Nutrition

EVIDENCE FOR PROTECTION BY BREAST-FEEDING AGAINST INFANT DEATHS FROM INFECTIOUS DISEASES IN BRAZIL

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Summary In a population-based case-control study of infant mortality in two urban areas of southern Brazil, the type of milk in an infant's diet was found to be an important risk factor for deaths from diarrhoeal and respiratory infections. Compared with infants who were breast-fed with no milk supplements, and after adjusting for confounding variables, those completely weaned had 14·2 and 3·6 times the risk of death from diarrhoea and respiratory infections, respectively. Part-weaning was associated with corresponding relative risks (RR) of 4·2 and 1·6. The risk of death from infections other than diarrhoea or respiratory infection was less clearly associated with breast-feeding (completely weaned, RR = 2·5; partly weaned, RR = 0·4). Cow's and formula milk seemed to be equally hazardous. For deaths due to diarrhoea the increased risk associated with not breast-feeding was greatest in the first two months of life (RR for completely weaned *vs* breast-fed without supplementary milk = 23·3).

INTRODUCTION

BREAST-MILK has unique anti-infective properties[1,2] and there is considerable evidence of a protective effect of breast-feeding against morbidity due to some infectious diseases and especially that due to diarrhoea.[3,4] Breast-fed infants in developing countries are at lower risk of death than those who are artificially fed[5-7] but little information is available on the protection afforded against specific causes of death.[8] In a 1984 review only nine studies that related feeding mode to diarrhoea-associated mortality were found in English.[4] All but one were from what are now developed countries and had been done before 1947, when modern milk-formulae for infants were not available. The only study from a developing country, in Egypt in 1979–80, did not include proper controls, but included for this purpose infants dying from causes other than diarrhoea.[9] We cannot find any recent studies on the relation between feeding mode and deaths from respiratory and other infections.

We have done a population-based case-control study to investigate the relation between infant-feeding patterns and mortality due to infectious diseases in children under one-year-old in the metropolitan areas of Porto Alegre and Pelotas in southern Brazil. These cities have a combined population of 2·5 million and are in one of the most developed areas of Brazil. The infant mortality rate[10] is about 40 per 1000 and the median duration of breast-feeding is 3·3 months.[11]

POPULATION AND METHODS

Between Dec 24, 1984, and Dec 23, 1985, all hospitals, coroner services, and health authorities and registries in the cities were visited weekly to obtain information on deaths among infants resident in the study areas. We have found with these methods that few deaths are overlooked.[10,12]

When the hospital case-notes, death certificate, or necropsy report included an infectious disease as the underlying or associated cause of death, or when the cause was ill-defined or not stated, a physician visited the infant's home to collect information on feeding habits and to question the parents about the signs and symptoms preceding death to try to ascertain the underlying cause of death. 96·5% of all eligible cases were successfully located. Further information on the possible cause of death was abstracted from medical records with standard questionnaires.[13] Two reviewers went through the available information independently to determine the underlying cause of death. Disagreements were resolved by the study coordinator (C. G. V.). All reviewers were blind to the infant's feeding history. Deaths due to infectious diseases were classified into three groups: diarrhoea (ICD codes 001–009, 9th revision), respiratory infections (ICD 382, 460, 480–487, and 519·8), and other infections. The main diagnoses in the last group were meningitis (12 deaths), skin infections (10), measles (8), whooping cough (7), neonatal sepsis (6), and tuberculosis (5).

Several factors which increase the risk of death also reduce the probability of breast-feeding. To avoid this bias, we excluded all cases and controls who had a low birth weight (under 1500 g), who were not singletons, who had stayed in hospital for more than 15 days immediately after birth, or who had major congenital malformations or cerebral palsy. 14% of potential cases were excluded with these criteria. Also excluded were all cases dying before the eighth day of life, because feeding practices are unlikely to have affected such deaths.

For each case two controls were selected. Those chosen were the first neighbour aged 7 to 364 days, and the next child in the neighbourhood aged between 7 and 182 days. By this approach we expected to obtain a control group with a similar age and socioeconomic distribution to that of the cases. The same efforts aimed at locating all cases were used to interview all eligible controls.

