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Interventions for the control of diarrhoeal diseases among young children: promotion of breast-feeding

R. G. FEACHEM[1] & M. A. KOBLINSKY[2]

The literature on the relative risks of diarrhoea morbidity to infants on different feeding modes suffers from several methodological problems. Thirty-five studies from 14 countries were reviewed; 83% of studies found that exclusive breast-feeding was protective compared to partial breast-feeding, 88% that exclusive breast-feeding was protective compared to no breast-feeding, and 76% that partial breast-feeding was protective compared to no breast-feeding. When infants receiving no breast milk are contrasted with infants on exclusive or partial breast-feeding, the median relative risks are 3.0 for those aged 0-2 months, 2.4 for those aged 3-5 months, and 1.3-1.5 for those aged 6-11 months. Above 1 year of age no protective effect of breast-feeding on diarrhoea morbidity is evident. When infants receiving no breast milk are contrasted with those on exclusive breast-feeding, median relative risks are 3.5-4.9 in the first 6 months of life. The literature does not suggest that the relative risks of diarrhoea morbidity for bottle-fed infants are higher in poor families than in more wealthy families. The protective effects of breast-feeding do not appear to continue after the cessation of breast-feeding. There is evidence of considerably increased diarrhoea severity among bottle-fed infants.

There is a limited, and mostly pre-1950, literature on the relative risks of diarrhoea mortality to infants on different feeding modes. Nine studies from 5 countries were reviewed, most of which showed that breast-feeding protects substantially against death from diarrhoea. When infants receiving no breast milk are contrasted with those on exclusive breast-feeding, the median relative risk of death from diarrhoea during the first 6 months of life is 25. When partially and exclusively breast-fed infants are contrasted, the median relative risk of death from diarrhoea is 8.6.

Breast-feeding can be promoted by changes in hospital routine and by giving information and support to mothers. A review of 21 studies from 8 countries shows that, by such promotion, the most likely reductions in the prevalence of non-breast-fed infants are 40% among infants aged 0-2 months, 30% among those aged 3-5 months, and 10% among those between 6 months and 1 year old. Theoretical calculations based on these data show that such promotion can reduce diarrhoea morbidity rates by 8-20% and diarrhoea mortality rates by 24-27% in the first 6 months of life. For children aged 0-59 months, diarrhoea morbidity rates would be reduced by 1-4% and mortality rates by 8-9%. A recent study in Costa Rica has documented a substantial impact of breast-feeding promotion on neonatal diarrhoea morbidity and mortality, and on diarrhoea morbidity in infants aged 0-5 months. The Costa Rican data show good agreement with the theoretical computations presented in this paper.

Several important aspects of breast-feeding and diarrhoea remain to be clarified by research. However, the need for this research should not delay action to promote breast-feeding and to monitor its effects upon feeding practice and upon diarrhoea.

The long debate on the merits of breast-feeding initially focused on the differences in mortality rates between breast-fed and bottle-fed infants. Since about 1930, and especially since 1955, increased attention has been paid to differential morbidity rates. Some studies on mortality and morbidity in relation to feeding mode singled out particular infectious causes of death or illness—most commonly, diarrhoeal and respiratory diseases. The literature on the relationships between breast-feeding and

[1] Reader in Tropical Public Health Engineering and Head of Department of Tropical Hygiene, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT, England. Requests for reprints should be sent to Programme for Control of Diarrhoeal Diseases, World Health Organization, 1211 Geneva 27, Switzerland.

[2] Scientific Coordinator, International Centre for Diarrhoeal Disease Research in Bangladesh, Dhaka, Bangladesh.

diarrhoea is now substantial and permits an assessment of breast-feeding promotion as an intervention for the reduction of diarrhoea morbidity or mortality in infants. Several recent studies and reviews of breast-feeding provide a useful background to the present, more focused analysis (*2, 17, 47, 51, 64, 66, 81, 86*)[a-c] of the role of breast-feeding promotion in diarrhoeal disease control. This review is the third in a series of reviews of potential anti-diarrhoea interventions now being published in the *Bulletin of the World Health Organization* (*19-21*).

EFFECTIVENESS

For breast-feeding promotion to be an effective diarrhoea control intervention, it must be true that:

either

breast-fed infants have reduced diarrhoea morbidity rates, mortality rates, or severity	*hypothesis 1*

and

the prevalence of breast-fed infants can be increased by appropriate promotional activities	*hypothesis 2*

or

the promotion of breast-feeding can reduce diarrhoea morbidity rates, mortality rates, or severity in infants	*hypothesis 3*

Most of the literature on this topic is addressed to hypothesis 1 or 2. The potential effectiveness of breast-feeding promotion would be suggested by a demonstration either of the correctness of hypotheses 1 and 2 or of the correctness of hypothesis 3. The evidence for and against these hypotheses is examined below.

[a] EVENSEN, S. *Relationship between infant morbidity and breast-feeding versus artificial feeding in industrialized countries: a review of the literature.* Copenhagen, WHO Regional Office for Europe, 1982 (unpublished document ICP/NUT 010/6).

[b] *Joint WHO/UNICEF meeting on infant and young child feeding*, Geneva, 1979 (unpublished document).

[c] WHO/UNICEF. *Infant and young child feeding: current issues*, Geneva, 1981 (unpublished document).

Hypothesis 1. *Breast-fed infants have reduced diarrhoea morbidity rates, mortality rates, or severity*

Definitions

A review of breast-feeding and diarrhoeal disease rates requires clear-cut definitions of the various feeding modes that are to be contrasted. The number of feeding modes defined should be small (say, 3 to 5) in order to increase the sample size of infants on each feeding mode and in order that the operational significance of the comparisons will be apparent. However, to assign all of the many permutations of infant feeding practice to only 3-5 categories inevitably introduces a degree of imprecision to the definitions. In this review the following three categories have been adopted:

—exclusive breast-feeding, which applies to infants receiving only breast milk (and is thus not usual in infants over 6 months old);

—no breast-feeding, which applies to infants receiving no breast milk;

—partial breast-feeding, which applies to infants who receive breast milk plus other milk or foods.

The feeding modes described in the literature are assigned to one of these three categories. In several studies the feeding modes have not been clearly defined or do not correspond to any of the categories listed above. In these cases, the feeding mode is designated so as to minimize the computed protective effect of breast-feeding.

Methodological problems

The studies on breast-feeding and diarrhoea reviewed here made use of different methods for the collection and analysis of their data. Studies that were judged to have serious methodological flaws were rejected but the quality of those that were included varies widely. The most commonly encountered problem other than definition of feeding mode (see above) was failure to control possible confounding variables. The age of the infant is a confounding variable encountered in all the studies; older infants are less likely to be exclusively breast-fed than younger infants and also have different diarrhoeal disease rates for reasons other than feeding mode. Emphasis has therefore been placed here on studies that analyse breast-feeding and diarrhoea rates by narrow age ranges (e.g., 0-2 months, 3-5 months, etc.); studies that examine a wider age range of infants, e.g., aged 0-11 months, are judged to be of little value.

A second common set of confounding variables is socioeconomic status and child care. Mothers who breast-feed may be more or less educated and wealthy, and may take more or less care of their child than other mothers. Two distinct patterns emerged from the studies that analysed the effect of these confounding variables. In some poor communities, especially in developing countries and in the developed countries before 1930, breast-feeding was more common among lower socioeconomic strata. In such communities the confounding socioeconomic variables tend to increase the diarrhoea rates and therefore minimize the apparent protective effect of breast-feeding. In an uncontrolled study in such communities the protection afforded by breast-feeding may be underestimated. In certain more prosperous communities, especially in developed countries, breast-feeding is at present more common among the middle classes because it is fashionable. Here the confounding socioeconomic variables tend to decrease the diarrhoea rates and thus an uncontrolled study may overestimate the protective effect of breast-feeding. Several of the more recent studies that were reviewed controlled for confounding socioeconomic and child care variables, and such control should be regarded as essential for any future studies of breast-feeding and diarrhoea. These and other methodological problems inherent in studies of breast-feeding and health are reviewed elsewhere (*9*, *70*, *84*).[d]

Mechanisms of protection

If breast-fed infants experience less diarrhoeal illness or death than other infants, it may be due to one or more of the following factors:

— the immunological and antimicrobial properties of breast milk;

— the "bifidus factor" (exclusively breast-fed infants have an intestinal flora composed largely of Gram-positive anaerobic bacteria (*Bifidobacterium* species), which may inhibit colonization by Gram-negative facultative species such as *Escherichia coli*);

— infants receiving bottle-milk feeds are at risk from contamination of the milk, the bottle, or the teat, and infants receiving solid foods are at risk from contamination of the food (these risks may apply especially to bacterial pathogens that multiply in milk and some foods);

— breast-fed infants may have a better nutritional status than other infants, and thus a lesser risk of death from diarrhoea.

