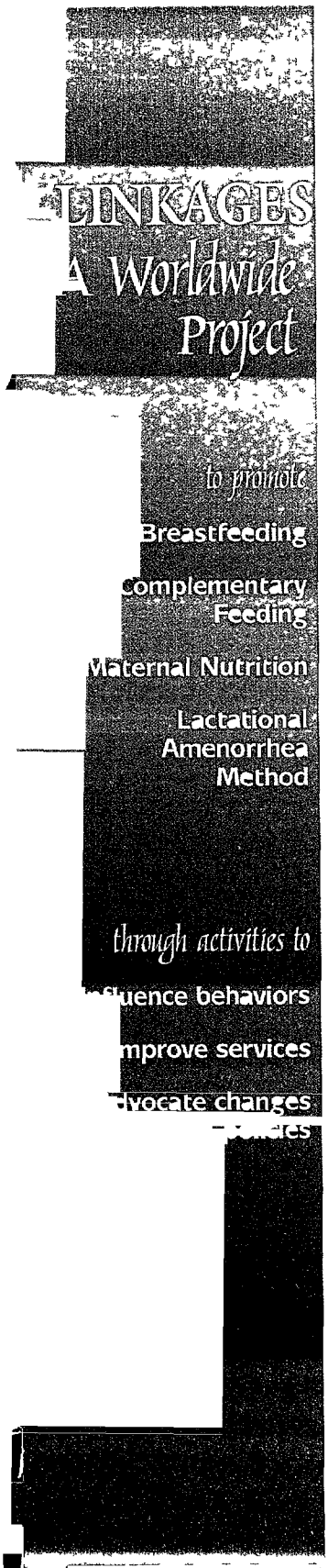

Quantifying the Benefits of Breastfeeding: An Annotated Bibliography

July 1998

Chessa Lutter, PhD

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I. Introduction

This annotated bibliography summarizes the published literature on seven topics related to the benefits of breastfeeding These topics are listed as follows

- Infant morbidity because of diarrhea, acute respiratory infections, and other infectious diseases
- Infant mortality because of diarrhea, acute respiratory infection, and all causes
- Child growth and nutrition (because of the positive effects of longer birth intervals)
- Child developmental and health effects
- Maternal health effects
- Economic benefits
- Environmental benefits

Articles on the association between breastfeeding and health and developmental outcomes are reviewed with respect to four major criteria 1) avoidance of detection bias and reverse causality through the use of an adequate study design, 2) adequate control for confounding factors through statistical analysis, 3) clear definition of breastfeeding, and, 4) clear definition of outcome measure(s) Articles are presented in order of their adherence to these criteria, with the stronger articles presented first

Where sufficient quantitative data are available, tables summarizing the key findings are provided Such tables are available for the topics relating to infant morbidity, infant mortality, child health effects, and maternal health effects

II. Search Methods

The data bases Medline and Popline were searched between February 26 and March 6, 1997 for key words related to the seven topics These key words, identified in italics for each topic, are as follows

- Infant morbidity *breastfeeding, lactation, diarrhea, acute respiratory infection, morbidity*
- Infant mortality *breastfeeding, lactation, infant mortality*
- Child growth and nutrition *breastfeeding, lactation, infant growth, nutritional status, birth intervals, fertility*
- Child developmental and health effects *breastfeeding, lactation, chronic diseases, cardiovascular disease, intelligence*
- Maternal health effects *breastfeeding, lactation, maternal health, breast cancer, ovarian cancer, anemia, hemorrhage, maternal depletion*
- Economic benefits *breastfeeding, lactation, economic benefits, health costs*
- Environmental benefits *breastfeeding, lactation, environmental benefits*

Diskettes containing the results of these searches are provided There are 14 files in total one file for Medline and one for Popline on each topic Information on the search formulation and the number of articles identified at each step of the search is contained in the first page of each search This search was limited to articles published in the English language and except for the topics on the economic and environmental benefits of breastfeeding, limited to articles available in the Library of Medicine of the National Institutes of Health Because the searches identified few published articles available on the economic and environmental benefits of breastfeeding, the review of these effects included unpublished working papers

The search strategy resulted in a large number of articles, only some of which were relevant to the specific topic under investigation For example, the search on infant mortality yielded 783 articles To narrow the search, article titles and key words were reviewed for relevance to the topic In addition, where recent review articles were available, the references were checked against the search to ensure that all relevant articles were identified This review process often resulted in the identification of additional relevant literature

III. Annotated Bibliography

1. Effect of Breastfeeding on Morbidity

1.1 Effect of Breastfeeding on Diarrheal Morbidity

Popkin BM, Adair L, Akin JS et al., Breast-feeding and diarrheal morbidity Pediatr 1990,86(6).874–82

COUNTRY Philippines

SETTING Urban and rural, results presented separately

DESIGN Prospective, n = more than 3,300 infants

BREASTFEEDING DEFINITION Exclusive breastfeeding, breastmilk and non-nutritive liquids only, breastmilk and nutritive foods, no breastmilk

OUTCOME MEASURE Risk of diarrhea

RESULTS Risk of diarrhea was associated with infant feeding mode in both urban and rural samples Exclusively breastfed infants were used as the reference category Among urban infants < 6 months of age, breastfeeding with the addition of non nutritive liquids only resulted in a relative risk of 2 to 3, or from 2 to 3 times the risk of diarrhea (depending on the specific 2 month age interval) The use of nutritive foods with breastmilk resulted in a relative risk of 11 to 13 (depending on the specific 2 month age interval) Infants < 6 months of age who were not breastfed had a relative risk of 13 to 17 (depending on the age interval)

Compared to exclusive breastfeeding, rural infants < 6 months of age given non nutritive liquids only in addition to breastmilk had a relative risk of about 2, or twice the risk of diarrhea Infants < 6 months of age given breastmilk and nutritive foods had a relative risk of 4 to 6 (depending on the specific 2 month age interval) or from 4 to 6 times the risk of diarrhea Infants < 6 months of age who were not breastfed had a relative risk of about 5, or 5 times the risk of diarrhea

After 8 months of age, the association between infant feeding mode and diarrhea declined considerably There was a slight protective effect of breastfeeding compared to no breastfeeding in urban areas only

METHODOLOGICAL ISSUES: The design addresses the problem of reverse causality and numerous control variables were included to control for various biological and behavioral variables that affect susceptibility to illness and exposure to diarrheal pathogens (e g birth weight, weight velocity, sex, household use of soap, etc) Breastfeeding was clearly defined as was the outcome measure

Brown KH, Black RE, de Romana GL, de Kanashiro HC Infant-feeding practices and their relationship with diarrheal and other diseases in Huascar (Lima), Peru. Pediatr 1989,83 31–40

COUNTRY: Peru

SETTING Urban

DESIGN Prospective, n=153 infants

BREASTFEEDING DEFINITION. Exclusive breastfeeding, breastfeeding and other liquids, breastfeeding and artificial milk, breastfeeding and solids, no breastfeeding

OUTCOME MEASURE Risk of diarrhea, acute respiratory infection, and skin infections Only those outcome pertaining to diarrhea are reported here

RESULTS Risk of diarrhea was significantly associated by infant feeding mode in the expected direction Exclusively breastfed infants were used as the reference category The results show that infants < 6 month of age given non nutritive liquids only in addition to breastmilk had a relative risk of about 2 Infants < 6 month of age given breastmilk and artificial milk had a relative risk of 1 6 to 2 4 (depending on the specific 2 month age interval) Infants < 6 months of age given breastmilk and solids had a relative risk of 2 6 to 3 4 (depending on the specific 2 month age interval) Infants < 6 months of age who were not breastfed had a relative risk of 3 4 to 5 5 (depending on the age interval) Breastfeeding and solids was also protective of diarrhea

for infants 6 to 11 month as compared to infants who received artificial milk The relative risk for infants 6 to 8 month was 1 7 and for infants 9 to 11 month was 1 5

METHODOLOGICAL ISSUES The design addresses the problem of reverse causality As compared to the study by Popkin et al , this study controlled for fewer biological and behavioral variables that affect susceptibility to illness and exposure to diarrheal pathogens Breastfeeding and the outcome measures were well defined

Monthrrow AL, Reves RR, West MS, et al , Protection against infection with Giardia Lamblia by breast-feeding in a cohort of Mexican infants Journal of Pediatrics 1992;121·363–70

COUNTRY. Mexico

SETTING Urban

DESIGN Prospective, n=197 followed from birth to 18 month of age

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding

OUTCOME MEASURE Risk of Giardia infection

RESULTS Breastfeeding was significantly associated with both symptomatic and asymptomatic Giardia infection Compared to exclusive breastfeeding, infants who were partially breastfed had a risk ratio of 3 and infants who were not breastfed had a risk ratio of 5 Breastfeeding was not associated with the duration of Giardia infection This article shows that breastfeeding is highly and negatively associated with risk of Giardia infection in a dose-response manner However, once infection is established, breastfeeding is not associated with the severity of infection, as measured by duration of illness

METHODOLOGICAL ISSUES Addressed problem of reverse causality Controlled for other potential confounding factors Examined risk in relation to both first infection and all infections Both breastfeeding and outcome measures were clearly defined

Dewey KG, Heinig MJ, Nommsen-Rivers LA Differences in morbidity between breast-fed and formula-fed infants J Pediatr 1995,126 696–702

COUNTRY USA

SETTING· Urban

DESIGN Prospective, n=45 breastfed infants and n=41 formula fed infants followed for first 24 months of life

BREASTFEEDING DEFINITION Human milk was the major form of milk for breastfeeding infants throughout the first year of life The formula-fed group included infants who had never breastfed and infants who had breastfed < 3 months

OUTCOME MEASURES: Respiratory infection, diarrhea, acute otitis media, other symptoms as measured by weekly maternal recall Medical records were also reviewed Only those results pertaining to diarrhea are reported here

RESULTS: Statistical comparisons between groups were made for two 12-month intervals (birth to 12 months and 12–24 months) Incidence was calculated as the number of episodes per 100 days at risk Prevalence was calculated as the number of days the child was ill during each interval During the first year of life, the incidence of diarrhea was twice as high among formula fed infants as compared to breastfed infants (adjusted incidence/100 days at risk = 0 14 for breastfed infants and 0 31 for formula fed infants) Diarrheal morbidity during the second year of life did not differ between the two groups The authors suggest that breastfeeding is protective against diarrheal disease even in affluent, highly educated populations

METHODOLOGICAL ISSUES Day care use was positively associated with both formula feeding and diarrheal disease and was controlled in the analysis The data were conservatively analyzed with the child rather than each day of observation as the unit of analysis Both breastfeeding and the outcome measures were clearly defined

Mahmood DA, Feachem RG, Huttly SRA Infant feeding and risk of severe diarrhoea in Basrah City, Iraq A case-control study Bull WHO 1989,67(6) 701–6

COUNTRY Iraq

SETTING Urban

DESIGN Case-control Cases (n= 597) and controls (n=723) were infants hospitalized with diarrhea at local health clinics Controls were infants brought in for routine immunizations with no recent history of hospitalization

BREASTFEEDING DEFINITION: Exclusive breastfeeding, partial breastfeeding, no breastfeeding Breastfeeding practices were those prior to onset of illness

OUTCOME MEASURE Risk of hospitalization with diarrhea

RESULTS Diarrhea was significantly affected by infant feeding mode Exclusive breastfeeding was used as the reference category The results show that infants 2 to 3 months of age who were partially breastfed had a relative risk of 6 2 and infants who were not breastfed had a relative risk of 36 7 Infants 3 to 4 months of age who were partially breastfed had a relative risk of 2 9 and infants who were not breastfed had a relative risk of 23 8 Infants older than 6 months were also protected by breastfeeding Among older infants, partial breastfeeding was used as the reference category The relative risk of not breastfeeding for infants 6 to 7 months was 3 9 Among infants 8 to 11 months, there was no protective effect of breastfeeding

This study also examined if previous breastfeeding was protective of diarrhea Previous breastfeeding was defined in two different ways 1) infants who had stopped breastfeeding two months prior to hospitalization and 2) infants who had stopped breastfeeding within two months prior to hospitalization Previous breastfeeding had no protective effect on hospitalization for diarrhea for either measure

Bottle feeding was extremely harmful in young infants Compared to exclusive breastfeeding, infants who were not breastfed and bottle fed had a relative risk of 37 for ages 2 to 3 months and 24 for ages 4 to 5 months Sterilization of bottles as opposed to no sterilization had no effect on hospitalization for diarrhea

It was estimated that 60% of all cases of hospitalized diarrhea could be prevented if optimal infant feeding practices were observed (e g exclusive breastfeeding for all infants < 6 months of age and partial breastfeeding and food thereafter)

METHODOLOGICAL ISSUES Addressed problem of reverse causality and controlled for a number of other potential confounding variables The study calculated population attributable risk Breastfeeding and outcome measures were clearly defined One limitation is the use of hospital rather than community controls

Feachem RG, Koblinsky MA Interventions for the control of diarrhoeal diseases among young children Promotion of breast-feeding Bull WHO 1984,62(2) 271–291

COUNTRY Developed and developing countries

SETTING Various settings

DESIGN Review of 35 studies from 14 counties

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding, no breastfeeding

OUTCOME MEASURES Diarrheal morbidity and mortality Only those outcomes related to diarrheal morbidity are reported here