A detailed feeding history was taken from the mother or from the person who looked after the infant. For the cases, special attention was given to recording the feeding mode just before the terminal illness, and to establish whether ill-health had been a possible cause of weaning. Such infants were considered as still breast-fed in the analysis of the study. The feeding information for the controls was also taken for the date when the matched case was last symptom-free.

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TABLE I—DISTRIBUTION OF CASES AND CONTROLS ACCORDING TO TYPE OF MILK CONSUMED

Type of milk	Cause of death			Controls
	Diarrhoea	Respiratory infections	Other infections	
Breast only	17 (10·0%)	21 (16·5%)	20 (33·3%)	281 (39·4%)
Breast + formula	19 (11·2%)	12 (9·4%)	1 (1·7%)	70 (9·8%)
Breast + cow's	14 (8·2%)	11 (8·7%)	4 (6·7%)	70 (9·8%)
Formula only	60 (35·3%)	40 (31·5%)	11 (18·3%)	119 (16·7%)
Cow's only	60 (35·3%)	43 (33·9%)	24 (40·0%)	174 (24·4%)
Total	170	127	60	714

Information was collected on variables which might confound the association between feeding habits and mortality. These included the infant's age and sex, birth order, intervals, and weight, family income, occupation and education of the parents, ethnic group, maternal age, housing, crowding, water and sanitation variables, antenatal care, and type of delivery. These variables were taken into account in the analysis with logistic regression methods for matched studies.[14] Variables whose inclusion in the model produced a significant improvement in fit were: infant's age (0–1, 2–3, 4–5, 6–8, and 9–11 months); birthweight (< 2500, 2500–2999, 3000–3499, and ≥ 3500 g); interval from preceding birth (first born, < 24, 24–35, and ≥ 36 months); social status of the family head (casual workers, regular job, and businessmen and self-employed); maternal schooling (none, 1–3, 4–5, and ≥ 6 years); type of water supply (piped in house, piped in plot, other); type of housing (shack, other), family income (< 0·2, 0·2–0·3, 0·4–0·9, and ≥ 1·0 times the minimum wage per capita). These variables did not have the same confounding effect for the three groups of causes of death and therefore different subsets were used for the different causes (see footnotes to tables II and III).

RESULTS

357 cases and 714 controls were studied. The mean age of both groups was 4·3 months. Their distribution according to the type of milk consumed is shown in table I.

The relative risks associated with different milk diets for the three groups of causes of death are shown in table II. Estimates are given adjusted for age only and also for other confounding variables. In general, the risks associated with diets including cow's milk were similar to those associated with formula milk. The greatest differences in risk were seen for deaths from diarrhoea. Compared with infants who were exclusively breast-fed, those also given formula or cow's milk had 4·2 times (95% confidence interval [CI] 1·7–10·1) the risk of death from diarrhoea, while those not receiving any breast-milk had a risk 14·2 times higher (95% CI 5·9–34·1). These results are from combining categories in table II.

Breast-feeding was also associated with a reduced risk of death from respiratory infections, though the magnitude of the relative risks was smaller than for diarrhoea-associated deaths. Breast-fed infants who also received a milk supplement had a 1·6 times (95% CI 0·7–3·6) higher risk of respiratory death than exclusively breast-fed infants. Those fed only on formula or cow's milk had a 3·6 times (95% CI 1·7–7·5) higher risk.

The risk of death from infections other than diarrhoea and respiratory infections was also increased among those completely weaned (relative risk 2·5, 95% CI 1·0–6·4) although those who received supplements with breast-milk had a similar risk to those exclusively breast-fed (relative risk 0·4, 95% CI 0·1–1·6).

The risk associated with non-milk food supplements (such as mashed fruit and vegetables, soup, porridge, and the normal family diet) was also analysed. For deaths from diarrhoea the addition of non-milk supplements to the diet of exclusively breast-fed children was associated with an increased risk, although the lower 95% confidence limit was under 1·0 (table III). For infants already receiving milk other than breast-milk, the addition of non-milk supplements was associated with a small reduction in risk. Among those dying of respiratory infections non-milk supplementation was associated with reduced risks. Infants fed only on milk (breast, formula, or cow's) had 3·1 (95% CI 1·4–6·8) times the risk of death of those also receiving non-milk supplements. Among infants dying of other infections there were no differences in risk associated with the various feeding modes.

The relative risks for deaths from diarrhoea associated with not breast-feeding were greatest for infants under 2 months (table IV). The same interaction between age and risk was not apparent for respiratory or other infections.