The protective mechanisms of breast-feeding are a complex subject, in which there is substantial ongoing research. This is especially true of the first of the four items listed above. It is probable that the mechanisms of protection, and their relative importance, vary by pathogen and by the age of the infant. It is not the purpose of this paper to review the literature on protective mechanisms, and the interested reader is referred to other publications (*3*, *4*, *14*, *17*, *26*, *30*, *33*, *40–42*, *55*, *58*, *60*, *65*, *83*).

Morbidity

Annex 1 lists 35 studies in 14 countries from which the relative risk of diarrhoeal illness for infants on one feeding mode, compared to infants on another feeding mode, can be computed. Both methods and findings vary greatly among these studies. For partial breast-feeding compared to exclusive breast-feeding, 30 relative risks are computed of which 25 (83%) are > 1. For no breast-feeding compared to exclusive breast-feeding, 25 relative risks are computed of which 22 (88%) are > 1. For no breast-feeding compared to partial breast-feeding, 45 relative risks are computed of which 34 (76%) are > 1. Thus the pooled results from 35 studies indicate that in most circumstances breast-feeding protects against diarrhoea morbidity. More analysis on these pooled data is not useful since the results are strongly influenced by the age of the infants under study.

The age-specific relative risks derived are summarized in Fig. 1 and 2, which show clearly the effect of age. When infants receiving no breast milk are contrasted with infants on exclusive or partial breast-feeding (Fig. 1), the median relative risks are 3.0 for ages 0–3 months, 2.4 for ages 3–5 months,[e] and 1.3–1.5 for ages 6–8 and 9–11 months. Above 1 year of age, no protective effect of breast-feeding on

[d] See footnote *a* on page 272.

[e] The 0–3-months age group includes studies of both the 0–2-months group and the 0–3-months group. This age group therefore overlaps by one month (month 3) with the 3–5-months age group. These remarks also apply to Fig. 1 and 2.

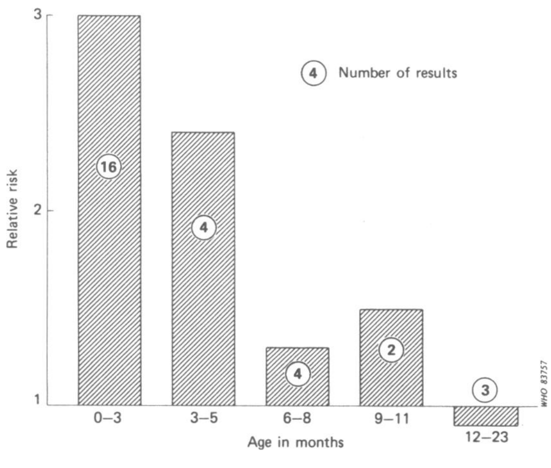

Fig. 1. Median relative risks of diarrhoea morbidity for infants receiving no breast-feeding compared to infants with partial or exclusive breast-feeding (data from Annex 1).

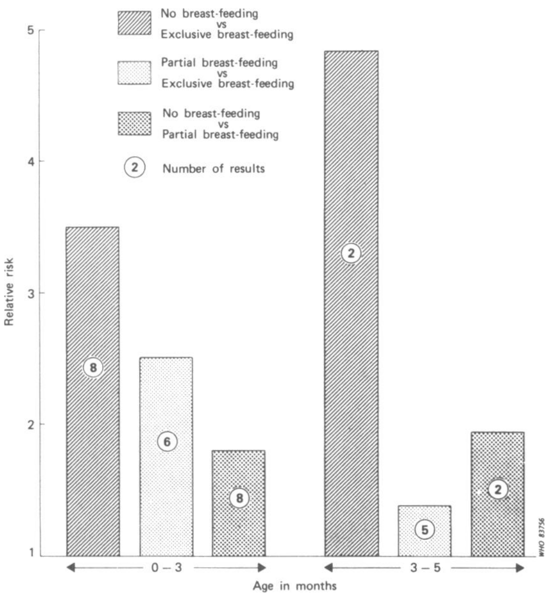

Fig. 2. Median relative risks of diarrhoea morbidity by feeding mode (data from Annex 1).

diarrhoea morbidity is evident. When infants receiving no breast milk are contrasted with those on exclusive breast-feeding (Fig. 2), the median relative risks are 3.5–4.9 in the first 6 months of life. Beyond 6 months of age, exclusive breast-feeding is not a nutritionally recommended feeding mode and may be a risk factor, rather than a protective factor, for diarrhoea. This possibility is illustrated by the data from Ethiopia and Uganda (Annex 1).

It is possible that the relative risks of diarrhoea for bottle-fed infants are greatest in families of lowest socioeconomic status where diarrhoea incidence is high and nutritional status is low, and where there are many opportunities for the contamination of bottle milk. The data in Annex 1 were analysed (not shown) to test this possibility and gave no grounds for supposing that the relative risks of diarrhoea for bottle-fed infants are lower in more wealthy families. Breast-feeding appears to protect against diarrhoea irrespective of the levels of hygiene. This suggests either that the main protective mechanisms are the immunological and antimicrobial properties of the breast milk together with the "bifid" flora of the gut or that contamination of bottle milk is an important cause of infant diarrhoea even in families of upper and middle socioeconomic status. The possible lack of association between the relative protection afforded by breast-feeding and socioeconomic status should be further studied.

The discussion above deals only with the protective effects of a particular feeding mode during the period when this feeding mode is applied. It is conceivable that breast-feeding confers some protection against diarrhoea after breast-feeding has been discontinued. Few studies present data that allow this possibility to be analysed. The findings of Ferguson et al. (*23*) in New Zealand are summarized in Table 1. All infants described in Table 1 had ceased breast-feeding and their period prevalences of diarrhoea are compared according to their past experience of breast-feeding. The data are weakened by the use of period prevalence rather than incidence but, none the less, the results do not suggest that a longer duration of breast-feeding was associated with a lower period prevalence of diarrhoea. This cessation of protection after discontinuation of breast-feeding has been reported also in studies of all significant illness episodes (*9*) and of total hospital admissions (*15*).

Severity

Only a few studies provide data from which the relationship between breast-feeding and diarrhoea severity may be assessed. Table 2 summarizes 5 studies of case–fatality ratios. Four of these (from England in the 1930s, USA in the 1920s, and Rwanda recently) show major differences in case–fatality ratios by feeding mode. These results could be confounded by other clinical problems of the children who died; those not breast-fed could have been undernourished or chronically ill, for instance. The data from Birmingham, England, in the 1930s (*73*) show that the prevalences of undernutrition (< 80%

Table 1. Period prevalence of treated diarrhoeas and all diarrhoeas in specified age groups, by duration of previous breast-feeding[a]

Age group (months, inclusive)	Duration of previous exclusive breast-feeding (months)	Period prevalence (%)	
		Treated diarrhoeas[b]	All diarrhoeas[c]
4–11	0	22	44
	0–3	25	48
12–23	0	29	63
	0–3	32	64
	4–7	31	64
	8–11	29	65

[a] Data from Ferguson et al. (*23*).