RESULTS This study reviewed the literature on the relationship between infant feeding mode and risk of diarrheal disease Infant age was broken into the following categories 0–3 month, 3–5 months, 6–8 months, 9–11 month, and 12–23 month A dose-response relationship in the association between infant feeding mode and risk of diarrheal disease was found with infants being exclusively breastfed having the lowest risk, partially breastfed infants of intermediate risk and bottle-fed infants of highest risk Among infants 0–3 months of age the relative risk for no breastfeeding versus exclusive breastfeeding was 3 5, for partial breastfeeding versus exclusive breastfeeding the relative risk was 2 6 and for no breastfeeding versus partial breastfeeding the relative risk was 1 8 The association between infant feeding mode and risk is also related to infant age in a dose-response manner with younger infants deriving the greatest benefit The relative risk for exclusive breastfeeding versus no breastfeeding is 3 for infants aged 0–3 months and 2 4 for infants aged 3–5 months The relative risks for partial breastfeeding and no breastfeeding are 1 3 to 1 5 for infants aged 6–8 and 9–11 months After 1 year of age, no association between infant feeding mode and risk of diarrheal disease was found Also, no association was found between breastfeeding and risk of diarrheal disease once breastfeeding had ceased, indicating that the protective effect of breastfeeding lasted only while breastfeeding continued

METHODOLOGICAL ISSUES The quality of the studies used in the analysis varied considerably Many of the calculations of relative risk are not adjusted for other factors that influence both infant feeding mode and diarrhea Furthermore, tests of significance or confidence intervals are not provided to determine the extent to which the risks are significant

Clemens J, Rao M, Ahmed R, et al Breast-feeding and risk of life-threatening rotavirus diarrhea Prevention or postponement? Pediatrics 1993,923 680–85

COUNTRY Bangladesh

SETTING Rural

DESIGN Case-control Cases (n=102) infants and children < 24 months with clinically severe rotavirus diarrhea Controls (n=2,587) were randomly selected from the community

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding, no breastfeeding

OUTCOME MEASURE Life-threatening rotavirus diarrhea

RESULTS This study examined the association between breastfeeding and the risk of life-threatening rotavirus diarrhea among infants/children younger than 24 months of age No breastfeeding was used as the reference category for calculation of risk Among infants, exclusive breastfeeding and partial breastfeeding were associated with reduced risk of life-threatening rotavirus diarrhea The adjusted relative risk for exclusive breastfeeding is 0 06, suggesting that exclusive breastfeeding is associated with a 94% reduction in severe infection Partial breastfeeding was also associated with reduced risk with an adjusted relative risk of 0 44 After adjusting for potential confounding variables, the trend for increasing protection against severe rotavirus diarrhea in infants by feeding mode was significant and in the expected direction (exclusive breastfeeding > breastfeeding > no breastfeeding) In the second year of life, breastfeeding was not associated with a protective effect In fact, the relative risk for breastfeeding compared to no breastfeeding is elevated (2 85), indicating increased risk among breastfed infants but fails to reach statistical significance because of the large confidence intervals surrounding the estimate Because of this trend toward increased risk in the second year of life, there was no overall protective effect of breastfeeding in the first two years of life The authors argue that breastfeeding may postpone the occurrence of severe rotavirus infection to a later age and that breastfeeding may not have any overall effect on life-threatening rotavirus infection Although the authors do not discuss this issue, it is important to consider the risk to the infant of a life-threatening infection in the context of infant age Although breastfeeding may only delay the risk of infection, it is likely that the consequences of such an infection would be greater for a younger infant than a toddler

METHODOLOGICAL ISSUES Almost all subjects in the study were breastfed, which may have limited statistical power to detect a significant protective effect in the second year of life However, a *posteriori* calculations show that the type II error of missing a true level of protection of only 10% was < 0 01 Life-threatening rotavirus infection appears to be rare and to constitute only a small proportion of total diarrheal cases

Clemens JD, Stanton B, Stoll B, Shahid NS, Banu H, Chowdhury AKML Breastfeeding as a determinant of severity in Shigellosis Amer J Epidemiology 1986,123(4).710–20

COUNTRY: Bangladesh

SETTING Rural

DESIGN Case-control, n = 53 cases and 487 controls All children were < 36 months of age

BREASTFEEDING DEFINITION Breastfed versus non breastfed

OUTCOME MEASURE Severe shigellosis versus non-severe Shigellosis

RESULTS The adjusted odds ratio for severe infection was 0 38 (p< 0 001) for breastfed children, suggesting that breastfeeding was protective of severe infection This protective effect held for all age groups studied (< 12 months, 12–24 months, 24–36 months) This is one of the few studies to show a protective effect of breastfeeding among children greater than 12 months

METHODOLOGICAL ISSUES. Cases were children with severe shigellosis infection and control were children with non severe cases of shigellosis infection Results report the reduction in severity of infection because of any breastfeeding

Ketsela T, Asfaw M, Kebede D Patterns of breast feeding in western Ethiopia and their relationship to acute diarrhoea in infants J Trop Pediat. 1990;36.180–83

COUNTRY: Ethiopia

SETTING Rural

DESIGN Cross sectional, n = 331 infants < 6 months of age, cluster sample at the community level

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding, no breastfeeding

OUTCOME MEASURES Acute diarrhea

RESULTS Exclusive breastfeeding as compared to partial breastfeeding was associated with reduced risk of diarrhea in two of the three age intervals examined (2–4 and 4–6 months of age) The lack of effect between birth and 2 months of age is due to the low prevalence of diarrhea in this age group Among infants 2–4 months of age, the relative risk of partial breastfeeding compared to exclusive breastfeeding was 5 42 (95% confidence interval 2 10, 14 1) Among infants 4–6 months of age, the relative risk of partial breastfeeding compared to exclusive breastfeeding was 5 00 (95% confidence interval 1 53, 16 0) Thus, infants 2–6 months of age who were partially breastfed had 5 times the risk of diarrhea compared to exclusively breastfed infants

METHODOLOGICAL ISSUES Does not control for reverse causality or potential confounding factors Does control for age Both breastfeeding and outcome measures are clearly defined

Hossain MM, Radwan MM, Arafa SA, Habib M, DuPont HL Prelacteal infant feeding practices in rural Egypt J Trop Pediat 1992,38 317–22

COUNTRY Egypt

SETTING Rural

DESIGN Prospective, n = 157 infants followed from birth to 12 months age

BREASTFEEDING DEFINITION The key independent variable in this study is prelacteal feeding, defined as the administration of any foods or drinks to the infant before the first breastfeed Hence, infants are categorized according to prelacteal feeding status, prelacteals versus no prelacteals The relationship between prelacteal status and breastfeeding practices is not presented clearly, which is an important limitation in that the negative effect of prelacteals on diarrhea may be through the effect of prelacteals on subsequent mode of infant feeding For example, the following two conflictive statements on this relationship are presented 1) "Age specific prevalence of exclusive breastfeeding or partial breastfeeding did not differ significantly by prelacteal feeding status" and 2) "prelacteally-fed infants were significantly less likely to be exclusive breastfeeding "

OUTCOME MEASURE Risk of diarrhea

RESULTS Prelacteal feeding was positively though not statistically associated with diarrhea Prelacteal feeding was negatively associated with exclusive breastfeeding in infants < 12 months, but had no effect on breastfeeding mode in infants 12–23 and 24–47 months Although not significant, this study suggests that prelacteal feeding may have a negative effect on diarrhea independent of its relationship to infant feeding mode

METHODOLOGICAL ISSUES Small sample size may limit statistical power and a posterion type II error calculations were not performed The relationship between prelacteal feeds and subsequent breastfeeding practices is not clearly defined

Ahmed F, Clemens JD, Rao MR, Sack DA, Khan MR, Haque E Community-based evaluation of the effect of breast-feeding on the risk of microbiologically confirmed or clinically presumptive Shigellosis in Bangladeshi children Pediatr 1992,90(3) 406–411

COUNTRY Bangladesh

SETTING Within the Matlab surveillance area

DESIGN Case-control Cases (n=269) were children < three years of age with culture-confirmed or clinically presumptive shigellosis Controls (n=819) were children who lived nearby cases and were presumably exposed to the same pathogens but did not have shigellosis or other invasive diarrhea

BREASTFEEDING DEFINITION Exclusive breastfeeding (which included fully breastfeeding children), partial breastfeeding, no breastfeeding

OUTCOME MEASURE. Risk of shigellosis

RESULTS This study examined the effect of infant feeding mode on Shigellosis The results show that any breastfeeding is strongly associated with risk of disease No breastfeeding is used as the reference category for calculation of risk The adjusted odds ratio for any breastfeeding was 0 48, which indicates that breastfeeding was associated with a 52% reduction in risk The strength of the effect was greatest for infants and decreased with age, but was still significant during the third year of life For example, breastfeeding was associated with a reduction in risk of 90%, 60%, and 40% for 0–11 month old infants, 12–24 month old infants, and 24–35 month old infants, respectively Of particular importance was the finding that breastfeeding was associated with a significant protective effect against strains that were resistant to conventional antibiotic treatment (adjusted odds ratio 0 40) The protective effect of breastfeeding was also greater for children who were more stunted (for z score < -3 0, the adjusted odds ratio was 0 30) Overall, approximately two-thirds of the expected shigellosis episodes were apparently prevented by breastfeeding

METHODOLOGICAL ISSUES· All controls were in close contact with a case child and hence the association between breastfeeding and risk of disease is unlikely to be confounded by differences in exposure Breastfeeding was also defined conservatively as any breastmilk All odds ratios were adjusted for known potentially confounding factors

Howie HP, Forsyth JS, Ogston SA, Clark A, du V Florey C Protective effect of breast feeding against infection Br Med J 1990,300.11–16

COUNTRY· Scotland

SETTING Community setting in Dundee

DESIGN Prospective until 24 months of age (n=674 mother/infant pairs)

BREASTFEEDING DEFINITION Breastfeeding duration categorized as follows 1) full breastfeeding (> 13 weeks with only water and juice, n=97), 2) partial breastfeeding (> 13 weeks

with addition of solids and/or formula, n=130), 3) weaned early (< 13 weeks breastfeeding, n=180), and, 4) bottle feeders (n=267)

OUTCOME MEASURE Prevalence of gastroenteritis

RESULTS This study examined the effect of infant feeding mode on gastroenteritis The results show that after adjustment for potential confounding factors (social class, maternal age, and parental smoking) that breastfeeding for 13 weeks or more was associated with a significantly reduced risk of diarrheal incidence in the intervals 24–26 weeks, 27–39 weeks, and 40–52 weeks The effect during the 14–26 weeks interval was particularly strong with a reduction in incidence of between 6 6 and 16 8% Infants breastfeeding < 13 weeks had rates of illness similar to that of bottle fed infants No effect of the timing of introduction of complementary foods on gastroenteritis was observed This was one of the few studies to show that the protective effect of breastfeeding was maintained beyond the period of weaning

METHODOLOGICAL ISSUES This study adjusted for all known potential confounding factors Both breastfeeding and outcome measures were clearly defined Relative risks or odds ratios were not reported

VanDerslice J, Popkin B, Briscoe J Drinking-water quality, sanitation, and breastfeeding their interactive effects on infant health WHO Bull 1994,72 589–601

COUNTRY Philippines

SETTING. Peri urban

DESIGN Prospective, data presented for first 6 months of life only, n=2355

BREASTFEEDING DEFINITION Breastfeeding duration categorized as follows 1) exclusive breastfeeding and breastfeeding with non-nutritive liquids, 2) mixed fed, and, 3) completely weaned

OUTCOME MEASURE Risk of diarrhea and diarrhoeal prevalence as assessed by maternal recall for previous 7 days

RESULTS Using a large cohort followed prospectively, this study examined the effect of various feeding modes on risk of diarrhea Only infants < 6 months of age are included in the present analysis The infant feeding categories of exclusive breastfeeding and breastfeeding with only the addition of non-nutritive liquids are combined for the regression analysis The authors hypothesize that the protective effect of breastfeeding will be greatest when drinking water is contaminated and environmental sanitation is inadequate The results show that exclusive

breastfeeding and full breastfeeding with uncontaminated water were associated with the least risk of diarrhea Supplementing breastfeeding infants with small amounts of contaminated water nearly doubled the risk of diarrhea from 0 08 to 0 15 Full breastfeeding was protective of diarrhea in communities with both good and bad sanitation, however, the magnitude of the effect was twice as high in areas of poor sanitation as opposed to good sanitation

METHODOLOGICAL ISSUES This is one of the strongest studies from an analytic perspective as it uses instrumental variables to avoid the problem of antigenicity in the dependent variables The results are consistent and biologically plausible with a dose-response in the relationship between degrees of breastfeeding and risk, and also with infants in less clean environments deriving a greater benefit from breastfeeding

Megraud F, Bourdraa G, Bessaoud K, Bensid S, Dabis F, Soltana R, Touhami M Incidence of Campylobacter infection in infants in Western Algeria and the possible protective role of breastfeeding Epidemiol Infect 1990,105 73–8

COUNTRY: Algeria

SETTING Urban/rural

DESIGN: Case-control, cases (n=411) are infants who presented at a clinic with diarrhea, controls (n=217) are infants who came to the clinic for immunizations and who did not have diarrhea in the previous 2 weeks

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding

OUTCOME MEASURE· Incidence of Campylobacter infection

RESULTS. Exclusive breastfeeding as compared to partial breastfeeding significantly protects infants < 6 months of age from campylobacter infection The odds ratio was 0 1, which suggests a 90% reduction in infection Overall the odds ratio for infants (< 12 month) was 0 3, which suggests a 70% reduction in infection

METHODOLOGICAL ISSUES The authors state that only infants < 6 months were breastfed, which makes it impossible to study the role of breastfeeding on risk of Campylobacter infection among older infants Reverse causality was not addressed Data were not adjusted for socioeconomic status Controls were from a clinic setting rather than the community, which may limit the external validity of the study