There was no evidence that the protection afforded by breast-milk continued after weaning. Recently weaned infants were at higher risk of death from all infectious diseases than those who had been off the breast for 2 months or more, but the lower 95% confidence limit was under 1·0.

DISCUSSION

Our results suggest that breast-feeding offers strong protection against death from diarrhoea and respiratory infections in southern Brazil, especially in the first few months of life. Totally weaned infants were at greatest risk but even part-weaning was associated with an increased risk. For other infections, infants who had been totally weaned had an increased risk of death compared with those exclusively breast-fed, but those receiving breast-milk and other milk were not found to have a higher risk.

The types of milk consumed were associated with differences in risk of a similar magnitude to those obtained with the feeding mode classification, which also took into

TABLE II—RELATIVE RISK FOR INFANT MORTALITY DUE TO INFECTIOUS DISEASES ANALYSED BY TYPE OF MILK CONSUMED

Type of milk	Relative risk (95% CI)					
	Diarrhoea		Respiratory infections		Other infections	
	Adjusted for age	Adjusted for confounders*	Adjusted for age	Adjusted for confounders†	Adjusted for age	Adjusted for confounders‡
Breast only	1·0	1·0	1·0	1·0	1·0	1·0
Breast + formula	3·5 (1·5–7·8)	4·5 (1·7–12·4)	2·4 (1·0–5·9)	2·1 (0·8–6·0)	0·2 (0–2·0)	0·1 (0–0·7)
Breast + cow's	4·1 (1·7–10·1)	3·4 (1·1–10·3)	1·2 (0·5–3·0)	1·2 (0·4–3·4)	2·4 (0·5–11·5)	1·4 (0·2–7·9)
Formula only	11·9 (5·5–25·5)	16·3 (6·4–41·3)	3·2 (1·6–6·6)	3·9 (1·8–8·7)	4·5 (1·2–17·0)	2·3 (0·5–11·3)
Cow's only	7·8 (3·7–16·6)	11·6 (4·5–29·8)	2·6 (1·2–5·5)	3·3 (1·4–7·8)	4·7 (1·8–12·4)	2·6 (0·9–7·0)
Likelihood ratio test	54·7 (p < 0·001)	52·3 (p < 0·001)	12·5 (p < 0·02)	14·1 (p < 0·01)	18·9 (p < 0·001)	14·6 (p < 0·01)

*Age, social status, birth weight, type of housing, availability of piped water, birth interval, and maternal education
†Age, social status, birth weight, maternal education, family income, and whether or not non-milk supplements were given
‡Age, birth weight, maternal education, and family income

TABLE III—RELATIVE RISK FOR INFANT MORTALITY DUE TO INFECTIOUS DISEASES ANALYSED BY DIFFERENT FEEDING MODES

Feeding mode	Relative risk (95% CI)					
	Diarrhoea		Respiratory infections		Other infections	
	Adjusted for age	Adjusted for confounders*	Adjusted for age	Adjusted for confounders*	Adjusted for age	Adjusted for confounders*
Breast only	1·0	1·0	1·0	1·0	1·0	1·0
Breast + other milk	3·7 (1·5–8·6)	5·7 (2·0–16·8)	2·3 (1·0–5·3)	1·7 (0·6–4·2)	1·1 (0·3–4·8)	0·5 (0·1–3·1)
Breast + non-milk supplement	1·9 (0·5–7·3)	2·6 (0·4–15·4)	0·3 (0·1–1·3)	0·2 (0–1·0)	2·1 (0·4–12·8)	1·1 (0·1–9·2)
Breast + other milk + non-milk	3·6 (1·2–10·4)	3·7 (1·0–13·6)	0·2 (0·1–1·0)	0·3 (0·1–1·4)	0·8 (0·1–9·0)	0·2 (0–3·0)
Other milk only	14·7 (6·5–33·3)	18·3 (6·7–50·1)	3·0 (1·4–6·5)	2·9 (1·3–6·5)	9·8 (2·5–38·5)	4·4 (0·9–20·3)
Other milk + non-milk supplement	6·5 (2·5–16·8)	15·6 (4·6–52·4)	1·1 (0·5–2·7)	1·2 (0·5–3·0)	4·2 (1·0–18·1)	1·6 (0·3–9·0)
Likelihood ratio test	59·0 (p < 0·001)	53·0 (p < 0·001)	26·1 (p < 0·001)	19·2 (p < 0·005)	18·1 (p < 0·005)	11·0 (p = 0·05)

*Confounders as for table II except for respiratory infections: age, social status, birth weight, maternal education, and family income

account other supplementary foods. Infants receiving formula milk appeared to be at a slightly higher risk than those receiving cow's milk. Non-milk supplementation did not appear to be as hazardous as the use of artificial milks, and there was some evidence of protection against respiratory deaths.