[b] Diarrhoeas reported to a medical practitioner or hospital for treatment.

[c] All diarrhoeas, including those managed at home.

Table 2. Case–fatality ratios for diarrhoea cases in four countries, by feeding mode

Country and place	Date of study	Socio-economic status	Age group (inclusive)	Total number of diarrhoea cases (deaths)	Case–fatality ratios (%)			Ratio of case–fatality ratios (No BF/ Part BF)	Reference
					Excl. BF[a]	Part BF[a]	No BF[a]		
Canada									
Toronto[b]	1939	?	0–11 mo.	314 (46)		14	15	1.1	*13*
England									
Liverpool	1936	Lower/ middle	3–26 wk	130 (9)		5	9	1.8	*69*
Birmingham[b]	?	?	0–9 mo.	500 (240)		26	77	3.0	*73*
Rwanda									
Kigali[b]	1977–78	?	0–23 mo.	849 (95)		7	22	3.1	*50*
USA									
Chicago	1924–29	Lower	0–3 mo.	1877 (22)	0.6	0.9	20	22	*35*
			4–8 mo.			0.3	2	6.7	*36*

[a] For definitions of feeding modes, see footnote *b* to Annex 1.
[b] Study of hospitalized diarrhoea cases only.

weight-for-age) among non-breast-fed infants who died of diarrhoea, and among all diarrhoea cases, were 41% and 37% respectively, suggesting that the apparent effect of feeding mode on case–fatality ratio (Table 2) was not confounded by malnutrition. Grulee (*35*), commenting on the Chicago (1924–29) study, wrote that "1924 to 1929 were the years of plenty" and that "undernutrition does not enter into the picture". The Chicago study used data from the surveillance of over 20 000 infants. Such data are less likely to be confounded by undernutrition, and much less likely to be confounded by chronic illness, than data derived from hospitalized cases only.

An investigation of shigellosis in Bangladesh (*77*) found that severity was related to feeding mode. Breast-fed and non-breast-fed children under 2 years old with shigellosis were compared; among the breast-fed group, fewer required intravenous therapy (16% vs 38%) and fewer were admitted as inpatients (5% vs 19%).

Breast-feeding may play a role in reducing the nutritional consequences of diarrhoea episodes in young children. A study of children aged 6–35 months, hospitalized with acute watery diarrhoea in Bangladesh, showed that those being breast-fed had calorie and protein intakes (per kg of body weight) 1.5 and 2.5 times greater, respectively, than those not breast-fed (*45*).

More information is required on the effects of feeding mode on diarrhoea severity. Such studies should control for age, nutritional status, and chronic illness and should investigate the severity of diarrhoeas of known etiology.

Mortality

Annex 2 lists 9 studies in 5 countries from which the relative risks of diarrhoea mortality for infants on one feeding mode, compared to infants on another feeding mode, can be computed. The data are less extensive than those on morbidity (Annex 1) and do not permit such detailed analysis by age. For partial breast-feeding compared to exclusive breast-feeding, 7 relative risks are computed, ranging in value from 1 to 10. For no breast-feeding compared to exclusive breast-feeding, 13 relative risks are computed, ranging in value from 3 to 43. For no breast-feeding compared to partial breast-feeding, 9 relative risks are computed, ranging in value from 2 to 19. Thus the pooled results from 9 studies suggest that breast-feeding may protect substantially against death from diarrhoea.

The age-specific relative risks of diarrhoea mortality, from 2 studies in which age-specific analysis is possible, are presented in Fig. 3. The relative risk of death from diarrhoea for non-breast-fed infants is greatly increased in the early months of infancy compared to the later months. The relative risks of diarrhoea mortality for infants 0–5 months old are summarized in Fig. 4 by feeding mode. When infants receiving no breast milk are contrasted with those on exclusive breast-feeding the median relative risk of death from diarrhoea during the first 6 months of life is 25. When infants on mixed feeding modes (partial breast-feeding) are contrasted with those on exclusive breast-feeding the median relative risk of death from diarrhoea is 8.6. It must be cautioned that these

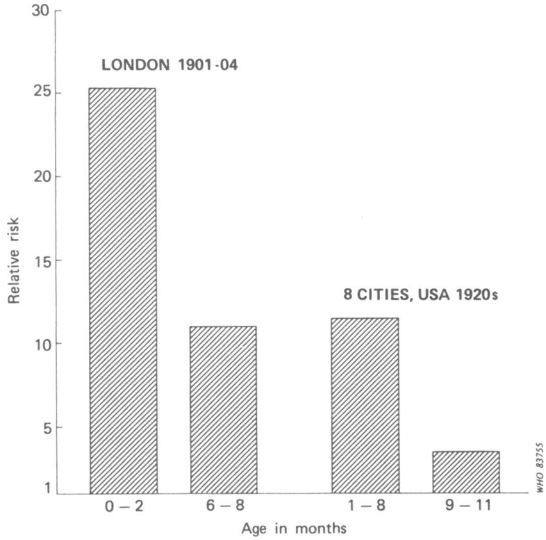

Fig. 3. Relative risks of diarrhoea mortality for infants receiving no breast-feeding compared to infants exclusively breast-fed (data from Annex 2).

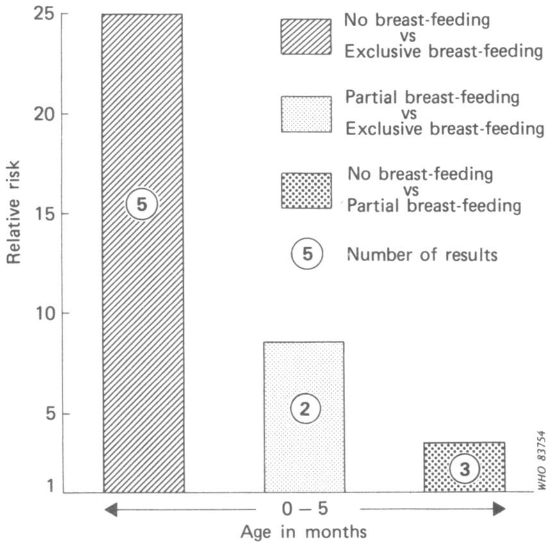

Fig. 4. Median relative risks of diarrhoea mortality by feeding mode (data from Annex 2, including studies of 0–2, 3–5 and 0–5-months age groups).

results are derived from only two studies (*62*, *69*) and mainly from the study of Newman (*62*). Comparison of Fig. 2 and 4 shows that the relative risks of diarrhoea mortality by feeding mode are 2–6 times greater than those of diarrhoea illness. This implies a similar difference in the case–fatality ratios by feeding mode. Table 2 shows the ratios of no breast-feeding to partial breast-feeding case-fatality ratios to be 1.1, 1.8, 3.0, 3.1, 6.7 and 22.

As with the case–fatality ratios (Table 2), the mortality rates by feeding mode (Annex 2) could be confounded with undernutrition or chronic illness. A factor that causes the abandonment of breast-feeding, such as a chronic illness, could also increase the risk of death from diarrhoea. Four studies listed in Annex 2 controlled for these, or related factors, or excluded infants who were disadvantaged from birth owing to prematurity, low birth-weight, or congenital defects. In addition, four of the studies in Annex 2 derived their mortality rates from records of over 100 deaths from diarrhoea. With sample sizes of this magnitude it is unlikely that rare events such as chronic illness would substantially alter the computed effect of feeding mode.

Despite these comments, the data from which to draw conclusions about the relative risks of diarrhoea mortality by feeding mode are limited in extent and quality. The studies are old (only one since 1947); all except one are from what are now wealthy and temperate countries (Canada, England, Sweden, and the USA); they provide poor breakdown of mortality rates by age; and they do not adequately control for potentially confounding variables. The age of the studies is of concern first because their designs are inadequate as judged by today's epidemiological standards, and secondly because the non-breast-fed infants were not receiving modern infant milk formulae. The importance of this last point is uncertain. Of the four potential protective mechanisms listed above, only nutritional status is likely to be affected by the type of breast-milk substitute.