Clavano NR Mode of feeding and its effect on infant mortality and morbidity J Trop Pediatr 1982,28 28–93

COUNTRY Philippines

SETTING Urban

DESIGN Cross-sectional, infants (n=9,886) born in hospital with infant feeding mode recorded on medical record

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding, no breastfeeding, infant feeding mode unknown

OUTCOME MEASURE. Risk of diarrhea and mortality in the early neonatal period

RESULTS Mode of infant feeding in the hospital was significantly related to risk of diarrhea Of the 138 infants with diarrhea, 90% were formula fed, 6% were partially breastfed, and 4% were exclusively breastfed Mode of infant feeding was also significantly related to mortality Of the 67 infants who died, 96% were formula-fed, 1% were partially breastfed, and 3% were exclusively breastfed The study covers period of 4 years during which rooming-in and formal breastfeeding policies were introduced After rooming-in and formal breastfeeding policies were introduced, the proportion of infants exclusive breastfeeding increased by 135% and the incidence of death among clinically infected newborns dropped by 95 3%

METHODOLOGICAL ISSUES Reverse causality was not controlled, which is a major limitation given that the risk of death in the early neonatal period is significant and is likely to also affect infant feeding mode

Kovar MG, Serdula MK, Marks JS, Fraser DW Review of the epidemiologic evidence for an association between infant feeding and infant health Pediatr 1984,74(4 Part 2 supplement) 615–638)

COUNTRY USA and other industrialized countries

SETTING Various settings

DESIGN Review article of studies published since 1970

BREASTFEEDING DEFINITION Depends on the study

OUTCOME MEASURE Mortality and morbidity patterns, allergic diseases, malnutrition, psychological and intellectual development Only those outcomes related to diarrheal morbidity are reviewed here

RESULTS This study reviewed the literature on the association between infant feeding mode and a number of outcome measures It found that the number of post-neonatal deaths with a cause attributable to a hypothesized association with infant feeding method is not trivial However, evidence was not available to determine the actual association between feeding methods and post-neonatal mortality With respect to diarrheal morbidity, the authors found that although most of the studies had significant methodological shortcomings, they showed an association between breastfeeding and reduced risk of infection This is an outdated but nonetheless excellent review that has recently been updated in the following reference Heinig MJ, Dewey KG Health advantages of breast feeding for infants A critical review *Nutr Res Rev* 1996,9 89–110

Heinig MJ, Dewey KG Health advantages of breast feeding for infants· A critical review. Nutr Res Rev 1996,9 89–110

COUNTRY. U S and other industrialized countries

SETTING Rural and urban

DESIGN Review article of studies published since 1970

BREASTFEEDING DEFINITION Variable depending on the study

OUTCOME MEASURES Physiological and behavioral development, morbidity (acute infectious diseases, gastrointestinal disease, necrotizing enterocolitis, respiratory diseases, otitis media, bacteremia and meningitis, infant botulism, urinary tract infections, chronic illness, insulin-dependent diabetes mellitus, chron's disease and ulcerative colitis, childhood cancer, allergy), and mortality

RESULTS. This study reviewed the literature on the association between infant feeding mode and a large number of outcome measures Overall it found that breastmilk is associated with small though consistent differences in cognitive tests, diarrheal disease, lower respiratory disease, and otitis media It found that breastfeeding may be associated with a number of other outcomes but that the evidence is incomplete This is an excellent review and has a comprehensive reference list that is useful if one needs to find articles looking at the relationship between breastmilk and specific disease outcomes

Duffy LC, Tyers TE, et al , The effects of infant feeding on rotavirus-induced gastroenteritis A prospective study Amer J Public Health 1986,76 259–263

COUNTRY USA

SETTING. Urban

DESIGN Prospective, n = 197 infants followed from birth to about 9 months of age

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding, bottle feeding

OUTCOME MEASURE Risk of non-specific gastroenteritis and rotavirus infection

RESULTS This study followed a cohort of low socioeconomic status infants from birth through the winter rotavirus season, which occurred when the infants were between 6 and 9 months of age Infants were categorized by infant feeding mode at birth (exclusive breastfeeding, partial breastfeeding, bottle-feeding) and again at 4 months of age Infants exclusively breastfeeding through 4 months of age had the lowest attack rate of non-specific gastroenteritis The relative risk was 29 compared to other infant feeding modes, which were used as the reference group There was no evidence of a protective effect of breastfeeding for rotavirus infection However, breastfeeding infants did have less severe forms of infection

METHODOLOGICAL ISSUES This is a methodologically strong study, which controlled for many potential confounding factors

Kumar V, Kumar L, Diwedi P Morbidity related to feeding pattern in privileged urban and under privileged rural infants Indian Pediatrics 1981,18 743–749

COUNTRY India

SETTING Urban and rural community based

DESIGN Prospective, n=170 infants from upper socioeconomic status urban families and n=109 infants from lower socioeconomic status rural families

BREASTFEEDING DEFINITION Exclusive breastfeeding for first four months without supplementation, mixed fed (breastfed for first 4 months with supplementation), bottle-fed (not breastfeeding or breastfeeding < 4 months)

OUTCOME MEASURES Diarrhea, upper respiratory tract infection, fever, otitis media, skin infections Only those results pertaining to diarrhea are presented here

RESULTS The results show that among upper socioeconomic infants, mixed or bottle feeding was associated with twice the risk of total illness as compared to exclusive breastfeeding during the first 4 months of life Most of this association was explained by the association between feeding mode and diarrhea a four-fold difference was found between exclusive breastfeeding and mixed or bottle-fed infants with respect to risk of diarrhea The association between exclusive breastfeeding versus mixed or bottle feeding and total illness was less strong though still significant between 5 and 12 months of life Among the poor rural infants, partial breastfeeding was associated with a 4 fold risk of diarrhea during the first 4 months of life compared to exclusive breastfeeding (No infants were weaned and so no comparisons for this infant feeding mode could be made)

METHODOLOGICAL ISSUES· This is really two separate studies, one examining the association between infant feeding mode and illness among upper socioeconomic urban infants and the second examining the same relationships among lower socioeconomic rural infants The study does not control for potential confounding factors that may be associated with infant feeding practices and risk of illness or reverse causality

Mondal SK, Sen Gupta PG, Gupta DN, Ghosh S, et al., Occurrence of diarrhoeal disease in relation to infant feeding practices in a rural community in West Bengal, India. Acta Paediatr 1996,85 1159–1162

COUNTRY India

SETTING Rural

DESIGN Community-based prospective study of 148 infants ages 0 to 2 years who were followed for 12 months

BREASTFEEDING DEFINITION· Exclusively breastfed, predominantly breastfed (includes water and water-based drinks), partially breastfed, not breastfed

OUTCOME MEASURES· Incidence of diarrhea

RESULTS This prospective community-based study examined the relationship between diarrhea and infant feeding patterns The results show that although most infants are breastfed for more than one year, the duration of exclusive breastfeeding is short Infants who were switched from exclusive to partial breastfeeding prior to 3 months of age had an incidence rate ratio for diarrhea of 3 02 with a 95% confidence interval of 1 043 to 8 802 This shows that early complementary feeding (< 3 months) was associated with three times the risk of diarrhea

METHODOLOGICAL ISSUES The authors use the terminology "weaned" to describe infants who are being fed complementary foods

Bohler E, Aalen O, Bergstrom S, Halvorsen S Breast feeding and seasonal determinants of child growth in weight in East Bhutan Acta Paediatr 1995,84 1029–1034

COUNTRY Bhutan

SETTING Rural

DESIGN Prospective cohort (n = 113) followed for 32 months

BREASTFEEDING DEFINITION Partially breastfed versus not breastfed Infant feeding practices were recorded monthly

OUTCOME MEASURES Incidence of diarrhea, respiratory tract infection, and weight gain Only those results related to diarrhea are reported here

RESULTS The relationship between breastfeeding practices, morbidity, and child nutritional status in relation to seasonal rainfall was studied monthly in a cohort of 113 children who were followed monthly for 32 months The analysis focused only on children from 12 to 36 months of age Breastfeeding between 13 and 36 months of age was associated with reduced risk of diarrhea The odds ratio was 0 51 with a 95% confidence interval of 0 34 and 0 78 Breastfed children also gained significantly more weight during the monsoon season, and protected children against weight loss because of diarrhea This is one of the few studies to show a protective effect of breastfeeding after infancy

METHODOLOGICAL ISSUES The authors did not provide socioeconomic characteristics of the families of breastfeeding versus non breastfeeding children nor did they control for potential confounding variables, which may have biased the results

Long KZ, Wood JW, Garıby EV, Weiss KM, Mathewson JJ, de la Cabada FJ, duPont H, Wilson RA Proportional hazards analysis of diarrhea due to Enterotoxigenic Escherichia coli and breastfeeding in a cohort of urban Mexican children Amer J Epidem 1994,139 193–205

COUNTRY Mexico

SETTING Urban

DESIGN Prospective, n = 98 mother/infant pairs followed for the first 3 to 50 weeks of the infants' life

BREASTFEEDING DEFINITION Exclusively breastfed, partially breastfed, not breastfed

OUTCOME MEASURES Incidence and duration of diarrhea

RESULTS Non breastfed infants fed only formula had an incidence density of diarrhea more than three times higher than exclusively breastfed infants and twice as high as partially breastfed infants Of particular interest is the finding that infants colonized with enterotoxigenic Escherichia coli producing heat-labile toxin (LT-ETEC) have a lower risk of diarrhea when breastfed, specifically by the amount of pathogen-specific secretory antibody the infant is receiving per day via the mother's breastmilk, and by the provision of medicinal teas The risk of LC-ETEC is associated with the introduction of high-carbohydrate weaning foods This study shows that the introduction of complementary foods increases the hazard of pathogen colonization and that the symptomatic expression of infection depends on the amount of protective antibody the infant receives via breastmilk

METHODOLOGICAL ISSUES This is an excellent study that shows through laboratory measures that breastfeeding protects infants against diarrhea through two long hypothesized mechanisms 1) reduced risk of pathogens from contaminated complementary foods and 2) the transfer of antibodies through breastmilk

Mobak K, Gottschau A, Aaby P, Hojlyng N, Ingholt L, de Silva APJ. Prolonged breast feeding, diarrhoeal disease, and survival of children in Guinea-Bissau. Br Med J 1994,308 1403–1406

COUNTRY Guinea-Bissau

SETTING Urban

DESIGN Community based cohort study (n=849) of children under 3 years of age

BREASTFEEDING DEFINITION Exclusively breastfed, partially breastfed, weaned

OUTCOME MEASURES Incidence and duration of diarrhea

RESULTS Weaning was significantly associated with increased risk of diarrhea Among children 12 to 24 months, the relative risk of diarrhea was 1 41 for weaned children (95% confidence interval, 1 29 to 1 62) compared to children still breastfed The mean duration of diarrhea was also significantly longer in weaned children compared to breastfed children (6 6 versus 5 3 days)

(p<0 001) Among children 24 to 36 months, the relative risk of diarrhea was 1 67 (95% confidence interval, 1 29 to 2 15) for weaned children compared to children still breastfed A similar increase in risk of diarrhea was found when the rate and duration was compared one month before and one month after weaning for each child These results were independent of age of weaning and show that the protective effect of breastfeeding on diarrhea is unlikely to be confounded by unknown factors associated with both infant feeding practices and risk of diarrhea The longitudinal analysis also shows that children with low weight-for-age were breastfed longer than the better nourished children (p<0 02) Paired analysis showed no improvement in nutritional status after weaning This finding suggests that mothers tend to wean poorly nourished children later than well nourished children and that the association between prolonged breastfeeding and poor nutritional status is explained by maternal behaviors regarding children who are doing poorly rather than a negative effect of breastfeeding on child growth

METHODOLOGICAL ISSUES This is one of the few studies to show a protective effect of breastfeeding on risk of diarrhea among children 12 to 36 months of age It is methodologically strong in that it controls for potential confounding in the relationship between infant feeding practices and risk of diarrhea by conducting within child analyses

Unni JC, Richard J Growth and Morbidity of Breast-fed and artificially-fed infants in urban South Indian families J Trop Pediatr 1988,34 179–81

COUNTRY India

SETTING. Urban

DESIGN Prospective (clinic based), n = 271 infants followed from birth to 22 weeks However, only 60 infants completed the study

BREASTFEEDING DEFINITION Group 1 = exclusive breastfeeding or breastfeeding 5 or more times per day, Group 2 = breastfeeding fewer than 4 times per day or artificially fed

OUTCOME MEASURES Diarrheal morbidity

RESULTS· The relationship between feeding mode and diarrhea was only significant at 6 and 14 weeks

METHODOLOGICAL ISSUES This is a weak study, with the potential for a large degree of misclassification between infant feeding modes No infants were exclusively breastfed Attrition was extremely high It did not control for reverse causality nor control for potential confounding factors

Campbell CE, Latham MC Infant feeding and morbidity among poor migrant squatters in Hermosillo, Sonora, Mexico Nutr Res 1988,8 969–979

COUNTRY. Mexico

SETTING Rural

DESIGN Prospective, n=105 poor migrant women and infants < 8 months

BREASTFEEDING DEFINITION Partial breastfeeding, age at weaning

OUTCOME MEASURE: Incidence of diarrhea as assessed by maternal recall for prior two week period

RESULTS The study was divided into three rounds of data collection Regression analysis showed that partial breastfeeding versus no breastfeeding was significantly associated with reduced risk of diarrhea illnesses at all three rounds of data collection The data on risk of illness and infant feeding mode are not presented in a manner that permits the exact effect to be quantified

METHODOLOGICAL ISSUES: The analysis did control for potential confounding factors but not for reverse causality

Jalil F, Karlberg J, Hanson LA, Lindblad BS Growth disturbance in an urban area of Lahore, Pakistan related to feeding patterns, infections and age, sex, socio-economic factors and seasons Acta Paediatr Suppl 1989,350 44–54

COUNTRY. Pakistan

SETTING Urban

DESIGN Prospective, n=910 infants followed every 3 months from birth to 24 months of age

BREASTFEEDING DEFINITION Inadequate "Age at weaning" used to examine the relationship between infant feeding mode and morbidity However, this term was never defined and it cannot be determined whether this indicated the age at which other foods were introduced or when breastfeeding ceased

OUTCOME MEASURE Risk of diarrhea

RESULTS Did not find an association between "age at weaning" and diarrheal morbidity

METHODOLOGICAL ISSUES Infant feeding mode poorly categorized

Oyejide CO, Fagbami AH An epidemiologic study of rotavirus diarrhoea in a cohort of Nigerian infants II incidence of diarrhoea in the first two years of life Int J Epidemio 1988,17 908–912

COUNTRY Nigeria

SETTING Urban

DESIGN Prospective, n=131 infants followed every 3 months from birth to 24 months of age

BREASTFEEDING DEFINITION Inadequate Not well defined with respect to outcome measure

OUTCOME MEASURES Incidence of acute diarrhea and rotavirus diarrhea

RESULTS The focus of this study was to examine the epidemiology of rotavirus infection during the first 2 years of life Information on breastfeeding appears to be ancillary to the main focus of the study The authors report that breastfeeding was common but that exclusive breastfeeding was rare within the first month of life nearly 90% of infants were also being bottle-fed No association between infant feeding mode and rotavirus infection was found However, the breastfeeding definitions and methods used to test this association were not reported, making it difficult to assess the validity of the finding

METHODOLOGICAL ISSUES Infant feeding mode poorly categorized

Rubin DH, Leventhal JM, Krasilnikoff PA, et al , Relationships between infant feeding and infectious illness A prospective study of infants during the first year of life Pediatr 1990,85 464–471.