To what extent were our findings due to bias inherent in the case-control approach? It was not possible to keep the interviewers blind to the case-control status of the infants. Evidence that this probably did not bias the results seriously is suggested by the findings of variation in the odds ratios according to the type of infection (table II). As the field-workers collected information on the clinical history only at the end of the interview, these findings suggest that there was not any important interviewer bias.

Another potential source of bias is that the mothers of cases may have started bottle-feeding as a consequence of the terminal illness. We tried to avoid this bias by asking about feeding habits before the onset of illness, and by also asking about any health-related reasons for a change in feeding practices. Cases and controls in whom an illness could have affected feeding practice were considered as being fed as they were before the beginning of the episode. Had this not been done the measured risks would have been incorrectly assessed to be 2–3 times higher.

Infants who are breast-fed may be different from those who are bottle-fed with respect to variables that affect mortality, such as maternal characteristics, birth-weight, malformations, and perinatal morbidity.[15] We tried to control for the effects of socioeconomic status by choosing neighbourhood controls, and we adjusted for several related confounding variables in the analyses. We also excluded children who were unlikely to be breast-fed such as twins, those with very low birth weight, or those with malformations. We cannot be certain that all possible confounding variables were taken into consideration, but the magnitude of the odds ratios observed makes it unlikely that all the effects described are due to confounding biases.[16]

Further evidence that our results represent causal relations is provided by the finding of a consistent gradient in the risk of diarrhoea-associated deaths with a 4-fold increase for infants receiving breast-milk plus artificial milk compared with those receiving breast-milk only, and a 14-fold increase for those not receiving any breast-milk. A similar but less strong gradient was found for deaths due to respiratory infections.

Breast-feeding may directly protect against infant mortality from infectious diseases by the anti-infective properties of breast-milk,[1,2] or the effect may be indirect by shielding the child from contaminated food and water sources. Both of these mechanisms may operate but their relative importance is likely to be different for diarrhoeal and respiratory diseases. Shielding is probably more important for deaths due to diarrhoea. Part of the protective effect of breast-feeding may also come from the close and continued contact with the mother. Infants may be weaned because the mother has to leave the home to work. But few mothers in the present study gave this as a reason for weaning.

TABLE IV—RELATIVE RISK FOR INFANT MORTALITY DUE TO INFECTIOUS DISEASES AT DIFFERENT AGES ACCORDING TO TYPE OF MILK CONSUMED

Age (mo)	Type of milk consumed		
	Breast only	Breast + other*	Other only*
Diarrhoea†			
<2	1·0	3·1 (5·3)	24·7 (23·3)
2–11	1·0	2·5 (2·2)	3·5 (5·3)
Respiratory			
<2	1·0	2·7 (2·2)	3·3 (4·1)
2–11	1·0	1·2 (1·3)	2·0 (3·4)
Other infections			
<2	1·0	0·9 (0·5)	3·9 (1·9)
2–11	1·0	0·7 (0·3)	2·9 (2·0)

*Based on matched analysis but not adjusted for confounding variables. Figures in parentheses are adjusted for confounding variables (excluding age) as in table II.
†Likelihood ratio test for interaction, p < 0·001

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Home Monitoring

CHANGING RELATION BETWEEN HOME AND CLINIC BLOOD-PRESSURE MEASUREMENTS: DO HOME MEASUREMENTS PREDICT CLINIC HYPERTENSION?