Reliable data on the effect of feeding mode on diarrhoea mortality rates in developing countries today are not available. The collection of such data through correctly designed studies is a priority item for research programmes in both diarrhoeal diseases and maternal and child health. Evidence that such studies will find a significant relative risk of diarrhoea mortality among bottle-fed infants comes from studies of overall infant mortality by feeding mode. For instance, a study in north-eastern Brazil found that, when numerous confounding variables were controlled, children who were never breast-fed were 1.7 times more likely to die in infancy than other children (*29*).

Etiology-specific diarrhoea and breast-feeding

There is a growing literature on substances in human colostrum and milk that act against specific agents of diarrhoea. Most attention has been focused on antibodies against rotavirus (*71*, *72*, *90*), antibodies against *Escherichia coli* and its toxins (*1*, *28*, 48), and antibodies against *Vibrio cholerae* and its toxin (*53*, *72*).

Little is known of the relationships between feeding mode and the epidemiology of diarrhoeas of known etiology. High relative risks of cholera in Bahrain, and of salmonellosis in Arkansas, USA, in infants receiving no breast milk have been documented (Annex 1). In a study of 5-day-old babies in London, England, the prevalences of rotavirus infection among breast-fed and non-breast-fed infants were 22% and 58% respectively (*6*). Only 14% of infected breast-fed infants excreted $> 10^9$ virus particles per gram of faeces, compared to 52% of non-breast-fed infected infants. In a study of children under 1 year old, hospitalized with diarrhoea in Mexico City, Mexico, 5% of those with rotavirus infection were breast-fed compared to 16% of those with other diarrhoeas (*16*). In a study of children under 2 years old with diarrhoea in Dhaka, Bangladesh, the proportion who were breast-fed was 59% in those with shigellosis compared to 78% in those with other diarrhoeas (*77*). A similar association with breast-feeding was not found for the other common enteric pathogens.

This information is incomplete and partially contradictory. It is uncertain whether the protection against diarrhoea morbidity and mortality associated with breast-feeding (Fig. 1–4) extends to all diarrhoeas or is due to high protection against some agents and low protection against others. Studies on feeding mode in relation to the incidence and severity of specific diarrhoeas are needed to clarify the situation and to guide intervention policy towards geographical areas in which breast-feeding may be especially important.

Hypothesis 2. *The prevalence of breast-fed infants can be increased by appropriate promotional activities*

The most recent and comprehensive account of patterns of breast-feeding is provided by a WHO collaborative study of 22 857 mothers in 9 countries (*86*). The reader concerned with the details of breast-feeding trends and practices should study this report. Simplified data on three contrasting patterns of breast-feeding (dubbed here patterns A, B and C) have been abstracted and are set out in Table 3. Pattern A may be found in relatively urbanized and wealthy communities in developing countries and in some developed countries. It is a pattern where non-breast-feeding is prominent and it may be an increasingly common pattern in many developing countries, especially in urban areas. Pattern C is a pattern of predominant breast-feeding and may be found in many poor and traditional societies in developing countries.

Table 3. Three contrasting patterns for breast-feeding[a]

Pattern of breast-feeding[b]	Countries and the socioeconomic strata of the population studied				Type of feeding[c]	Prevalence (%) of breast-feeding by age of infant		
	All strata	Upper/ middle	Urban poor	Rural poor		0–2 mo.	3–5 mo.	6–11 mo.
A	Hungary Sweden	Chile Ethiopia Guatemala Nigeria Philippines	Chile		Excl. BF	30	10	0
					Part BF	45	35	15
					No BF	25	55	85
B		India Nigeria	Guatemala Philippines	Chile Philippines	Excl. BF	50	30	5
					Part BF	40	45	55
					No BF	10	25	40
C		Zaire	Ethiopia India Nigeria Zaire	Ethiopia Guatemala India Nigeria Zaire	Excl. BF	75	50	20
					Part BF	25	45	70
					No BF	0	5	10

[a] All data drawn from Fig. 3 and Tables 3 and A5 of the WHO breast-feeding study (*86*). The data have been greatly simplified for the purposes of this analysis on breast-feeding and diarrhoea; for the details of breast-feeding patterns, please consult the full report (*86*).

[b] Patterns A, B, and C may be expected in 'modern', 'transitional', and 'traditional' communities, respectively. It is assumed that these communities suffer low, medium, and high incidences of diarrhoea, respectively (see Tables 6 and 8).

[c] For definitions of feeding modes, see footnote *b* to Annex 1.

Pattern B is intermediate between patterns A and C and may be found in societies that are transitional, in terms of both social norms and wealth. This three-part categorization of breast-feeding patterns is a considerable simplification of the actual global picture as described by WHO (*86*). This simplification is necessary for the computations on breast-feeding promotion and diarrhoea reduction that follow below. The reader interested in a specific community, where the breast-feeding pattern is known, can insert local data in place of those given in Table 3 and repeat the computations.

In some countries, most notably certain developed countries (with breast-feeding pattern A, Table 3), growing public awareness of the advantages of breast-feeding has caused substantial increases in the prevalence of breast-fed infants over a short time period (*64*). In Oslo, Norway, the prevalence of breast-feeding in infants aged 3 months was 14% in 1972-73 and 31% in 1974-75. In Copenhagen, Denmark, the median duration of breast-feeding doubled, from 2 to 4 months, between 1975 and 1977. In the USA the prevalence of infants who were only breast-fed rose from an all-time low of 26% in 1973 to 54% in 1980.

Promotion of breast-feeding can reduce the prevalence of non-breast-fed infants substantially. Table 4 summarizes the impact on breast-feeding of local breast-feeding promotions in Brazil, Czechoslovakia, England, Guatemala, Scotland, Singapore, Sweden, and the USA. Because of the very varied pre-promotion levels of breast-feeding, the impacts are expressed as percentage reductions in the prevalences of infants receiving no breast milk. In the computations (see below) the most likely reductions in the prevalences of non-breast-fed infants of various ages due to breast-feeding promotion are taken as 40% for the 0-2-months age group, 30% for the 3-5-months age group, and 10% for the 6-11-months age group (Table 4).

Table 4. The effectiveness of breast-feeding promotion programmes in reducing the prevalence of infants receiving no breast milk[a]

Age of infant (months, inclusive)	No. of results	% reduction in prevalence of non-breast-fed infants[b]	
		Range	Median
0-2	23	8-100	42
3-5	8	7-43	28
6-11	6	2-43	11

[a] Data derived from Winikoff & Baer (*85*) (summary of 20 studies in 8 countries) and from Hardy et al. (*43*).

[b] If the prevalences of non-breast-fed infants of a given age before and after the promotion are 70% and 50% respectively, the % reduction is 28.6%.

Hypothesis 3. *The promotion of breast-feeding can reduce diarrhoea morbidity rates, mortality rates, or severity in infants*

It is possible to calculate the theoretical impacts of breast-feeding promotion using the data assembled above on hypotheses 1 and 2. Median relative risks of both morbidity and mortality by age have been derived (Fig. 1-4), three contrasting patterns of breast-feeding have been described (Table 3), and the impact of breast-feeding promotion on breast-feeding has been reviewed (Table 4). The next step is to characterize the impact on breast-feeding of breast-feeding promotions having three levels of success: high impact, medium impact, and low impact. The consequences to breast-feeding patterns of these three levels of success are quantified in Table 5. The data on medium impact are derived from Table 4, while high and low impacts are assumed to influence twice and one half, respectively, of the proportion of target mothers.