COUNTRY Denmark

SETTING Urban

DESIGN Prospective for first year of child's life (n=500) Monthly questionnaires mailed to mothers

BREASTFEEDING DEFINITION The following breastfeeding definitions were used 1) exclusive breastfeeding, 2) breastfeeding > formula feeding, 3) breastfeeding = formula feeding, 4) breastfeeding < formula feeding, and, 5) formula feeding only

OUTCOME MEASURE Four outcome measures were used of which one, gastroenteritis, pertains to diarrheal disease

RESULTS The authors used child months of observation as the unit of analysis After adjustment for major co-variates (birth weight, social class, number of children in the family, day care, other illnesses in the family), no significant relationships were found between infant feeding category and risk of gastroenteritis The authors conclude that breastfeeding does not provide substantial protection against gastroenteritis during infancy in a middle-income population in a developed country

METHODOLOGICAL ISSUES Measurement error is a potential problem in this study, particularly with respect to the two mixed feeding groups identified as "breast feeding > formula feeding" and "formula feeding > breast feeding " Infant feeding mode was based on maternal recall and the potential for misclassification among mothers of mixed fed infants is substantial For the majority of the analyses, the mixed-fed infants were grouped with the exclusive breastfeeding infants or bottle-fed infants (exclusive breastfeeding and breastfeeding > formula feeding versus bottle-fed and formula feeding > breastfeeding) Thus, misclassification may have biased the findings toward the null The overall response rate was 73%, ranging from 92% at month 1 to 44% at month 12 Mothers were blind to the study objectives

Ruuska T Occurrence of acute diarrhea in atopic and nonatopic infants. The role of prolonged breast-feeding J Pediatr Gastro Nutr 1992,14 27–33

COUNTRY Finland

SETTING Urban

DESIGN Prospective, n=336 infants followed for a total of 717 child-years

BREASTFEEDING DEFINITION The following breastfeeding definitions were used 1) breastfeeding < 6 months, 2) breastfeeding 7–12 months, 3) breastfeeding 13–24 months

OUTCOME MEASURE: Episodes of diarrhea stratified by whether the child also had gastrointestinal allergy, atopic eczema, or was nonatopic

RESULTS In this study, 83% of infants breastfed for at least 3 months and 71% breastfed for 6 months of life The incidence of diarrheal disease was relatively low The effect of breastfeeding

on risk of diarrhea was variable and associated with the atopic status of the child Breastfeeding for more than 6 months was associated with reduced risk of diarrhea in the first year, with the effect being greater in non-atopic compared to atopic infants During the second year of life the authors report that breastfeeding was associated with increased risk of diarrhea so that there was no overall effect on the incidence of diarrhea during the first two years of life However, they do not show data to support their assertion

METHODOLOGICAL ISSUES This is a confusing study that does not adequately control for the time dependent nature of the protective effect of breastfeeding on diarrhea For example the authors show that infants age 0 to 6 months who are breastfed for more than 6 months have fewer episodes of diarrhea as compared to infants who are breastfed for < 6 months This analysis ignores the fact that infant feeding mode after 6 months cannot affect risk of diarrhea prior to 6 months

Mazrou YY, Khan MU, Aziz KMS, Farag MK Role of social factors in the prevalence of diarrhoeal diseases in under-five Saudi children J Trop Pediatr 1995,41 (Supplement 1) 45–51

COUNTRY Saudi Arabia

SETTING Urban/rural

DESIGN Cross-sectional, n = 4756 children < 5 years

BREASTFEEDING DEFINITION· Exclusive breastfeeding, breastfeeding and bottle-fed, bottle-fed only, other food only

OUTCOME MEASURE Prevalence of diarrhea

RESULTS The prevalence of diarrhea was 18 5 percent, 23 3 percent, 17 7 percent and 13 percent for children exclusively breastfed, breastfed and bottle-fed, bottle-fed only, and receiving other food only, respectively The prevalence of diarrhea is significantly higher in infants in the breastfeeding and bottle category as compared to other categories

METHODOLOGICAL ISSUES The data are not age adjusted, which is important as breastfeeding practices and risk of diarrhea are related to age Does not control for socioeconomic status and the authors state that breastfeeding is more common among non-educated rural mothers and most women who only bottle fed are educated and employed Thus there is the potential for large biases in reported associations because of confounding by age and socioeconomic status

Scott-Emuakpor MM, Okafor UA. Comparative study of morbidity and mortality of breast-fed and bottle-fed Nigerian infants East African Med J 1986,63(7) 452–457

Country Nigeria

SETTING Urban
DESIGN Retrospective, n=401 mothers (who had a total of 414 children ages 0 to 24 months) attending various clinics and who were questioned about infant feeding practices and child illnesses and mortality

BREASTFEEDING DEFINITION. Exclusively breastfed, partially breastfed, weaned

OUTCOME MEASURES Diarrheal morbidity

RESULTS The risk of diarrheal illness was significantly lower in exclusively breastfed children compared to partially breastfed or bottle-fed children (p<0 001)

METHODOLOGICAL ISSUES The data are not age-adjusted, which would tend to bias the analyses in favor of a protective effect of exclusive breastfeeding on morbidity

1. Effect of Breastfeeding on Morbidity
1.2 Effect of Breastfeeding on Respiratory Infection Morbidity

Brown KH, Black RE, de Romana GL, de Kanashiro HC Infant-feeding practices and their relationship with diarrheal and other diseases in Huascar (Lima), Peru Pediatrics 1989,83 31–40.

COUNTRY Peru

SETTING Urban

DESIGN Prospective, n=153 infants

BREASTFEEDING DEFINITION. Exclusive breastfeeding, breastfeeding and other liquids, breastfeeding and artificial milk, breastfeeding and solids, no breastfeeding

OUTCOME MEASURE Risk of diarrhea, acute respiratory infection, and skin infections Only those outcomes pertaining to acute respiratory infection are reported

RESULTS Risk of acute respiratory infection was significantly associated with infant feeding mode in the expected direction Exclusive breastfeeding infants were used as the reference category Infants < 6 months of age who received other liquids in addition to breastmilk had a relative risk of 1 8 No breastfeeding was associated with a relative risk of 4 1

Launer LJ, Habicht J-P, Kardjati S Breast feeding protects against illness and weight loss due to illness Amer J Epidemio 1990,131(2) 322–331

COUNTRY Indonesia

SETTING Rural

DESIGN Prospective, n=33 infants 3–12 months of age

BREASTFEEDING DEFINITION Infants categorized into four groups according to the amount of time (measured in minutes) spent breastfeeding during the observation periods None were exclusively breastfeeding

OUTCOME MEASURE Acute respiratory infection

RESULTS Measured diarrheal prevalence was too low to assess its relationship to breastfeeding The effect of breastfeeding on fever was not significant There was a significant decrease in the number of days ill from acute respiratory infection as time spent breastfeeding increased Breastfeeding also prevented weight loss because of acute respiratory infection

METHODOLOGICAL ISSUES Small sample size and low prevalence of illness reduced statistical power to detect significant differences Also, exclusive breastfeeding was not practiced in this setting Differences in specific infant feeding modes were not examined

Dewey KG, Heinig MJ, Nommsen-Rivers LA Differences in morbidity between breast-fed and formula-fed infants J Pediatr 1995,126 696–702

Country USA

SETTING Urban

DESIGN Prospective, n=45 breastfed infants and n=41 formula fed infants followed for first 24 months of life

BREASTFEEDING DEFINITION Human milk was the major form of milk for breastfeeding infants throughout the first year The formula-fed group included infants who had never breastfed and infants who had breast-fed < 3 months

OUTCOME MEASURES Respiratory infection, diarrhea, acute otitis media, other symptoms as measured by weekly maternal recall and medical records Only those findings pertaining to respiratory infection are reported here

RESULTS Statistical comparisons between groups were made for 12-month intervals (birth–12 months and 12–24 months) Incidence was calculated as the number of episodes per 100 days at risk Prevalence was calculated as the number of days the child was ill during each interval Day care use was positively associated with risk of respiratory infection in the formula-fed group but not in the breastfed group The number of siblings was positively associated with incidence of respiratory infection in the breastfed group but not in the bottle-fed group Controlling for these factors (day care and siblings), no association was found between the incidence of respiratory infection and infant feeding mode during either the first year or second year of life

METHODOLOGICAL ISSUES The data were conservatively analyzed with the child rather than each day of observation as the unit of analysis

Douglas RM, Woodward A, Miles H, Buetow S, Morris D A prospective study of proneness to acute respiratory illness in the first two years of life Int J Epidemio 1994,23(4)·818–826

COUNTRY Australia

SETTING Urban

DESIGN Prospective for first 24 months of child's life Large drop-out rate

BREASTFEEDING DEFINITION Duration of partial breastfeeding

OUTCOME MEASURE. Two outcome measures were used 1) "Proneness score" developed by adding together the percent of days with a cold, dry cough, or wheezy/noisy breathing and 2) episodes of acute respiratory infection Outcome information was recorded by the mother

RESULTS Increased duration of breastfeeding was associated with an increase in episodes of respiratory infection and a higher "proneness score" in the second year of life Passive smoking was inversely associated with respiratory episodes indicating that children exposed to passive smoke had fewer episodes than children not exposed Both findings are contrary to other published reports showing breastfeeding to be protective of respiratory illness and passive smoke exposure to be positively associated with respiratory illness

METHODOLOGICAL ISSUES Poor definition of breastfeeding and the extremely high drop-out rate limits the credibility of the study The amount of variance explained for the two outcome measures was low, which suggests either measurement error or selection of an inappropriate outcome

Wright AL, Holberg CJ, Martinez FD, Morgan WJ, Taussig LM Breast feeding and lower respiratory tract illness in the first year of life Br Med J 1989,299 946–949

COUNTRY USA

SETTING Urban children enrolled in a health maintenance organization

DESIGN Prospective ascertainment of illness during infancy Retrospective ascertainment of breastfeeding

BREASTFEEDING DEFINITION Duration of any breastfeeding categorized as follows 1) 0–1 month, 2) 1–4 months, and, 3) > 4 months

OUTCOME MEASURE Type of lower respiratory tract illness (wheezing and non-wheezing) at different age intervals during infancy

RESULTS This study investigated the effect of any breastfeeding on lower respiratory tract infection during infancy The results show that breastfeeding was associated with reduced risk of wheezing illness only during the first 4 months of life The adjusted odds ratio was 1 7 Non wheezing illnesses were not associated with infant feeding mode An interactive effect between breastfeeding and sharing a room and wheezing illness was found infants who shared a room and were not breastfeeding had three times the risk of a wheezing illness as compared to infants who were exposed to only one of these risk factors The authors conclude that breastfeeding protects against wheezing respiratory tract illness only in the first 4 months of life and that these effects are particularly strong when other risk factors, such as sharing a room are present

Wright AL, Holberg CJ, Taussig LM, Martinez FD Relationship of infant feeding to recurrent wheezing at age 6 years Arch Pediatr Adolesc Med 1995,149 458–763

COUNTRY USA

SETTING Urban

DESIGN Prospective for first 6 years of the child's life A total of 1,246 infants enrolled in the study with both infant feeding data and data on wheezing at 6 years of age available

BREASTFEEDING DEFINITION Duration of any breastfeeding categorized by one-month intervals

OUTCOME MEASURE: Recurrent wheezing, defined as four or more episodes in the past year as assessed by parental questionnaire Atopic skin disease was assessed by skin prick tests

