0.91–1.2	1.0	0.91–1.1
Not breastfed	4.5	1.4–13.7	0.9	0.39–2.3	2.4	0.50–11.5
Not breastfed in the prior 2 months	10.3	2.7–39.9	1.2	0.48–2.9	2.1	0.53–8.2
Not breastfed—adjusted	5.7	1.8–18.4	0.9	0.35–2.3	7.2	0.87–59.5

\* RR, rate ratio; CI, confidence interval, ALRI, acute lower respiratory infection.

† Completed months of breastfeeding; expressed as the rate ratio for mortality for each month not breastfed.

‡ Breastfeeding status (yes/no) immediately prior to the illness which led to death, or at interview.

§ Breastfeeding status (yes/no) in the 2 months prior to death or interview.

|| Adjusted for nutritional status (includes birth weight-for-age as first measure), mother's education, socioeconomic status (toilet facilities), and previous birth interval.

The effect of breastfeeding on mortality from combined ALRI and diarrhea was similar to that for diarrhea alone. In the 0- to 5-month age group, the crude rate of combined ALRI and diarrheal mortality increased by 1.5 times for every month the child was not breastfed. Compared with children who were still breastfeeding or had stopped within the previous 2 months, children who had never breastfed or had stopped more than 2 months prior to the point of comparison were 10.3 times more likely to die of combined ALRI and diarrhea. When adjusted for nutritional status, mother's education, household toilet facilities, and previous birth interval, the estimated rate ratio for mortality associated with not breastfeeding in the first 6 months of life was 5.7.

### Interactions

None of the interaction terms tested in the Cox regression models were statistically significant, and therefore they were not included in the final models. When the breastfeeding models were stratified by birth weight, the rate ratios for mortality in the first 6 months of life were higher for low birth weight infants than for normal birth weight infants for both diarrhea (4.8 vs. 3.0) and combined ALRI and diarrhea (4.8 vs. 2.5), but the differences were not significant. When the models were stratified by maternal education ( $\leq 6$  years vs.  $>6$  years), the relative rate of diarrheal mortality associated with not breastfeeding was nearly five times greater for children of less educated mothers (6.9 vs. 1.5,  $p = 0.046$ ), and the relative rate of combined ALRI and diarrheal mortality was also nearly five times greater (5.6 vs. 1.2,  $p = 0.17$ ). The relative rate for ALRI mortality showed little evidence of an interaction; children of less educated mothers had a rate ratio of 1.1, while children of better educated mothers had a rate ratio of 1.3.

### DISCUSSION

This study supports a growing body of evidence that not breastfeeding is a major risk factor for mortality in infants. To our knowledge, it is also one of the first longitudinal studies to have examined the association between breastfeeding and deaths due to diarrhea and ALRI. Like Victora et al. (5) in Brazil, we found that not breastfeeding had a greater effect on diarrheal death than on death due to ALRI. In our study, failing to initiate breastfeeding or ceasing to breastfeed during the first 6 months of life was associated with an 8- to 10-fold increase in the rate of diarrheal mortality. The relative rate of death due to combined ALRI and diarrhea also increased by a factor of about five in this age group, while the relative rate of death due to ALRI

alone did not increase. In the 6- to 11-month age group, not breastfeeding did not significantly increase the rate of diarrheal mortality as might be expected. One possible explanation for this is that most breastfed children were given increasing amounts of weaning foods after 6 months of age, and weaning has been shown to put children at increased risk of infection (11). In addition, the maternal antibody protection associated with breastfeeding begins to decrease at approximately 6 months of age.

We also found that in the early months, breastfeeding may interact with mother's education and, to a lesser extent, birth weight to affect mortality. Our results suggest that the risk of mortality associated with not breastfeeding is greater for low birth weight infants compared with normal weight infants and for infants whose mothers have little formal education compared with infants with better-educated mothers. In other analyses of the Cebu data (12), it was shown that higher maternal education is correlated with greater utilization of preventative and curative health services. These findings suggest the need for child survival interventions that target high risk groups.

Several strengths of this study deserve mention: the large sample size; the quality of the data, which were meticulously collected with few missing or inconsistent values; the use of a validated verbal autopsy instrument to determine cause of death; and the use of proportional hazards modeling to study the time-dependent variables—breastfeeding status and nutritional status. We also tried to account for possible confounding factors. We examined a large number of socioeconomic, environmental, biologic, and health care variables and found several that confounded the relation between breastfeeding status and mortality: age of the child, nutritional status, mother's education, socioeconomic status (as indicated by household toilet facilities), and previous birth interval. We also accounted for potential reverse causality and self-selection biases by examining breastfeeding status immediately prior to the illness that led to death and breastfeeding status in the 2 months prior to the death. In comparison with our study, studies which used breastfeeding status at the time of death without accounting for cessation during illness may have overestimated the risk of mortality. When we considered breastfeeding in the prior 2 months, we found that for all ages and causes of death, the rate ratio estimates were of equal or greater magnitude as the rate ratio estimates for breastfeeding status immediately prior to the illness that led to the death. This seems to indicate that it is not just breastfeeding status during an illness episode which affects the illness outcome but also the

presence or absence of benefits accrued from prior breastfeeding.