From the data assembled in Fig. 1-4 and Tables 3-5 it is possible to compute the impact on age-specific diarrhoea morbidity and mortality rates of breast-feeding promotions with a given level of success (say, medium impact) in a community of known breast-feeding pattern (say, pattern A). For morbidity rates, key assumptions are presented in Table 6 and the reductions in age-specific diarrhoea morbidity rates are set out in Table 7. Considering breast-feeding promotions of medium impact, diarrhoea morbidity rates in the first 3 months of infancy may be reduced by 8-20%, and in the second 3 months of life by 9-17%, with the highest percentage reductions being achieved in communities where breast-feeding is initially least common (pattern A). Negligible reductions in diarrhoea morbidity rates are achieved among children over 6 months old. The computed reductions in total diarrhoea morbidity for the first five years of life are only 1-4%.

For mortality rates, key assumptions are presented in Table 8 and the reductions in age-specific diarrhoea mortality rates are set out in Table 9. Considering breast-feeding promotions of medium impact, diarrhoea mortality rates in the first 6 months of infancy may be reduced by 24-27%, and diarrhoea mortality rates for the first five years of life by 8-9%. Zero reductions in diarrhoea mortality rates are computed for children over 6 months old (Table 9) because of the conservative assumption of a relative risk of 1.0 for this age group (see footnote *d* to Table 8). The impacts on children aged 0-59 months are similar, whatever the initial level of breast-feeding (patterns A, B and C) because of the high diarrhoea mortality rates assumed for 0-5-month old infants in communities having breast-feeding pattern C (Table 8).

The computed morbidity and mortality reductions (Tables 7 and 9) for the total 0-59-months age group

Table 5. Data on the three levels of impact of breast-feeding promotion programmes[a]

Level of impact	Percentage changes in breast-feeding prevalence by age of infant and type of feeding						
	0–2 mo.			3–5 mo.			6–11 mo.[b]
	From No BF to Part BF[c]	From No BF to Excl. BF	From Part BF to Excl. BF	From No BF to Part BF	From No BF to Excl. BF	From Part BF to Excl. BF	From No BF to Part BF
High	40	40	80	30	30	60	20
Medium	20	20	40	15	15	30	10
Low	10	10	20	7.5	7.5	15	5

[a] *Explanation*: Consider a promotion with medium impact on the 0–2 mo. age group. It is assumed that the behaviour of 40% of the target mothers can be changed (Table 4). Thus 40% of Part BF switch to Excl. BF and 40% of No BF switch to Part BF or Excl. BF (20% to each mode). For low impact it is assumed that only 20% of target mothers can be influenced, while for high impact it is assumed that 80% of target mothers can be influenced.

[b] Since most authorities recommend supplementary feeding of infants over 5 months, it is assumed that the breast-feeding promotion would encourage Part BF and not Excl. BF in this age group.

[c] For definitions of feeding modes, see footnote *b* to Annex 1.

Table 6. Assumptions made in calculating the impact of breast-feeding promotions on diarrhoea morbidity

Age group (months, inclusive)	Relative risk of diarrhoea morbidity by feeding mode[a]		Episodes of diarrhoea per child per year, by breast-feeding pattern (Table 3)[c]			Proportion (%) of 0–59 month-old children falling within the stated age group
	Part BF vs Excl. BF[b]	No BF vs Excl. BF[b]	A	B	C	
0–2	2.0	4.0	1.0	2.0	3.0	7
3–5	2.0	4.0	1.0	2.0	3.0	6
6–11	1.3	1.6	1.5	3.0	4.0	11
12–59	1.0	1.0	0.5	1.5	2.0	76

[a] See Annex 1 and Fig. 1 and 2.

[b] For definitions of feeding modes, see footnote *b* to Annex 1.

[c] Estimates derived from Snyder & Merson (*74*).

depend on the assumptions made on age-specific morbidity and mortality rates in Tables 6 and 8 (see footnotes *b* to Tables 7 and 9). These rates are based on the assumption that breast-feeding pattern A will most commonly be found in relatively wealthy communities having relatively low diarrhoea rates, whereas pattern C will be typical of very poor communities having the highest diarrhoea rates. Communities with breast-feeding pattern B are assumed to have intermediate diarrhoea rates. This generalization does not reflect the situation in all countries. There are areas having low breast-feeding prevalence but high diarrhoea rates (for instance, in urban slums in some Latin American cities), and there are areas having high breast-feeding prevalences but low diarrhoea rates (for instance, in Sweden).

The former case, of low breast-feeding prevalence and high diarrhoea rates, is of particular interest. A community was defined having breast-feeding pattern A (Table 3), but with diarrhoea morbidity and mortality rates the same as those assumed for communities with breast-feeding pattern C (Tables 6 and 8). Such a community might be found in an urban slum in Latin America. The age-specific percentage reductions in diarrhoea morbidity and mortality rates due to breast-feeding promotion in this community are exactly as calculated in Tables 7 and 9 for a community with breast-feeding pattern A. This is because the age-specific morbidity and mortality rate reductions are not dependant on the assumed diarrhoea rates; they depend rather on the relative risks by feeding mode and it has been assumed throughout these computations that these relative risks are the same in communities having breast-feeding patterns A, B and C. The diarrhoea rate reductions for the total 0–59-months age group are

Table 7. Percentage reductions in diarrhoea morbidity rates, by age of child, due to breast-feeding promotions of varying effectiveness

Pre-intervention pattern of breast-feeding[a]	Age of children (months, inclusive)	Reduction (%) in diarrhoea incidence by effectiveness of breast-feeding promotion[b]		
		High impact[c]	Medium impact[c]	Low impact[c]
A	0–2	39	20	10
	3–5	34	17	8
	6–11	4	2	1
	12–59	0	0	0
	0–59	8	4	2
B	0–2	31	15	8
	3–5	29	14	8
	6–11	2	1	0
	12–59	0	0	0
	0–59	5	2	1
C	0–2	16	8	4
	3–5	21	9	6
	6–11	1	0	0
	12–59	0	0	0
	0–59	3	1	1

[a] See Table 3.

[b] For reductions in the 0–2, 3–5, 6–11, and 12–59 months age groups the given percentage reductions are applicable, whatever the incidence of diarrhoea or the age structure in the community. The percentage reductions in the 0–59 months age group are calculated using the assumptions on diarrhoea incidence and age structure given in Table 6.

[c] See Table 5.

dependent on the age-specific diarrhoea rates assumed. However, similar percentage reductions are computed for the urban community in Latin America as for the more typical pattern A community (Tables 7 and 9), because the higher diarrhoea rates apply not only to the first 6 months of life when changes in breast-feeding are effective, but also to the next 4.5 years when they are not.

Clearly the absolute, rather than the proportional, reduction in diarrhoea morbidity and mortality rates will be higher in communities having higher initial diarrhoea rates. For instance, a community having breast-feeding pattern A and diarrhoea rates for that pattern as shown in Table 6, will have 67 diarrhoea episodes per 100 children under 5 years old per year. Following a breast-feeding promotion of high impact, there will be 61.5 episodes per year, an 8% reduction (Table 7) with only 5.5 episodes averted annually per 100 children under 5 years old. The Latin American slum community characterized above (breast-feeding pattern A, but diarrhoea rates as assumed for communities with pattern C), will have initially 233 episodes of diarrhoea per 100 children under 5 years old per year. Following a breast-feeding promotion of high impact, there will be 216 episodes per year, only a 7% reduction but with 17 episodes per year averted. Precisely the same arguments hold for mortality reductions.

A final note of caution is necessary. The impacts computed in Tables 7 and 9 depend on median relative risk data drawn from Annexes 1 and 2 and summarized in Fig. 1–4. In the relative risks of morbidity (Fig. 1 and 2) one may have considerable confidence. The studies are numerous, some are recent and some have used sophisticated epidemiological methods. In the relative risks of mortality one must have much less

Table 8. Assumptions made in calculating the impact of breast-feeding promotions on diarrhoea mortality

Age group (months, inclusive)	Relative risk of diarrhoea mortality, by feeding mode[a]		Diarrhoea deaths per 1000 children per year, by breast-feeding pattern (Table 3)[c]			Proportion (%) of 0–59 month-old children falling within the stated age group
	Part BF vs Excl. BF[b]	No BF vs Excl. BF[b]	A	B	C	
0–5	8.0	25.0	11	24	40	13
6–11	1.0[d]	1.0[d]	9	16	20	11
12–59	1.0	1.0	3	6	12	76

[a] See Annex 2 and Fig. 3 and 4.