RESULTS. This study investigated two hypotheses 1) breastfeeding for any length of time is associated with lower rates of recurrent wheezing at 6 years of age and 2) the apparent protective effect of breastfeeding against recurrent wheezing is attributable to the fact that breastfed children are less likely to have had wheezing lower respiratory infections early in life The results show that when potential confounding factors are included in a multi-variate model, nonatopic children who had not been breastfed had three times the odds of recurrent wheezing (odds ratio = 3 03) The authors conclude that 11% of recurrent wheezing among nonatopic children could be attributed to not breastfeeding Breastfeeding duration did not affect this relationship the same degree of protection was afforded by 1 month of breastfeeding as 6 months Breastfeeding had no affect on wheezing among atopic children

METHODOLOGICAL ISSUES Although the authors controlled for many potential confounding factors, because of the different characteristics of families of breastfed and not breastfed children it is possible that a third factor related to both breastfeeding and wheezing may explain the associations found

Forman MR, Graubard BI, Hoffman HJ, Harley EE, Bennett P The Pima infant feeding study and respiratory infections during the first year of life Int J Epid 1984,13 447–453

COUNTRY U S , population of American Indians

SETTING. Rural

DESIGN: Retrospective, n=571 infants studied

BREASTFEEDING DEFINITION· Infants were categorized into three infant feeding groups as follows 1) bottle-fed only , 2) partially breastfed and bottle-fed, and 3) exclusively breastfed for 5 months and then mixed breastmilk and other foods (about 25% also received a bottle during the period of mixed feeding)

OUTCOME MEASURE Risk of first episode of upper respiratory infection for which treatment was sought at a hospital

RESULTS Among infants with a first respiratory infection between birth and 4 months of age, exclusive breastfeeding was associated with significantly lower rates as compared to partially breastfeeding or bottle-fed infants The adjusted odds ratio for this association was 0 61 (p=0 05) The adjusted odds ratio between 5 and 8 months of age is 0 48 (p=0 02) There was no association between infant feeding mode and risk of respiratory infection between 9 and 12 months of age Overall, the adjusted odds ratio of an upper respiratory infection during the first year of life among exclusive breastfeeding infants was 0 63 (p=0 06) Infant feeding mode was not associated with risk of pneumonia Partial breastfeeding was associated with an increased risk of otitis media as compared to exclusive breastfeeding or bottle feeding

METHODOLOGICAL ISSUES·

Bohler E, Aalen O, Bergstrom S, Halvorsen S Breast feeding and seasonal determinants of child growth in weight in East Bhutan Acta Paediatr 1995,84·1029–1034

COUNTRY Bhutan

SETTING. Rural

DESIGN Prospective cohort (n = 113) followed for 32 months

BREASTFEEDING DEFINITION Partially breastfed versus not breastfed Infant feeding practices were recorded monthly

OUTCOME MEASURES Incidence of diarrhea, respiratory tract infection, and weight gain Only those results related to respiratory tract infection are reported here

RESULTS The relationship between breastfeeding practices, morbidity, and child nutritional status in relation to seasonal rainfall was studied monthly in a cohort of 113 children who were followed monthly for 32 months The analysis focused only on children from 12 to 36 months of age Breastfeeding between 13 and 36 months of age was associated with reduced risk of respiratory tract infection The odds ratio was 0 63 with a 95% confidence interval of 0 40 and 0 99 Breastfed children also gained significantly more weight during the monsoon season This is one of the few studies to show a protective effect of breastfeeding after infancy

METHODOLOGICAL ISSUES The authors did not provide socioeconomic characteristics of the families of breastfeeding versus non breastfeeding children nor did they control for potential confounding variables, which may have biased the results

Rubin DH, Leventhal JM, Krasilnikoff PA, et al , Relationships between infant feeding and infectious illness A prospective study of infants during the first year of life Pediatr 1990,85 464–471

Country· Denmark

Setting. Urban

Design: Prospective for first year of child's life Of the monthly questionnaires mailed to mothers, the overall response rate was 73% Mothers were blind to the study objectives

BREASTFEEDING DEFINITION The following breastfeeding definitions were used 1) exclusive breastfeeding, 2) breastfeeding > formula feeding, 3) breastfeeding = formula feeding, 4) breastfeeding < formula feeding, and, 5) formula feeding only

OUTCOME MEASURE Three of the four outcome measures used pertain to respiratory infections 1) upper respiratory infection, 2) otitis media, and, 3) lower respiratory illness

RESULTS· The authors used child months of observation as the unit of analysis After adjustment for major co-variates (birth weight, social class, number of children in the family, day care, other illnesses in the family), no significant relationships were found between infant feeding category and any of the illnesses examined The authors conclude that breastfeeding does not provide substantial protection against common childhood illnesses during infancy in a middle-income population in a developed country

METHODOLOGICAL ISSUES Measurement error is a potential problem in this study, particularly with respect to the two mixed feeding groups identified as "breast feeding > formula feeding" and "formula feeding > breast feeding " Infant feeding mode was based on maternal recall and the potential for misclassification among mothers of mixed fed infants is substantial For the majority of the analyses, the mixed-fed infants were grouped with the exclusive breastfeeding infants or bottle-fed infants (exclusive breastfeeding and breastfeeding > formula feeding versus bottle-fed and formula feeding > breastfeeding) Thus, misclassification may have biased the findings toward the null The overall response rate was 73%, however the response ranged from 92% at month 1 to 44% at month 12 Mothers were blind to the study objectives

Howie PW, Forsyth JS, Ogston SA, Clark A, du V Florey C Protective effect of breast feeding against infection Br Med J 1990,300 11–16

COUNTRY Scotland

SETTING Community setting in Dundee

DESIGN Prospective until 24 months of age (n=674 mother/infant pairs)

BREASTFEEDING DEFINITION breastfeeding duration categorized as follows 1) full breastfeeding (> 13 week with only water and juice, n=97), 2) partial breastfeeding (> 13 week with addition of solids and/or formula, n=130), 3) early weaners (< 13 weeks breastfeeding, n=180), and, 4) bottle feeders (n=267)

OUTCOME MEASURE Prevalence of respiratory infections Hospitalization for respiratory infection

RESULTS This study examined the effect of infant feeding mode on respiratory infections, gastroenteritis, and other infections Only those results pertaining to respiratory infections are included here The results show that after adjustment for potential confounding factors (social class, maternal age, and parental smoking) that breastfeeding was associated with a small protective effect on respiratory infection at 0–13 and 40–52 wk During the first 13 week of life, the adjusted rate of respiratory infection in bottle fed infants was 37% compared to about 25% for partial and full breastfed infants There was not relationship between infant feeding mode and infections of the ear, mouth, eye, colic, eczema, and diaper rash

METHODOLOGICAL ISSUES This study adjusted for all known potential confounding factors

Chen Y, Yu S, Li W-x. Artificial feeding and hospitalization in the first 18 months of life Pediatr 1988,81 58–62

COUNTRY China

SETTING Not specified

DESIGN Community-based retrospective study of 1,163 children from birth to 18 months of age

BREASTFEEDING DEFINITION Breastfed at any time during the first 18 months of life versus never breastfed

OUTCOME MEASURE Risk of hospitalization for respiratory infection

RESULTS This study examined the association between hospitalization during the first 18 months of life and infant feeding patterns Data were adjusted for infant sex, birth weight, paternal education, and household smoking status Breastfeeding was associated with lower socioeconomic status children whose fathers had a university education were significantly more likely to be bottle-fed compared to children whose fathers had lower education Thus, to the extent that risk of hospitalization is inversely associated with socioeconomic status the results would be biased against finding an effect because of breastfeeding The rate of hospitalization for a first episode of respiratory infection was 18% for artificially fed children and 11% for children who had ever been breastfed The results show that children who had never received any breastmilk had twice the risk of hospitalization for respiratory infection The adjusted odds ratio for method of feeding and risk of hospitalization with respiratory infection was 2 11, with a 95% confidence interval of 1 34 to 3 30 The risk of hospitalization for respiratory infection was three times higher among artificially fed infants with less educated fathers compared to artificially fed infants with more educated fathers These estimates are likely to be conservative given the manner in which breastfeeding was defined and the potential for random error in recall

METHODOLOGICAL ISSUES This is a methodologically strong study that adds considerably to the evidence that breastfeeding protects against respiratory infection

Campbell CE, Latham MC Infant feeding and morbidity among poor migrant squatters in Hermosillo, Sonora, Mexico Nutr Res 1988,8·969–979

COUNTRY: Mexico

SETTING Rural

DESIGN Prospective, n=105 poor migrant women and infants < 8 month

BREASTFEEDING DEFINITION. Any breastfeeding, age at weaning

OUTCOME MEASURE. Incidence of respiratory infection as assessed by maternal recall for prior two week period

RESULTS· The study was divided into three rounds of data collection Regression analysis showed that any breastfeeding versus no breastfeeding was significantly associated with reduced risk of diarrhea illnesses in two of the three rounds of data collection The data on risk of illness and infant feeding mode are not presented in a manner that permits the exact effect to be quantified

Breast feeding and acute lower respiratory infection Acta Paediatr 1994,83 714–718

COUNTRY Italy

SETTING. Not specified

DESIGN Case-control Two groups of infants were studied The first group (n=73) were infants < 6 months of age hospitalized with pneumonia or bronchiolitis The second group (n=88) were infants < 12 months of age hospitalized with pertussis-like illness Controls were infants admitted to the same ward with a non-respiratory illness related diagnosis and matched on age and month of admission

BREASTFEEDING DEFINITION Exclusive breastfeeding, partial breastfeeding, and no breastfeeding

OUTCOME MEASURE Hospitalization for pneumonia or bronchiolitis or with pertussis-like illness

RESULTS Infants < 6 month of age with pneumonia or bronchiolitis were less likely to have been breastfed compared to controls The odds ratio was 0 42 with a 95% confidence interval of 0 19 to 0 90 The protective effect of breastfeeding was stronger for those infants being breastfed at the time of admission the relative risk for this analysis was 0 22 with a 95% confidence interval of 0 09 to 0 55 Infants who had stopped breastfeeding more than two weeks prior to admission were no longer protected by breastfeeding infants in this category had similar risks for hospitalization as infants never breastfed Breastfeeding was also significantly protective of more serious illness There was no effect of breastfeeding among infants with pertussis-like illness

METHODOLOGICAL ISSUES Controlled for all known potential confounding factors and ruled out reverse causality The use of hospital-based controls may have introduced unknown bias

Kumar V, Kumar L, Diwedi P Morbidity related to feeding pattern in privileged urban and under privileged rural infants Indian Pediatrics 1981,18 743–749

COUNTRY India

SETTING: Urban and rural community based

DESIGN Prospective, n=170 infants from upper socio-economic status(SES) urban families and n=109 infants from lower SE rural families

BREASTFEEDING DEFINITION Exclusive breastfeeding for first four months without supplementation, mixed fed (breastfed for first 4 months with supplementation), bottle-fed (not breastfeeding or breastfeeding < 4 month)
OUTCOME MEASURES. Diarrhea, upper respiratory tract infection, fever, otitis media, skin infections

RESULTS The authors use child-months as the unit of analysis The results show that infant feeding mode was not associated with upper respiratory infection or otitis media in the first 4 months of life in either the urban high SES group or the rural low SES group Between 5 and 12 months in the urban high SES group, exclusive breastfeeding as compared to mixed or bottle-feeding was associated with a significant 2-fold decrease risk for upper respiratory infection (8 9% for exclusive breastfeeding infants versus 19% for mixed and 15 4 for bottle-fed infants) For the rural lower SES group, exclusive breastfeeding as compared to mixed feeding was associated with a 2-fold decrease in risk for upper respiratory infection (7 6% for exclusive breastfeeding infants versus 16% for mixed-fed infants) The authors show no significant findings with respect to otitis media

METHODOLOGICAL ISSUES This is really two separate studies, one examining the association between infant feeding mode and illness among upper SES urban infants and another examining the same relationships among lower SES rural infants The study does not control for potential confounding factors that may be associated with infant feeding practices and risk of illness

Jalil F, Karlberg J, Hanson LA, Lindblad BS Growth disturbance in an urban area of Lahore, Pakistan related to feeding patterns, infections and age, sex, socio-economic factors and seasons Acta Paediatr Suppl 1989,350 44–54

COUNTRY Pakistan

SETTING Urban

DESIGN Prospective, n=910 infants followed every 3 months from birth to 24 months

BREASTFEEDING DEFINITION. Inadequate "Age at weaning" used to examine the relationship between infant feeding mode and morbidity However, this term was never defined and it cannot be determined whether this indicated the age at which other foods were introduced or when breastfeeding ceased

RESULTS Did not find an association between "age at weaning" and acute respiratory infection

METHODOLOGICAL ISSUES Infant feeding mode poorly categorized

1. Effect of Breastfeeding on Morbidity
1.3 Effect of Breastfeeding on Otitis Media

Duncan B, Ey J, Holberg CJ, Wright AL, Martinez F, Taussig LM. Exclusive breast-feeding for at least 4 months protects against otitis media. Pediatrics 1993, 91(5) 867–872

COUNTRY USA

SETTING urban

DESIGN Retrospective review of medical records of 1220 infants using a health maintenance organization

BREASTFEEDING DEFINITION Duration of exclusive breastfeeding and partial breastfeeding categorized as follows 1) no breastfeeding (n=169), 2) breastfeeding < 4 months (n=269), 3) breastfeeding > 4 months with supplemental formula or foods (n=200), 4) breastfeeding > 4 months with supplemental foods beginning between 4 to 6 months (n=199), and, 5) exclusive breastfeeding for 6 months or more (n=154)

OUTCOME MEASURE This study examined the effect of infant feeding mode during infancy on two outcomes 1) acute otitis media and 2) recurrent otitis media (defined as 4 or more episodes of acute otitis media in a 6-month period or four episodes in a 12-month period)