Because we did not distinguish between exclusive, partial, or token breastfeeding in this study, the magnitude of the rate ratio for mortality is likely to have been underestimated. Judging from the results of a few studies which did consider degrees of breastfeeding (C. G. Victora, Acute Respiratory Infections Programme, World Health Organization, unpublished manuscript), it is likely that the children in this study who were exclusively breastfed had an even lower risk of mortality than was estimated. However, this is unlikely to have affected the interpretation of our results, because previous studies in Metro Cebu (13) have shown that there is extensive and early use of nonnutritive liquids in this population, resulting in low levels of exclusive breastfeeding. The small number of deaths in some age groups may have resulted in some unstable rate ratios, as evidenced by the width of the confidence intervals. The small numbers may also have affected the study of interactions. The lack of a stronger effect on mortality due to birth weight was also of some concern because of the possible unreliability of maternal recall of birth weights. Some studies do suggest, however, that mothers accurately report birth weights (14). We were able to show that mothers' descriptions of birth size may be a reasonable estimate of low birth weight, which could be a valuable technique for assessment of birth weight in some developing countries.

Findings from this study suggest that the promotion of breastfeeding as an early intervention for reducing mortality may be more effective against diarrheal mortality than against ALRI mortality, particularly in the first 6 months of life. In addition, since poor weaning practices may be undermining some of the benefits of breastfeeding, more efforts should be made to improve weaning practices. Greater attention should also be given to the identification of high risk children, such as those of low birth weight and those with poorly educated mothers, since they appear to be at an even greater risk of mortality.

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#### REFERENCES

- Habicht JP, DaVanzo J, Butz WP. Does breast-feeding really save lives, or are potential benefits due to biases? *Am J Epidemiol* 1986;123:279-90.
- Knodel J. Breast-feeding and population growth. *Science* 1977;198:1111-15.
- Feachem RG, Koblinsky MA. Interventions for the control of diarrhoeal diseases among young children: promotion of breast-feeding. *Bull WHO* 1984;62:271-91.
- Jason JM, Nieburg P, Marks JS. Mortality and infectious disease associated with infant-feeding practices in developing countries. *Pediatrics* 1984;74:702-27.
- Victora CG, Smith PG, Vaughan JP, et al. Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil. *Lancet* 1987;2:319-22.
- Division of Family Health, World Health Organization. The incidence of low birth weight: a critical review of available information. *World Health Stat Q* 1980;33:197-224.
- Kalter HD, Gray RH, Black RE, et al. Validation of postmortem interviews to ascertain selected causes of death in children. *Int J Epidemiol* 1990;19:380-6.
- Becker S, Peters D. Evaluation of key child survival activities in Metro Cebu, The Philippines: results of a baseline survey. Baltimore, MD: The Johns Hopkins University Institute for International Programs, 1991. (IIP Occasional Paper no. 13).
- National Center for Health Statistics. Growth curves for children birth-18 years, United States. Rockville, MD: National Center for Health Statistics, 1977. (Vital and Health Statistics, series 11, no. 165). (DHEW publication no. (PHS)78-1650).
- Dean AG, Dean JA, Burton AH, et al. EpiInfo, version 5. a word processing, database, and statistics program for epidemiology on microcomputers. Stone Mountain, GA. USD, Inc., 1990.
- Black RE, Brown KH, Becker S, et al. Contamination of weaning foods and transmission of enterotoxigenic *Escherichia coli* diarrhoea in children in rural Bangladesh. *Trans R Soc Trop Med Hyg* 1982;76:259-64.
- Becker S, Peters DH, Gray RH, et al. The determinants of use of maternal and child health services in Metro Cebu, the Philippines. *Health Transition Rev* 1993;3:77-89.
- Zohoori N, Popkin BM, Fernandez ME. Breast-feeding patterns in the Philippines: a prospective analysis. *J Biosoc Sci* 1993;25:127-38.
- Seidman DS, Slater PE, Ever-Hadani P, et al. Accuracy of mothers' recall of birthweight and gestational age. *Br J Obstet Gynaecol* 1987;94:731-5.