[b] For definitions of feeding modes, see footnote *b* to Annex 1.

[c] Estimates derived from Puffer & Serrano (*67*) and Snyder & Merson (*74*).

[d] It is possible that the relative risk in this age group is > 1, but there is inadequate data on which to estimate a value and so a conservative value of 1 has been adopted.

Table 9. Percentage reductions in diarrhoea mortality rates, by age of child, due to breast-feeding promotions of varying effectiveness

Pre-intervention pattern of breast-feeding[a]	Age of children (months, inclusive)	Reduction (%) in diarrhoea mortality rate by effectiveness of breast-feeding promotion[b]		
		High impact[c]	Medium impact[c]	Low impact[c]
A	0-5	56	26	13
	6-11[c]	0	0	0
	12-59	0	0	0
	0-59	17	8	4
B	0-5	54	27	16
	6-11[d]	0	0	0
	12-59	0	0	0
	0-59	18	9	5
C	0-5	44	24	14
	6-11[d]	0	0	0
	12-59	0	0	0
	0-59	14	8	4

[a] See Table 3.

[b] For reductions in the 0-5, 6-11, and 12-59 months age groups the given percentage reductions are applicable, whatever the diarrhoea mortality rates or the age structure in the community. The percentage reductions in the 0-59 months age group are calculated using the assumptions on diarrhoea mortality rates and age structure given in Table 8.

[c] See Table 5.

[d] See comment in footnote *d* to Table 8.

confidence for the reasons discussed above. Modern studies are needed on diarrhoea mortality by feeding mode to confirm or deny the substantial mortality reductions predicted in Table 9.

A recent study in Costa Rica (*56*) has documented a dramatic impact of breast-feeding promotion on neonatal diarrhoea morbidity and mortality. Between 1976 and 1980 hospital routines were changed so as to promote early breast-feeding and close mother–child contact. Over the same period neonatal diarrhoea morbidity fell by 91% from 17.7 to 1.6 cases per 1000 live births, and neonatal diarrhoea mortality fell from 3.9 to 0 deaths per 10 000 live births. These changes were attributed mainly to the emphasis given to the ingestion of colostrum by neonates. Another report of the same study (*57*) showed that the incidence of diarrhoea among infants aged 0-5 months was 36% lower in a population receiving intense breast-feeding promotion (only 15% of infants aged 5 months receiving no breast milk) than in a population receiving less intense promotion (41% of infants aged 5 months receiving no breast milk).

These morbidity reduction data from Costa Rica (*57*) agree closely with the theoretical calculations described above. The level of breast-feeding promotion in this population (where the prevalences of non-breast-fed infants were 10–19% at 0–2 months, 27–41% at 3–5 months, and 63% at 9 months) stands mid-way between breast-feeding patterns A and B in Table 3. It is predicted in Table 5 that a breast-feeding promotion of high impact would reduce these prevalences to 2–4% at 0–2 months, 10–16% at 3-5 months, and 50% at 9 months. The actual prevalences of non-breast-fed infants in the population where there was intense promotion in Costa Rica were 5–11% at 0–2 months, 13–16% at 3–5 months, and 31% at 9 months. The reduction in diarrhoea morbidity among infants aged 0–5 months, caused by a high-impact breast-feeding promotion, is predicted to be 34–39% in communities having breast-feeding pattern A, and 29–31% in communities having pattern B (Table 7). The actual reduction in morbidity among children aged 0–5 months in Costa Rica was reported to be 36%. This agreement between theoretical calculations and the Costa Rican experience suggests that the morbidity and mortality reductions predicted in Tables 7 and 9 may be achievable in practice, especially the more modest reductions predicted for a breast-feeding promotion with only medium impact.

FEASIBILITY AND COSTS

The promotion of breast-feeding, which has been reviewed elsewhere (*39*, *51*, *85*),[f] is generally of two kinds: information and support programmes and changes in hospital routine. The most cost-effective designs for these interventions in various societies are not known. Changes in hospital routine have to be made only once and they may not involve any increase in operating costs. However, such interventions will be effective only in societies where a substantial proportion of deliveries take place in hospitals where they are more likely to affect the initiation of breast-feeding than its duration. It is likely that a combination of information and support programmes, together with changes in hospital routine, will prove to be the most cost-effective intervention in many societies.

Costs of breast-feeding promotion activities have not been documented but they are probably low in comparison with most other anti-diarrhoea interventions. Studies of both the financial and the economic costs of breast-feeding compared to bottle-feeding have shown that breast-feeding is the cheaper alternative (*51*, *52*).

[f] See footnote *c* on page 272.

CONCLUSIONS

The literature on breast-feeding and diarrhoea is of varied quality; sometimes the findings are contradictory and substantial areas of ignorance remain. The purpose of this review is to attempt to draw a consensus from the literature.

Breast-feeding, whether exclusive or partial, appears to offer protection to children up to one year of age, but not beyond (Fig. 1 and 4). Protection is greatest in the first 3 months of life and falls thereafter (Fig. 1 and 3). During the first half year of life, exclusive breast-feeding is more protective than partial breast-feeding and partial breast-feeding is protective compared to no breast-feeding (Fig. 2 and 4).

The data summarized in Fig. 2 and 4 are suggestive of the possible mechanisms of protection of breast-feeding. If protection were due solely to the immunological and antimicrobial properties of the breast milk itself, then the relative risk of no breast-feeding versus partial breast-feeding might approximate that of no breast-feeding versus exclusive breast-feeding. In fact these relative risks are substantially different (Fig. 2 and 4). If protection were due solely to the contamination of foods other than breast milk, then the relative risk of no breast-feeding versus exclusive breast-feeding might approximate that of partial breast-feeding versus exclusive breast-feeding. This would also be the case if protection was caused solely by the dominant colonization of the intestine by *Bifidobacterium* (a feature only of exclusively breast-fed infants). In fact these relative risks are substantially different (Fig. 2 and 4). Thus the relative risks computed suggest that the protection is caused neither by breast-milk properties alone, nor by the "bifid" factor alone, nor by food contamination alone, nor by a combination of the last two mechanisms alone. Some combination of these three mechanisms, together with the non-specific nutritional benefits of breast-feeding, may be responsible for the observed degree of protection. The evidence that protection is not caused by food contamination alone is further supported by the protective effect of breast-feeding for infants in families of high socioeconomic status in developed countries, such as Canada, England, Finland, New Zealand and the USA (Annex 1). It is probable that the mechanisms of protection, and their relative importance, vary by pathogen and by the age of the infant.

The literature on breast-feeding promotion shows that breast-feeding may become substantially more common following changes in hospital routine combined with information and support programmes for mothers. Theoretical calculations show that a typical breast-feeding promotion may reduce diarrhoea mortality by 24–27% among infants aged 0–5 months and by 8–9% among children under 5 years of age (Table 9).

Only one study on the actual impact on diarrhoea of breast-feeding promotion has been located (*56*, *57*). This study, from Costa Rica, found substantial reductions in neonatal diarrhoea morbidity and mortality and a 36% reduction in diarrhoea morbidity among infants aged 0–5 months. A detailed comparison between the Costa Rican data and the theoretical calculations presented in this paper shows good agreement and gives confidence that the predicted morbidity and mortality reductions set out in Tables 7 and 9 can be achieved in practice.

This review has highlighted several areas of ignorance that require further research. The highest research priority is to determine the level of protection against diarrhoea mortality afforded by partial or exclusive breast-feeding among infants in various socioeconomic settings in developing countries. Well designed studies of diarrhoea morbidity by feeding mode in developing countries are also urgently needed. Studies are required into the relationships between diarrhoea severity and feeding mode and into the possible lack of association between the relative risk of diarrhoea in non-breast-fed infants and the socioeconomic status of their families. The relationships between breast-feeding and chronic diarrhoea, and the protection against nosocomial diarrhoea that may be afforded by the continued breast-feeding of hospitalized infants, are worthy of investigation.