RESULTS The results show that for both birth to 6 months of age and 6 months to 12 months of age, the mean number of episodes of acute otitis media decreased significantly with increased duration and exclusivity of breastfeeding Compared to infants not breastfed, infants who were breastfeeding > 4 months and exclusively breastfeeding for 4 months had half the mean number of acute otitis media episodes, and 40% fewer episodes than those infants whose diets had been supplemented prior to 4 months Infants who had breastfed < 4 months had similar levels of acute otitis media as compared to those infants not breastfed Infants who were exclusive breastfeeding for 6 or more months had similar levels of acute otitis media to those infants exclusive breastfeeding for 4 months There was no effect of feeding mode on age at first episode of acute otitis media

With respect to recurrent otitis media, both longer duration and exclusivity of breastfeeding were protective As with acute otitis media, rates were similar for those not breastfeeding or breastfeeding < 4 months and these groups were combined for further analysis to form the reference group Recurrent otitis media rates in infants exclusively breastfeeding for more than 6 months was 10% compared to 20 5% for those in the reference group Potential confounding factors included marital status, family history of allergy, gender, ethnicity, number of siblings in

the home, number of persons sharing a room with the infant, use of day care, maternal smoking, and the number of cigarettes the mother smoked per day

METHODOLOGICAL ISSUES Although the authors controlled for all known potential confounding factors, there may have been uncontrolled factors that affected both breastfeeding and risk of illness

A prospective cohort study on breast-feeding and otitis media in Swedish infants Pediatr Infect Dis J 1994,13 183–188

COUNTRY Sweden

SETTING Urban

DESIGN Prospective (n=400) infants followed from birth to 12 months of age

BREASTFEEDING DEFINITION Exclusively breastfed, partially breastfed, and weaned All infants had been breastfed for at least a short amount of time

OUTCOME MEASURE Acute otitis media

RESULTS The frequency of acute otitis media was significantly lower in the breastfed infants at the three different age intervals examined, 1–3, 4–7, and 8–12 months In the 1–3 month old age group, infants who were partially breastfed experienced significantly more episodes compared to exclusively breastfed infants ($p< 0\ 05$) The difference between exclusively breastfed infants and weaned infants was not significant, however, only 36 infants fell into the weaned category and the power to detect a difference was probably low During the two intervals, 4–7 months and 8–12 months weaned infants experienced significantly more episodes compared to partially breastfed infants ($p< 0\ 05$) The age at which the first episode occurred was inversely associated with breastfeeding duration The authors conclude that breastfeeding protects against acute otitis media

METHODOLOGICAL ISSUES The exact manner in which infants were classified in an infant feeding category was not clearly specified given that it is likely that within age intervals infants would change categories

Sheard NF Breast-feeding protects against otitis media Nutrition Reviews 19 1994,51(9) 275–277

COUNTRY USA

SETTING urban

DESIGN Review article

BREASTFEEDING DEFINITION

RESULTS This study summarizes the results by Duncan et al reported in this review

Dewey KG, Heinig MJ, Nommsen-Rivers LA Differences in morbidity between breast-fed and formula-fed infants J Pediatr 1995,126 696–702

COUNTRY USA

SETTING Urban

DESIGN Prospective, n=45 breastfed infants and n=41 formula fed infants followed for first 24 months of life

BREASTFEEDING DEFINITION Human milk was the major form of milk for breastfeeding infants throughout the first year The formula-fed group included infants who had never breastfed and infants who had breastfed < 3 months

OUTCOME MEASURES Respiratory infection, diarrhea, acute otitis media, other symptoms as measured by weekly maternal recall and medical records Only those findings pertaining to otitis media are reported here

RESULTS Statistical comparisons between groups were made in 12 month intervals (birth to 12 months and 12–24 month) Incidence was calculated as the number of episodes per 100 days at risk Prevalence was calculated as the number of days the child was ill during each interval During the first year of life, the incidence of acute otitis media was significantly higher among formula fed infants as compared to breastfed infants (adjusted incidence/100 days at risk = 0 45 for breastfed infants and 0 53 for formula fed infants) The number of episodes/year was also higher among formula fed infants as compared to breastfed infants (adjusted estimate 1 53 versus 1 78) The prevalence, defined as the number of days ill/year, was also higher among formula fed infants (adjusted estimate 10 versus 15 8) Risk of acute otitis media during the second year of life did not differ between the two groups, however, the duration of episodes was significantly

greater among formula-fed infants as compared to breastfed infants in both the first and second year of life The authors suggest that breastfeeding is protective against otitis media disease even in affluent, highly educated populations

METHODOLOGICAL ISSUES Day care use was not associated with risk of otitis media and was associated with the number of siblings only among formula-fed infants The data were conservatively analyzed with the child rather than each day of observation as the unit of analysis

1. Effect of Breastfeeding on Morbidity
1 4 Effect of Breastfeeding on Other Infections

Brown KH, Black RE, de Romana GL, de Kanashiro HC Infant-feeding practices and their relationship with diarrheal and other diseases in Huascar (Lima), Peru. Pediatrics 1989,83 31–40

COUNTRY: Peru

SETTING Urban

DESIGN Prospective, n=153 infants

BREASTFEEDING DEFINITION Exclusive breastfeeding, breastfeeding and other liquids, breastfeeding and artificial milk, breastfeeding and solids, no breastfeeding

OUTCOME MEASURE Risk of diarrhea, acute respiratory infection, and skin infections Only those outcome pertaining to skin infections are reported here

RESULTS. Breastfeeding was also protective of skin infections Compared to exclusive breastfeeding, infants < 6 months of age who received other liquids in addition to breastmilk had a relative risk of 3 8, breastfeeding and artificial milk was associated with a relative risk of 1 9, and breastfeeding and solids was associated with a relative risk of 2 8 Among infants 6–11 months, no breastfeeding was associated with a relative risk of 5 7 compared to any breastfeeding

METHODOLOGICAL ISSUES: The design addresses the problem of reverse causality As compared to the study by Popkin et al , this study controlled for fewer biologic and behavioral variables that affect susceptibility to illness and exposure to diarrheal pathogens Breastfeeding was well defined as were the outcome measures

2 Effect of Breastfeeding on Infant Mortality
2.1 Effect of Breastfeeding on Diarrheal Mortality

Victora CG, Smith PG, Patrick J, et al. Infant feeding and deaths due to diarrhea A case-control study Amer J Epidem 1989,129 1032–1041

COUNTRY Brazil

SETTING. Urban

DESIGN Matched case-control Cases (n=170) infants who had died from diarrhea A second comparison group consisted of 106 infants who were presumed to have died from noninfectious causes

BREASTFEEDING DEFINITION Exclusive breastfeeding, breastfeeding and powdered milk, breastfeeding and cow's milk, powdered milk only, cow's milk only

OUTCOME MEASURES Diarrheal mortality

RESULTS This study examined the association between infant feeding mode and diarrheal mortality in two urban areas of Brazil Exclusive breastfeeding was the reference group The results show that breastfeeding was associated in a dose-response manner with risk of mortality with the lowest risk among those infants exclusive breastfeeding, intermediate risk among those infants partially breastfeeding, and the greatest risk among those infants not breastfeeding The relative risks for breastfeeding and powdered milk and breastfeeding and cow's milk were 3 5 and 4 1, respectively The relative risks for powdered milk only and cow's milk only were 11 9 and 7 8, respectively The overall relative risks for partial and no breastfeeding were 4 2 and 14 2, respectively, indicating that as compared to exclusive breastfeeding partial breastfeeding was associated with 4 2 times the risk of death and no breastfeeding was associated with 14 2 times the risk of death

Similar results were obtained when cases were compared to controls who had died from noninfectious causes Risks were strongest for youngest infants among infants > 2 months those who received no breastmilk were 23 3 times more likely to die from diarrhea After 2 months of age the odds ratio dropped to 5 3

METHODOLOGICAL ISSUES The study was restricted to infants between the ages 7 and 364 days to avoid including neonatal deaths that were unlikely related to infant feeding mode Infant feeding mode was that prior to the onset of fatal illness to avoid the problem of reverse causality Potential confounding variables were controlled The study was also strengthened by using a second control group of infants who had died from non-infectious cases

Victora CG, Huttly SR, Fuchs SC, et al , Deaths due to dysentery, acute and persistent diarrhoea among Brazilian infants Acta Paediatr Suppl 1992,381 7–11

COUNTRY. Brazil

SETTING· Urban

DESIGN. Population based case-control study Cases (n=227) infants (< 12 months of age) who had died from dysentery, acute diarrhea, or persistent diarrhea Two neighborhood controls were used for each case

BREASTFEEDING DEFINITION Exclusive breastfeeding, breastfeeding, and no breastfeeding

OUTCOME MEASURES Mortality from acute diarrhea, persistent diarrhea, and dysentery

RESULTS This study examined the epidemiology of death from three causes acute diarrhea, persistent diarrhea, and dysentery in two urban areas in Brazil The design was similar to that reported in the previous study and the two studies use overlapping data Persistent diarrhea accounted for 62% of deaths, acute diarrhea for 28% of deaths, and dysentery for 10% of deaths The greatest number of deaths occurred between 3 and 5 months of age, which is when weaning most often occurred Infant feeding mode was strongly associated with risk of death for both acute and persistent diarrhea Using exclusive breastfeeding as the reference category, the age-adjusted relative risks for acute diarrhea were 4 0 and 21 for any breastfeeding and no breastfeeding, respectively The age-adjusted relative risks for persistent diarrhea were 4 3 and 10 0, for any breastfeeding and no breastfeeding, respectively The age-adjusted relative risks for dysentery failed to reach statistical significance

METHODOLOGICAL ISSUES: The study was restricted to infants between the ages 7 and 364 days to avoid including neonatal deaths that were unlikely related to infant feeding mode Infant feeding mode was that prior to the onset of fatal illness to avoid the problem of reverse causality Because of small sample size for each of the three outcomes examined, risks were only adjusted for age and not other potential confounding factors

Yoon PW, Black RE, Monthulton LH, Becker S Effect of not breastfeeding on the risk of diarrhea and respiratory mortality in children under 2 years of age in Metro Cebu, The Philippines Amer J Epidem 1996,143 1142–8

COUNTRY The Philippines

SETTING Urban

DESIGN Prospective, n=9,942 children followed from birth to 24 months of age

BREASTFEEDING DEFINITION Total months breastfed, breastfeeding status immediately prior to the illness that led to death, breastfeeding status during the 2 months before death

OUTCOME MEASURES Diarrhea alone, acute lower respiratory infection alone, combined diarrhea and acute lower respiratory infection Only those findings related to diarrheal mortality are reported here

RESULTS To determine if risk changed with age, data were analyzed in three age-groups (0–5 months, 6–11 months, and 12–23 months) Risk of death was significantly greater among infants as compared to children 12–23 months of age Potential confounding factors included those that were associated with both mortality and major risk factors These included maternal education, type of toilet facility, and length of previous birth interval There was a strong relationship between breastfeeding and previous birth interval children who were born 18 months or less after a sibling were much less likely to be breastfed Proportional hazards models were used to investigate the association between not breastfeeding and diarrheal mortality In the first 6 months of life there was a strong association between breastfeeding and diarrheal mortality Failing to initiate breastfeeding or ceasing to breastfeed was associated with a 10-fold increase in diarrheal mortality (adjusted rate ratio = 9 7) There were no significant associations among the older age groups The associations were greatest for low birth weight infants and infants whose mothers had little formal education

Habicht J-P, DaVanzo J, Butz WP Mother's milk and sewage Their interactive effects on infant mortality Pediatrics 1988,81(3) 456–461.

COUNTRY Malaysia

SETTING Urban and rural

DESIGN Retrospective, n=1,262 women and their 5,141 infants

BREASTFEEDING DEFINITION Breastfed versus not breastfed

OUTCOME MEASURES All cause mortality

RESULTS This study examined the relationships between breastfeeding, piped water, a toilet and infant mortality The results show that breastfeeding was highly protective As compared to breastfeeding, the adjusted relative risks of not breastfeeding were 5 2 if the household had neither a toilet or piped water, 2 67 if the household had a toilet only, and 2 51 if the household had both a toilet and piped water The authors calculate that 21% of all deaths in this sample were due to not breastfeeding

METHODOLOGICAL ISSUES Deaths in the first week of life were excluded to prevent reverse causality Analyses are adjusted for a number of potential confounding factors

Sachdev HPS, Kumar S, Singh KK, Puri RK Does breastfeeding influence mortality in children hospitalized with diarrhoea? J Trop Pediatr 1991,37·275–279

Sachdev HPS, Kumar S, Singh KK, Satyanarayana L, Puri RK Risk factors for fatal diarrhea in hospitalized children in India. J Pediatr Gastro Nutr 1991;12 76–81

COUNTRY: India

SETTING Urban

DESIGN Prospective, n=309 children < 18 months of age

BREASTFEEDING DEFINITION Breastfeeding status (yes or no) prior to onset of illness

OUTCOME MEASURES Death from diarrhea

RESULTS This study examined the association between infant feeding mode (breastfeeding versus no breastfeeding) on mortality risk of children < 18 months of age hospitalized with diarrhea Infant feeding mode in the 36 children who died was compared to that of 273 children who survived and were discharged from the hospital in satisfactory condition Results are adjusted for five potential confounding factors, which were not specified in the paper The adjusted odds ratio was 2 7, which was significant at the p<0 001 level Stratified multivariate analyses were performed to estimate the association between infant feeding mode and mortality as a function of age, nutritional status, and duration of diarrhea The results show that the protective effect of breastfeeding was greatest among younger children though still significant among older children The adjusted odds ratios were 6 0, 2 6, and 1 8 for children aged 0–6 months, 7–12 months, and 13–18 months, respectively The protective effect of breastfeeding was also greater for more malnourished children For children of low weight-for-age the adjusted odds ratios for weight-for-age <50% and >50% of the NCHS median were 5 7 and 2 2,

respectively For children of low height-for-age the adjusted odds ratios for height-for-age <85% and >85% of the NCHS median were 4 3 and 2 4, respectively Breastfeeding was also protective for children with protracted diarrhea The adjusted odds ratios for diarrhea > 14 days and < 14 days were 4 5 and 2 5, respectively