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Summary Blood-pressure screening in a family health centre identified 114 patients (53 male, 61 female) with diastolic pressures of 95 mm Hg and greater after three readings in the seated position (mean 163 [SEM 2]/104 [1] mm Hg). All were instructed in the use of the 'Copal UA 231/251' electronic sphygmomanometer and produced a series of readings taken at home over 3 days. They were recalled after 2 weeks and 4 weeks for repeat clinic measurements of blood pressure. Blood pressure fell on successive clinic visits; at the final visit only 59 patients (31 male, 28 female) had diastolic pressures of 95 mm Hg or greater. Average day-time home blood-pressure measurements (155 [2]/94 [2] mm Hg) were significantly lower than the screening blood-pressure measurements but were not significantly different from those at the third clinic visit (154 [2]/97 [1] mm Hg). Home blood-pressure measurements were successful in predicting outcome at the third clinic visit in 90 (79%) patients; home-monitored pressures suggested normotension when the final clinic visit diastolic blood pressure was still above 95 mm Hg in only 16 (14%) patients. Only 2 of these had a final clinic diastolic pressure above 105 mm Hg. Home monitoring represents a practicable and acceptable alternative to repeated clinic measurements in the initial assessment of hypertensive patients.

INTRODUCTION

THERE is increasing evidence that the measurement of blood pressure in a clinic by a doctor or nurse may be a less accurate predictor of ultimate risk than measurements carried out at home [1,2] Self-measurement of blood pressure has therefore become more widespread.[3] Ambulatory or self-monitored blood pressure at home is generally believed to be lower than that recorded in the doctor's clinic,[2,4] but it is not clear whether such a difference persists in patients who regularly attend blood-pressure clinics.

The tendency for clinic blood pressure to fall on successive measurement[5,6] has led the World Health Organisation to issue guidelines[7] on the approach to patients with raised blood pressure (particularly those with mild hypertension). These guidelines suggest a succession of readings over a 3-month period before drug therapy is started.

Our aim was to test the hypothesis that such repeated measurement might be replaced by a simple assessment of blood pressure made by the patient in the home environment. We used the semi-automatic electronic sphygmomanometer 'Copal UA 231/251' because of its simplicity of use and overall accuracy.[8,9]

MEAN (SEM) BLOOD-PRESSURE MEASUREMENTS AT SUCCESSIVE CLINIC VISITS AND AT HOME

Clinic			Home		
	Mean (SEM) BP (mm Hg)			Mean (SEM) BP (mm Hg)	
Visit	Systolic	Diastolic	Time	Systolic	Diastolic
1	163 (2)	104 (1)	Day*	155 (2)	94 (2)
2	157 (2)	98 (1)	Morning/night	144 (2)	86 (1)
3	154 (2)	97 (1)	Average	151 (2)	91 (1)

*Mean of three values

PATIENTS AND METHODS

A screening programme for the detection of hypertension was set up at a family-practitioner health centre in Edinburgh owing to increasing awareness of the need to detect symptomless hypertension. The population for this study was obtained from the initial phase of this screening exercise. 1500 patients aged 30–65 years responded to postal invitations. For each, blood pressure was measured with the patient seated, after 5 min rest, by a trained nurse (B. A. L.) who used a random-zero sphygmomanometer with the 5th Korotkoff sound to record diastolic blood pressure. The blood pressure recorded was the lowest of three measurements. All patients with a diastolic blood pressure of 95 mm Hg or greater entered the study. Each was instructed in the use of the electronic semi-automatic sphygmomanometer[8,9] and asked to carry out measurements on 3 consecutive days, in bed in the morning and at night, and on three occasions in the seated position during the day (mid-morning, after lunch, and early evening).

All patients were recalled to the health centre for repeat measurements with the random-zero sphygmomanometer after 2 weeks and 4 weeks. 14 patients did not attend for the third visit but they were actively sought, and a third blood-pressure measurement was obtained for all subjects.

No attempts at intervention were made but, if diastolic blood pressure was 95 mm Hg or greater after three visits, the patient was referred to his or her family practitioner for assessment of the need for therapy.

Results are expressed as the mean (SEM) and comparisons, where appropriate, were made by means of Student's paired *t* test.

RESULTS

At the initial clinic screening 114 patients (53 male, 61 female) aged 48 (4) years had a diastolic blood pressure when seated of 95 mm Hg or greater (163 [2]/104 [1] mm Hg). There were significant falls in both systolic ($p < 0.02$) and diastolic ($p < 0.0001$) blood pressure between the first and second visits, but the slight further fall by the third visit was not significant (see table). Patients with the highest

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