All these studies should be etiology-specific in order to clarify the undoubted differences in the levels of protection provided by breast-feeding against diarrhoeas of different etiology. The design of these studies requires careful and detailed planning. Fine age ranges must be used and several important confounding variables must be controlled. These requirements will tend to lead to study designs having many cells and large overall sample sizes. A prospective study may often be unduly expensive and complicated and a case-control approach will be preferable in these situations.

As regards operational research, more information is needed on the design, effectiveness, and cost of breast-feeding promotion in developing countries. Where possible, effectiveness should be measured not only by impact on breast-feeding patterns but also by impact on diarrhoea rates. This latter kind of impact measurement will typically require major prospective studies, like that reported from Costa Rica. For these studies to be worthwhile they must be very carefully designed and must incorporate a detailed analysis of the financial and economic costs of the breast-feeding promotion.

Despite the limitations in the mortality data, and the need for continued research as discussed above, the evidence that breast-feeding protects young infants from diarrhoea is strong. Governmental and other agencies with responsibility for diarrhoea control should act to promote breast-feeding on the basis of the evidence now available. Research will generate new understandings, both fundamental and operational, which will improve the effectiveness of these breast-feeding promotions.

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RÉSUMÉ

INTERVENTIONS POUR LA LUTTE CONTRE LES MALADIES DIARRHEIQUES CHEZ LE JEUNE ENFANT: ENCOURAGEMENT DE L'ALLAITEMENT MATERNEL

Le présent article est le troisième d'une série d'études sur ce qu'on peut faire dans les pays en développement pour abaisser la morbidité et la mortalité dues à la diarrhée chez l'enfant de moins de cinq ans. Il existe une documentation très fournie sur les risques relatifs de morbidité enfantine selon les différents modes d'alimentation. Cette documentation souffre de plusieurs problèmes méthodologiques. On a examiné 35 études émanant de 14 pays. Quatre-vingt-trois pour cent de ces études constatent que l'allaitement maternel total est plus protecteur que l'allaitement maternel partiel, 88% des études constatent que l'allaitement maternel total est plus protecteur que l'absence d'allaitement maternel et 76% constatent que l'allaitement maternel partiel est plus protecteur que l'absence d'allaitement maternel. Si l'on compare les enfants que ne reçoivent pas de lait maternel avec ceux qui sont nourris au sein totalement ou partiellement, le risque médian relatif est de 3 entre 0 et 2 mois, de 2,4 entre 3 et 5 mois et de 1,3 à 1,5 entre 6 et 11 mois. Au-delà d'un an d'âge, il n'y a pas d'effet protecteur visible de l'allaitement maternel contre la morbidité diarrhéique. Si l'on compare les enfants qui ne reçoivent pas de lait maternel avec ceux qui sont nourris entièrement au sein, le risque médian relatif est de 3,5 à 4,9 dans les six premiers mois de la vie. D'après la documentation étudiée, rien n'indique que le risque relatif de morbidité pour les enfants nourris au biberon soit plus élevé dans les familles pauvres que dans les familles plus riches. Par ailleurs, l'effet protecteur de l'allaitement maternel ne semble pas subsister après la cessation de cet allaitement. Par contre, il y a des signes d'augmentation considérable de la gravité de la maladie chez l'enfant nourri au biberon.

Il existe peu d'ouvrages, et ils sont pour la plupart antérieurs à 1950, sur les risques relatifs de mortalité du nourrisson selon le mode d'alimentation. On a examiné neuf études émanant de cinq pays, et la plupart montrent que l'allaitement maternel est une protection substantielle contre le risque de mortalité. Si l'on compare les nourrissons qui ne reçoivent pas de lait maternel avec ceux qui sont nourris uniquement au sein, le risque médian relatif de décès est de 25 dans les six premiers mois de la vie. Si l'on compare des enfants nourris totalement au sein et des enfants nourris partiellement au sein, le risque tombe à 8,6.

On peut encourager l'allaitement maternel en changeant les habitudes hospitalières, ainsi qu'en éduquant et en aidant les mères. L'examen de 21 études émanant de 8 pays montre que selon toute probabilité on peut ainsi abaisser la prévalence de la maladie chez les sujets ne recevant pas de lait maternel de 40% entre 0 et 2 mois, de 30% entre 3 et 5 mois et de 10% entre 6 mois et un an. Des calculs théoriques fondés sur ces chiffres montrent qu'une action d'envergure moyenne d'encouragement de l'allaitement maternel peut faire diminuer la morbidité diarrhéique dans une proportion de 8% à 20% et la mortalité dans une proportion de 24% à 27% au cours des six premiers mois de la vie. Pour les enfants âgés de 0 à 59 mois, la morbidité serait réduite dans une proportion de 1% à 4% et la mortalité dans une proportion de 8% à 9%. Une étude récente faite au Costa Rica a démontré une incidence substantielle de l'encouragement de l'allaitement maternel sur la morbidité et la mortalité du nouveau-né, et sur la morbidité du nourrisson de 0 à 5 mois. Les données costa-riciennes concordent avec les calculs théoriques présentés ici.

Plusieurs aspects importants de l'allaitement maternel et des maladies diarrhéiques doivent encore être éclairés par la recherche. Toutefois, la nécessité de cette recherche ne doit pas retarder l'action en vue d'encourager l'allaitement maternel et d'en surveiller les effets sur les pratiques alimentaires et sur la diarrhée.

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Annex 1

Relative risk of diarrhoea morbidity by feeding mode

Country/place	Date of study	Socio-economic status	Age group (inclusive)	Relative risk of diarrhoea morbidity[a]: Part BF vs Excl. BF[b]	No BF vs Excl. BF[b]	No BF vs Part BF[b]	Factors controlled	Reference
Bahrain[c]	1978	?	0–11 mo.			7.0	Case-control study. Pairs matched for age and place of residence (rural/urban). Water-related habits and child care practices were not risk factors for cholera.	*37*
Canada								
Toronto	1939	?	0–11 mo.			5.80		*13*
Manitoba Indian reservation	1972–75	Lower	0–11 mo.		10.32		Marital status of mother, occupation of father, and family income were not associated with breast-feeding. Women who breast-fed for > 12 mo. were older, had more children, less education, and lived in more crowded houses than those who breast-fed for < 12 mo.	*15*
Urban	?	?	0–23 mo.			3.20	Feeding modality controlled for socioeconomic status, parental education, and family size.	*5*
Winnipeg[d]	1976–79	All	0–16 mo.			1.41		*38*
Colombia	1964–65	Lower	0–5 mo. 6–11 mo.	2.37 2.37	2.91 1.64	1.33 0.69		*88*
Costa Rica	1979–82	Lower	0–2 mo. 3–5 mo. 6–8 mo. 9–11 mo.	1.37 3.31	6.47 6.92	4.73 2.09 1.29 1.00		*59*
England								
Liverpoool	1936	Lower/ middle	3–26 wk	6.36	12.85	2.02		*69*
Nationwide	1946–48	Lower	0–3 mo. 4–8 mo. 9–23 mo.	2.57	3.20	1.24 0.79 0.91		*12*
Oxford	?	?	2–11 mo.	2.98	2.33	0.78		*76*