METHODOLOGICAL ISSUES The authors control for reverse causality and risk analyses are stratified by age The additional stratified analyses on indices of nutritional status and duration of disease examine factors that are likely to covary significantly and it is not possible from the analyses to determine their relative importance Inferences that can be made from this study to the general population may be limited because hospitalized populations are not representative of the general population

Feachem RG, Koblinsky MA Interventions for the control of diarrhoeal diseases among young children Promotion of breast-feeding Bull WHO 1984,62(2) 271–291

COUNTRY Review article with results from many countries

SETTING: Specific to the country of study Some studies included only lower socioeconomic groups and some included all socioeconomic groups

DESIGN Review of 35 studies from 14 countries However, only 9 studies from 5 countries have data on mortality and these are the studies summarized here

BREASTFEEDING DEFINITION exclusive breastfeeding, partial breastfeeding, no breastfeeding

OUTCOME MEASURES Only that outcome related to diarrheal mortality is reported here

RESULTS This review article examines the relationship between infant feeding mode and risk of death from diarrheal disease Infant age is broken into several different categories depending on the specific infant feeding mode comparisons being made A dose-response in the association between infant feeding mode and risk of death from diarrheal disease was found with infants being exclusively breastfed having the lowest risk, partially breastfed infants of intermediate risk and bottle-fed infants of highest risk For example, among infants 0–5 months of age the relative risks for no breastfeeding versus exclusive breastfeeding was 25, for partial breastfeeding versus exclusive breastfeeding was 8 6 and for no breastfeeding versus partial breastfeeding 3 5 The association between infant feeding mode and risk is also related to infant age in a dose-response manner with younger infants deriving the greatest benefit The relative risks for exclusive breastfeeding compared to no breastfeeding are 25 for infants aged 0–2 months and 11 for infants aged 6–8 months Results are reported for risks after 1 year of age The relative risks for death from diarrhea are 2 to 6 times greater as compared to the risk of illness from diarrhea This

suggests a difference in the case-fatality ratio by feeding mode whereby breastfed infants benefit from increased protection from death given illness as compared to formula-fed infants

METHODOLOGICAL ISSUES The results reported here are old, all but one prior to 1947, and limited in quality Many do not control for potential confounding factors that could be related to both infant feeding method and risk of death from diarrhea The formula-fed children were not receiving modern formulas, which may have increased their risk of death as compared to infants being formula fed today

Robinson M Infant morbidity and mortality A study of 3266 infants The Lancet 1951(April 7) 788–794

COUNTRY England
SETTING: Urban and rural

DESIGN: Review of hospital records, n=3266 infants that had been followed between 1 and 7 months of age

BREASTFEEDING DEFINITION Exclusive breastfeeding (n=971), partly bottle-fed (n=1441), bottle-fed (n=854)

OUTCOME MEASURES Mortality and morbidity Only those results pertaining to diarrheal mortality are reported here

RESULTS: This study examined the association between infant feeding mode and mortality among a large cohort of children who had medical records available for the period 1 to 7 months of age The study population consisted of infants attending the same clinic between 1936 and 1942 A dose-response relationship was found with respect to exclusive breastfeeding, partial bottle-feeding, and full bottle-feeding and mortality from all causes as well as specifically from diarrhea The unadjusted over-all mortality rate per 1000 was 10 2 for exclusive breastfeeding, 25 7 for partly breastfeeding, and 57 3 for bottle-fed infants The unadjusted diarrhea mortality rate per 1000 was 0 for exclusive breastfeeding, 2 0 for partly breastfeeding, and 7 0 for bottle-fed infants Other factors that were associated with mortality were birth order, higher order children were at greater risk as compared to first born infants, social class, infants of laborers were at greater risk as compared to infants of clerks, skilled workers, and the unemployed

METHODOLOGICAL ISSUES The results in this study are not adjusted for potential confounding factors that are associated with both infant feeding method and risk of mortality However, the author did exclude from the analysis infants who died within the first two-weeks of life or who died from causes not associated with infant feeding method (birth anomalies, accidents) The

author also controlled for reverse causality in that the infant feeding method prior to the onset of fatal illness was used rather than the feeding mode at the time of death

2. Effect of Breastfeeding on Infant Mortality
2.2 Effect of Breastfeeding on Respiratory Infection Mortality

Yoon PW, Black RE, Moulton LH, Becker S Effect of not breastfeeding on the risk of diarrhea and respiratory mortality in children under 2 years of age in Metro Cebu, The Philippines Amer J Epidem 1996,143.1142–8

COUNTRY The Philippines

SETTING Urban
DESIGN Prospective, n=9,942 children followed from birth to 24 months of age

BREASTFEEDING DEFINITION Total months breastfed, breastfeeding status immediately prior to the illness that led to death, breastfeeding status during the 2 months before death

OUTCOME MEASURES Diarrhea alone, acute lower respiratory infection alone, combined diarrhea and acute lower respiratory infection Only those findings related to acute lower respiratory infection alone and combined diarrhea and acute lower respiratory infection are reported here

RESULTS To determine if risk changed with age, data were analyzed in three age-groups (0–5 months, 6–11 months, and 12–23 months) Risk of death was significantly greater among infants as compared to children 12–23 months of age Potential confounding factors included those that were associated with both mortality and major risk factors These included maternal education, type of toilet facility, and length of previous birth interval There was a strong relationship between breastfeeding and previous birth interval children who were born 18 months or less after a sibling were much less likely to be breastfed Proportional hazards models were used to investigate the association between not breastfeeding and acute lower respiratory infection or combined diarrhea and acute lower respiratory infection There was no effect of not breastfeeding on risk of death from acute lower respiratory infection However, among infants 0–5 months the rate of mortality associated with both acute lower respiratory infection and diarrhea was increased nearly 6 times by not breastfeeding (rate ratio = 5 7) There was no effect of not breastfeeding on the risk of death from combined diarrhea and acute lower respiratory infection in the older age group

METHODOLOGICAL ISSUES This is a methodologically very strong study Only infants > 4 days are included to exclude deaths in the early neonatal period that were unlikely to be related to

infant feeding mode The analysis addressed the problem of reverse causality and controlled for many important confounding factors Risks are analyzed by age

Victora CG, Vaughan JP, Lombardi C, et al., Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil The Lancet 1987 (August 8) 319–321

Victora CG, Smith PG, Barros FC, Vaughan JP, Fuchs SC Risk factors for deaths due to respiratory infections among Brazilian infants International J Epidem 1989,918–925

COUNTRY Brazil

SETTING. Urban

DESIGN Matched case-control Cases (n=170) infants who had died from diarrhea Two neighborhood controls were used for each case Those chosen were the first neighbor aged 7 to 364 days and the next closest neighbor aged 7 to 182 days

BREASTFEEDING DEFINITION Exclusive breastfeeding, breastfeeding and powdered milk, breastfeeding and cow's milk, powdered milk only, cow's milk only

OUTCOME MEASURES Mortality from respiratory infection and diarrhea Only those results for respiratory mortality are summarized here The results for diarrheal mortality are the same as those in Victora et al , Infant feeding and deaths due to diarrhea A case-control study Amer J Epidem 1989,129 1032–1041

RESULTS This study examined the association between infant feeding mode and mortality from respiratory infection in two urban areas on Brazil Exclusive breastfeeding was the reference group The results show that breastfeeding was associated with a reduced risk of death from respiratory infections, though the magnitude of the association was smaller than for diarrhea-related deaths Compared to exclusive breastfeeding, the relative risk for any breastfeeding was 1 6 However, the confidence intervals crossed 1 and therefore the finding was not significant In contrast, compared to exclusive breastfeeding the relative risk of no breastfeeding was 3 6 and statistically significant The risks were greatest for those infants under 2 months of age

METHODOLOGICAL ISSUES The study was restricted to infants between the ages 7 and 364 days to avoid including neonatal deaths that were unlikely related to infant feeding mode Infant feeding mode was that prior to the onset of fatal illness to avoid the problem of reverse causality Potential confounding variables were controlled

Robinson M Infant morbidity and mortality A study of 3266 infants The Lancet 1951(April 7) 788–794

COUNTRY England

SETTING Urban and rural

DESIGN Review of hospital records, n=3266 infants that had been followed between 1 and 7 months of age

BREASTFEEDING DEFINITION exclusive breastfeeding (n=971), partly bottle-fed (n=1441), bottle-fed (n=854)

OUTCOME MEASURES Mortality and morbidity Only those results pertaining to mortality from respiratory infections are reported here

RESULTS This study examined the association between infant feeding mode and mortality among a large cohort of children who had medical records available for the period 1 to 7 months of age The study population consisted of infants attending the same clinic between 1936 and 1942 A dose-response relationship was found with respect to exclusive breastfeeding, partial bottle-feeding, and full bottle-feeding and mortality from all causes as well as specifically from respiratory infections The unadjusted overall mortality rate per 1000 was 10 2 for exclusive breastfeeding, 25 7 for partly breastfeeding, and 57 3 for bottle-fed infants The unadjusted mortality rate from respiratory infection per 1000 was 8 2 for exclusive breastfeeding, 15 9 for partly breastfeeding, and 31 6 for bottle-fed infants For otitis media the unadjusted overall mortality rate per 1000 was 0 for exclusive breastfeeding, 2 0 for partly breastfeeding, and 8 1 for bottle-fed infants Other factors that were associated with mortality were birth order, higher order children were at greater risk as compared to first born infants, social class, infants of laborers were at greater risk as compared to infants of clerks, skilled workers, and the unemployed

METHODOLOGICAL ISSUES The results in this study are not adjusted for potential confounding factors that are associated with both infant feeding method and risk of mortality However, the author did exclude from the analysis infants who died within the first two-weeks of life or who died from causes not associated with infant feeding method (birth anomalies, accidents) She also controlled for reverse causality in that the infant feeding method prior to the onset of fatal illness was used rather than the feeding mode at the time of death

2 Effect of Breastfeeding on Infant Mortality
2.3 Effect of Breastfeeding on All-Cause Mortality

Habicht J-P, DaVanzo, J, Butz WP Does breastfeeding really save lives, or are apparent benefits due to biases? Amer J Epidemio 1986,123(2) 279–290

COUNTRY. Malaysia

SETTING urban and rural

DESIGN Retrospective, n=1,262 women and their infants, n=5,357

BREASTFEEDING DEFINITION· Total duration of exclusive breastfeeding and breastfeeding

OUTCOME MEASURE Infant mortality

RESULTS The effects of breastfeeding on infant mortality are reported for three sub periods of infancy 8–28 days, 29 days–6 months, and 7–12 months Logistic regression was used to estimate the effect of infant feeding mode on mortality The authors investigated the sensitivity of the association between infant feeding mode and mortality by estimating the effect for all live births, excluding cases where the length of breastfeeding was equal to the length of life or when death occurred on the first day of life, and also excluding cases where breastfeeding stopped because of fatal illness This sensitivity analysis showed that although the associations remained significant and in the expected direction, the magnitude of the associations were reduced compared to analyses conducted in the entire sample Multivariate analysis, which controlled for a number of factors associated with both infant feeding mode and risk of mortality, showed a dose-response relationship in the expected direction for full and partial breastfeeding and risk of death As expected, risks were also greater for younger infants For example, the reductions in deaths per 1000 infants per added month of full breastfeeding were 68 6, 24 9, and 3 4 for the period 8–28 days, 29 days–6 months, and 7–12 months, respectively The reduction in death per 1000 infants per added month of partial breastfeeding were 21 9, 11 2, and 1 7 for the three time periods

METHODOLOGICAL ISSUES This study controlled for reverse causality and also controlled for many potential confounding factors Age-related factors related to both mortality risk and infant feeding mode were also addressed

Butz WP, Habicht J-P, DaVanzo J Environmental factors in the relationship between breastfeeding and infant mortality The role of sanitation and water in Malaysia Amer J Epidemiol 1984,119(4) 516–525

COUNTRY Malaysia

SETTING Urban and rural

DESIGN Retrospective, n = 1,262 women and their 5471 infants

BREASTFEEDING DEFINITION Duration of supplemented and unsupplemented breastfeeding

OUTCOME MEASURE All-cause mortality

RESULTS This study examines the effect of breastfeeding, water, and toilet sanitation on infant mortality Infancy is divided into three time periods as follows 8–28 days, 2–6 months, and 7–12 months The results show that breastfeeding is significantly associated with mortality and that the strength of this association changes over the three time periods The association is greatest in the first month Infants who were fully breastfed throughout their first week of life have 16/1000 fewer deaths during this interval as compared to those not fully breastfed The estimated risk difference between unsupplemented breastfeeding the entire first four weeks and not breastfeeding at all is 25/1000 deaths during the interval 2 to 6 months In the last six months of infancy, infants who were fully breastfed through their first six months had 20/1000 fewer deaths as compared to those not breastfed at all An interaction between breastfeeding, toilet sanitation, and mortality was found the magnitude of the risk differences between breastfeeding and no breastfeeding increases in households with poor sanitation

METHODOLOGICAL ISSUES This is a methodologically strong study, which controlled for many potential confounding factors

Briend A, Bari A Breastfeeding improves survival, but not nutritional status, of 12–35 months old children in rural Bangladesh 1989,43 603–608

COUNTRY Bangladesh

SETTING Rural

DESIGN Prospective, n=1087 children aged 12–35 months followed monthly for two years

BREASTFEEDING DEFINITION Breastfed versus weaned

OUTCOME MEASURE Mortality

RESULTS This study examined the association between infant feeding mode, nutritional status, and mortality among children It is one of the few studies identified that looks at children beyond one year of age The unit of analysis was child months The results show that children who were breastfed had a significantly lower weight for age as compared to children who were weaned However, despite their better nutritional status, weaned children had a relative risk of dying of 2 6 compared to breastfed children The estimated prevented fraction of deaths was 38% Age-adjusted relative risks were 6 1, 4 5, 3 7, and 3 1 for children aged 12–17 months, 18–23 months, 24–29 months, and 30–36 months, respectively Malnourished children (weight-for-age < 60%) who were weaned had a relative risk of 6 0 compared to similarly malnourished children who were breastfed Although the estimates were not adjusted for potential confounding factors, the authors argue that the results are not likely to be spurious The tendency for mothers to wean their better nourished children earlier and the reported higher frequency of breastfeeding among the poorest women should have resulted in an underestimation of the strength of the association

METHODOLOGICAL ISSUES· The study does not control for reverse causality, that infant health condition determined infant feeding practices Although the authors argue that the poorest mothers breastfeed the longest and hence the unadjusted relative risks are likely to be an underestimate, the analysis does not control for potential confounding factors

Augustine T, Bhatia BD Early neonatal morbidity and mortality pattern in hospitalized children Indian J Mat Child Health 1994,5(1) 17–19.