South-east	1968–69	Upper/ middle	0–11 mo.			3.89	Sex, date of birth, birth weight, ages of parents, number of persons per house, number of sibs, and number of sibs at school, were not associated with breast-feeding.	*68*
Nationwide	1970–75	All	0–11 mo.			1.55	Feeding modality controlled for maternal age, child's sex, birth weight, birth rank, maternal smoking, and socio-economic status.	*78*
Ethiopia Addis Ababa	1979	All	0–5 mo.	6.19	9.14	1.48		*80*
			6–11 mo.	0.34	0.67	1.99		
Finland 4 towns	1949	?	0–11 mo.		3.04			*89*
Guatemala	1964	Lower	3–5 mo.	0.85				*32*
			6–8 mo.	1.14				
			9–11 mo.	1.32				
India Punjab	1955–59	Lower	0–2 mo.	1.26				*31*
			3–5 mo.	1.39				
			6–8 mo.	1.17				
			9–11 mo.	1.55				
New Delhi rural	?	Lower	3–5 mo.	1.39				*27*
			6–8 mo.	1.02				
			9–11 mo.	0.95				
urban	?	Middle	3–5 mo.	1.14				
			6–8 mo.	0.97				
Rural	?	?	0–11 mo.			3.01	Feeding modality controlled for socioeconomic status, parental education, occupation, and family size.	*5*
New Delhi	?	Lower	0–5 mo.		5.53		Cases and controls were socio-economically matched and both groups were hospitalized.	*61*
			6–11 mo.		1.20			
Israel	1971	Lower	0–5 mo.	10.47			Twins and infants with low birth-weight or birth defects were excluded.	*46*
Jamaica	1967–68	?	0–3 mo.		3.39[e]		Lower socioeconomic status, non-working mothers at 6 mo. post-birth, and no cribs, were associated with breast-feeding.	*34*

New Zealand								
Christchurch	1977	Upper/ middle	(treated diarrhoea) 0–3 mo.	2.41	3.60	1.49	Relative risks remained significant when controlled for maternal age, parity, parental education, race, number of parents, living standard, gestation period, and birth weight.	22
			(all diarrhoea) 0–3 mo.	3.92	4.99	1.27		
Christchurch	1977–79	Upper/ middle	(treated diarrhoea) 0–3 mo.			2.06	Relative risks for 0–3 mo. group remained significant when controlled for child's sex, maternal age, race, education, smoking, family size, number of parents, and quality of child care.	23
			4–11 mo.			1.23		
			12–23 mo.			0.88		
			(all diarrhoea) 0–3 mo.			2.81		
			4–11 mo.			1.21		
			12–23 mo.			0.97		
Uganda								
Villages near Kampala	1955	All	0–5 mo.	1.71				82
			6–11 mo.	0.64				
USA								
Chicago	1924–29	Lower	2 wk–8 mo.			1.83		35
Chicago	1924–29	Lower	0 mo.	2.24	0.95	0.42		36
			1 mo.	3.00	0.23	0.08		
			2 mo.	3.71	1.90	0.51		
			3 mo.	2.55	2.01	0.79		
			4 mo.			1.67		
			5 mo.			2.29		
			6 mo.			2.63		
			7 mo.			2.72		
			8 mo.			4.34		
Boston	1930–40	All	0–11 mo.			1.20		75
Navajo Indian reservation	1960	Lower	0–2 mo.		4.20[e]			25
			3–5 mo.		2.78[e]			
			6–8 mo.		1.38[e]			
			9–11 mo.		1.98[e]			
California	1973–75	Upper/ middle	0–2 mo.			5.77		49
Iowa	1973–78	Upper/ middle	0–5 mo.			4.15	Number of parents, number of sibs, number of clinic visits of infants with no sibs and those with one or more, parental education, urban vs rural, were not significantly associated with breast-feeding.	63

Cooperstown, NY	1974	Upper/ middle	0–11 mo.			1.97	Relative risks (of all illnesses) remained significant when parental education, maternal age, family size, birth weight, sex, Apgar score, and birth month were controlled. Higher relative risks (of all illnesses) were associated with male infant, lower maternal age, larger family size, and lower birth-weight.	*7, 8, 9*
Arkansas[f]	1977–78	Upper/ middle	0–11 mo.			96.0		*24*
Syracuse	1978	?	0–3 mo.		2.70			*18*
New York City	?	Lower	0–5 mo.			2.72	Feeding modality was controlled for mother's age, parity, ethnicity, and education.	Footnote *g*
Albuquerque, New Mexico	1979	All	0–11 mo.			2.01	Breast-feeding was associated with maternal age and education, home-ownership, and ethnicity, but not with sex, maternal career, family size, water source, medical care source, or day care.	*10*

[a] The relative risk of feeding mode X compared to feeding mode Y is computed by dividing the incidence of diarrhoea for children on feeding mode X by that for children on feeding mode Y. When incidence data were not reported, prevalence was used or the relative risk was computed from data on the distribution of feeding modes among infants with diarrhoea compared to healthy infants.

[b] Categories of feeding mode are defined as follows: Excl. BF = children receiving only breast milk throughout the stated age range; Part BF = children receiving breast milk and other milk and/or food throughout the stated age range and children receiving only breast milk or breast milk plus other milk/food for part of the stated age range; No BF = children receiving no breast milk throughout the stated age range.

[c] This study relates to cholera diarrhoea only.

[d] This study relates to rotavirus diarrhoea only.

[e] Children described as No BF included some who were Part BF and some who were No BF, but these two groups could not be separated.

[f] This study relates to *Salmonella* diarrhoea only.

[g] SOLIMANO, G. ET AL. Morbidity patterns in breast-fed and non-breast-fed infants in a low socioeconomic urban U.S. population. Poster session. *12th International Congress of Nutrition, San Diego, CA, 1981.*

Annex 2

Relative risk of diarrhoea mortality by feeding mode[a]

Country/place	Date of study	Socio-economic status	Age group (inclusive)	Relative risk of diarrhoea mortality[b] Part BF vs Excl. BF[c]	No BF vs Excl. BF[c]	No BF vs Part BF[c]	Factors controlled	Reference

Canada								
Toronto	1939	?	0–11 mo.			6.48		13
Egypt								
Menoufia	1979–80	Lower	0–11 mo.	3.33[d]				79
England								
Derby[e]	1900–03	Lower	0–11 mo.	2.53	5.83	2.31	Children born prematurely, or with defects or malformations, were excluded. Better housing associated with bottle-feeding.	44
Liverpool	1884–86	?	0–2 mo.		15			62
Finsbury[e]	1901–04	?	0–2 mo. 6–8 mo.	9.82	25.24 10.99	2.57		62
Brighton	1903–05	?	0–2 mo. 3–5 mo.	7.33	29.15 43.24	3.98		62
Croydon	1904	?	0–5 mo.		17.22			62
Liverpool	1936–42	Lower/ middle	3–26 wk	3/0[f]	6/0[f]	3.50	Premature and 'weakly' children were excluded.	69
Sweden								
Stockholm	1943–47	All	1–11 mo. 2–11 mo.	1.08 3.25	6.79 18.75	6.27 5.77	Breast-feeding associated with better child care. Relative risks (of total mortality) not influenced by age of mother or birth-weight.	54
USA								
Boston[e]	1911	All	2 wk–11 mo.			13.02		11
8 cities[e]	?	All	1–8 mo. 9–11 mo. 0–11 mo.		11.3 3.5 7.71		Relative risks (of total mortality) remained substantial when race, nationality, prematurity, maternal death, and plural birth were controlled. Relative risks (of total mortality) was higher in lower income groups.	87
Chicago	1924–29	Lower	2 wk–8 mo.			18.82		35, 36

[a] All the studies summarized here contain severe methodological flaws and the relative risks derived should be regarded as indicative only.

[b] The relative risk of feeding mode X compared to feeding mode Y is computed by dividing the diarrhoea mortality rate of children on feeding mode X by that for children on feeding mode Y. Where mortality rates were not reported, the relative risk was computed from data on the distribution of feeding modes among infants who died from diarrhoea compared to healthy infants.

[c] For definitions of feeding modes see footnote *b* to Annex 1.

[d] To compute this relative risk it was necessary to assume that the distribution of feeding modes among infants who died from causes other than diarrhoea was identical to that of infants in the general population. Provided that breast-feeding is not a risk factor for non-diarrhoea deaths, this assumption can only lead to an underestimation of the relative risk.

[e] Rates based on over 100 diarrhoea deaths.

[f] There were 0 deaths in the Excl. BF group.