COUNTRY India

SETTING: Hospital-based

DESIGN Retrospective review of medical records of newborns < 7 days old (n=169) admitted to a neonatal intensive care unit

BREASTFEEDING DEFINITION: Exclusive breastfeeding, partial breastfeeding, no breastfeeding, not yet fed

OUTCOME MEASURE. Mortality

RESULTS This study examined the association between infant feeding mode and mortality among infants admitted to the hospital in the first 7 days of life The results show that exclusive breastfeeding was associated with the lowest rate of mortality (29%) compared to infants not yet fed (64%) or those receiving sugar water or cow's milk with or without breastfeeding (43%) Statistics on the significance of these differences were not reported

METHODOLOGICAL ISSUES The study does not control for reverse causality, the possibility that infant health condition determined infant feeding practices This problem is particularly acute in this study given the very young age of the study population It is likely that many newborns who had not yet been fed upon admission to the hospital were too ill to initiate breastfeeding

Awathi S, Malik GK, Misra PK Mortality patterns in breast versus artificially fed term babies in early infancy A longitudinal study Indian Pediatrics 1991,28.243–248

COUNTRY: India

SETTING: Urban

DESIGN Prospective, n=507 term infants of which half (n=273) were breastfed and half (n=234) were not breastfed Infants were matched for socioeconomic status and divided into two groups (normal birth weight and low birth weight) and followed for 6 month

BREASTFEEDING DEFINITION Breastfed versus artificially fed

OUTCOME MEASURES Neonatal mortality and post-neonatal mortality (1–6 months only)
RESULTS This study examined the association between infant feeding mode (breastfeeding versus formula feeding) and neonatal and post-neonatal morbidity (through 6 months only) among normal and low birth weight infants Results are not adjusted for potential confounding factors or reverse causality, which may be a particular problem among low birth weight infants The results show that the percentage of neonates > 2 5 kg dying was 0 47 and 1 1 for the breastfed and artificially fed groups, respectively ($p<0$ 05) The comparable figures among the low birth weight neonates were 6 94 and 12 96 ($p<0$ 001) For post-neonatal mortality, the percentage of infants > 2 5 kg dying was 0 for both breastfed and artificially fed infants For low birth weight infants, the percentage dying was 2 78 for the breastfed group and 3 70 for the formula fed group ($p<0$ 001)

METHODOLOGICAL ISSUES The authors report significant loss to follow-up with only 334 infants studied for the entire 6 months follow-up period Moreover, they exclude those breastfed infants who switched into the formula feeding category during the study

Shahidullah M Breast-feeding and child survival in Matlab, Bangladesh J Biosoc Sci 1994,26 143–154

COUNTRY Bangladesh

SETTING. Rural

DESIGN Prospective, n=2,990 children followed from birth until 5 y of age

BREASTFEEDING DEFINITION Duration of unsupplemented and supplemented breastfeeding Unsupplemented and supplemented breastfeeding were not clearly defined, though it appears from one table that supplementation refers to food supplementation

OUTCOME MEASURES· All-cause childhood mortality

RESULTS A discrete hazard model approach was used to evaluate the effect of infant feeding mode and birth interval of mortality risk Important demographic and socioeconomic indicators were also included as control variables These included parity, sex of child, maternal education, and preceding birth interval The results show that other things being equal, the mortality risk of a child who has received complementary food is 2 1 times greater than that of a child who has not received complementary food Short subsequent birth interval had the greatest impact If the mother had become pregnant again, the index child was 4 4 times more likely to die as compared to a child whose mother did not become pregnant again The combined effects of complementary feeding and subsequent pregnancy were particularly important, a child who experienced both these events had nearly 9 times the risk of death as compared to a child who had not experienced these events Overall, this study showed that it was not the duration of any breastfeeding but rather the duration of unsupplemented breastfeeding that was the important determinant of childhood mortality

METHODOLOGICAL ISSUES The definition of breastfeeding was not clear and the analysis does not take into the account the fact that an infant feeding practice that is appropriate for one age, such as unsupplemented breastfeeding, may be inappropriate at another older age The authors state that eleven discrete age intervals were created for the analysis, but the results are not presented by age

Thapa S, Short RV, Potts M Breast feeding, birth spacing and their effects on child survival Nature 1988,335,679–682

COUNTRY 29 countries that had World Fertility Surveys

SETTING Urban and rural

DESIGN Cross-sectional, n=150,000 women

BREASTFEEDING DEFINITION Duration of breastfeeding

OUTCOME MEASURES All-cause childhood mortality

RESULTS This paper quantifies the total fertility rate It estimates the number of potential births currently inhibited by breastfeeding, and by modern forms of contraception in 29 countries and by three regions Africa, Asia, and America Estimates are provided of the change in the total fertility rate if breastfeeding duration were to decline by 25% and 50% Estimates are also provided of the increase in contraceptive prevalence that would be required to offset these declines in breastfeeding duration For example, it estimates that in Senegal a 25% decline in breastfeeding duration would require almost a tripling in contraceptive prevalence It discusses the effect of birth intervals on child survival using estimates from other studies For example, if a second birth occurs within 12 months of the index birth, the risk of death between one and five for the index child is at least 77% The authors estimate that if all mothers could space their births for at least two years, a 20% reduction in mortality in the first year of life would result This reduction corresponds to about a half a million lives

METHODOLOGICAL ISSUES This paper does not provide estimates of the risk of mortality by different infant feeding modes but rather an argument as to the effect of breastfeeding on the total fertility rate and by inference to the effect on mortality through the effect on birth spacing

Mobak K, Gottschau A, Aaby P, Hojlyng N, Ingholt L, de Silva APJ Prolonged breast feeding, diarrhoeal disease, and survival of children in Guinea-Bissau Br Med J 1994,308 1403–1406

COUNTRY. Guinea-Bissau

SETTING Urban

DESIGN Community based cohort study (n=691) of children under 3 years of age

BREASTFEEDING DEFINITION Exclusively breastfed, partially breastfed, weaned

OUTCOME MEASURES All cause mortality

RESULTS During a period of follow-up of 840 child years, 48 deaths occurred Weaned children had 2 6 times the risk of death compared to breastfed children (95% confidence interval, 1 1 to 6 2) The risk of death increased to 3 5 times (95% confidence interval, 1 4 to 8 3) when analyses adjusted for maternal education and ethnic group The excess mortality was independent of age at weaning Thus, although breastfed children tended to have lower nutritional status compared to weaned children, they were more likely to survive This is one of the few studies to show a protective effect of breastfeeding on risk of mortality among children 12 to 36 months of age

METHODOLOGICAL ISSUES This study controls for many factors that may confound the relationships under study It also analyzes the data in a number of different ways, which adds to the robustness of the findings

Srivastava SP, Sharma VK, Jha SP Mortality patterns in breast versus artificially fed term babies in early infancy. A longitudinal study. Indian Pediatr 1994,31 1393–1396

COUNTRY India

SETTING Urban

DESIGN Hospital-based follow-up of 1000 infants term infants, half of whom were breastfed and half of whom were bottle-fed

BREASTFEEDING DEFINITION· Breastfed versus artificially fed

OUTCOME MEASURES All cause mortality

RESULTS Self-diagnosed "lactation failure" or "poor lactation" was the most common reason for artificial feeding Sepsis was the major cause of early neonatal mortality among low birth weight infants and artificially fed infants Diarrhea was the main cause of mortality during the 1 to 6 month period Mortality was higher in both low birth weight and artificially fed infants, however, tests of significance were not provided

METHODOLOGICAL ISSUES Infants who changed from breastfeeding to bottle feeding were excluded from the analysis, which would bias the study toward finding a positive effect of breastfeeding on mortality The authors state that they followed 1000 term infants of whom half were breastfed and half were bottle-fed, but provided no other information about the selection criteria

Retherford RD, Choe MK, Thapa S, Ghuhaju BB To what extent does breastfeeding explain birth-interval effects on early childhood mortality? Demography 1989,26(3) 439–450

COUNTRY Nepal

SETTING Urban and rural

DESIGN Cross-sectional survey Data from the World Fertility Survey, n=4,050 ever married women aged 15–49

BREASTFEEDING DEFINITION* Duration of breastfeeding

OUTCOME MEASURES All-cause childhood mortality

RESULTS This paper examines the extent to which breastfeeding explains the birth-interval effect on early childhood mortality Two age categories are used birth to 18 months and 18 to 60 months No breastfeeding is used as the reference category Among children < 18 months the effect of breastfeeding on mortality was significant and large The relative risk of any breastfeeding is 0 19, which suggests an 81% mortality reduction Subsequent birth interval also has a large and significant effect on mortality of the index child Analysis of both the effects of breastfeeding and subsequent birth interval suggests that the effects of the subsequent birth interval on infant mortality of the index child are explained almost entirely by breastfeeding Between 18 and 60 months, the effect of breastfeeding is smaller though still significant, with an adjusted relative risk of 0 45 Unlike the case for mortality up until 18 months, breastfeeding only partly explains the effect of the subsequent birth interval on the mortality risk of the index child Thus, between the ages of 18 and 60 months, breastfeeding is only one of several factors through which following birth interval affects child mortality The results also show that fathers' literacy has no effect on infant mortality but a substantial effect on child mortality The authors interpret this finding to indicate that as long as a child is breastfed, it receives adequate nourishment and is not dependent upon its father's ability to provide (as assessed indirectly through the relationship between paternal literacy and socioeconomic status) However, after weaning, the ability of the family to provide adequate food is dependent on its socioeconomic status

METHODOLOGICAL ISSUES Although the analysis controls for many potential confounding factors, it does not adjust for the problem of reverse causality

Plank SJ, Milanesi ML Infant feeding and infant mortality in rural Chile Bull World Health Organization 1973,48 203–210

COUNTRY Chile

SETTING Rural

DESIGN Cross-sectional survey of n=1712 women

BREASTFEEDING DEFINITION Exclusive breastfeeding, any breastfeeding, bottle feeding

OUTCOME MEASURES. All-cause childhood mortality

RESULTS. This paper examines the association between infant feeding and mortality in rural Chilean infants Breastfeeding declined significantly as maternal education and paternal income increased Post-neonatal deaths were significantly associated with infant feeding mode Mortality rate ratios are provided for three overlapping age groups 1–12 months, 3–12 months, and 6–12 months In the 1–12 months age group, the rate ratios for exclusive breastfeeding, breastfeeding plus bottle, and bottle only were 29 2, 56 0, and 60 5, respectively Thus, using exclusive breastfeeding as the reference category, the unadjusted relative risk for bottle feeding was 2 In the 3–12 months age group, the rate ratios for exclusive breastfeeding, breastfeeding plus bottle, and bottle only were 13 8, 37 5, and 38 7, respectively In the 6–12 months age group, the rate ratios for exclusive breastfeeding, breastfeeding plus bottle, and bottle only were 10 0, 14 0, and 19 9, respectively Tests of statistical significance were not provided The authors note that some of the higher mortality associated with bottle feeding was an artifact because of the inclusion of low weight infants for whom supplementary milk was medically prescribed The results also showed that those infants given bottles in addition to being breastfed had mortality rates similar to those who only received a bottle Once bottle feeding began, breastfeeding appeared to offer no protection against mortality The results show an inverse association between infant mortality, family income, environmental factors, and medical care families with higher incomes, better household sanitation, and greater access to medical care were also more likely to use bottles and had greater mortality risks This suggests that the differences in infant mortality observed were attributable to bottle feeding and inappropriate use of supplementary foods

METHODOLOGICAL ISSUES Neonatal deaths and living children under 4 weeks of age were excluded to avoid some of the bias caused by reverse causality Risk ratios were not adjusted for potential confounding factors, though bottle feeding was associated with higher family income and maternal education Tests of statistical significance were not provided

Molteno CD, Kibel MA Postneonatal mortality in the Matroosberg Divisional Council area of the Case Western Health Region South African Med J 1989,75 575–578

COUNTRY South Africa

SETTING Urban

DESIGN Case-control Cases (n=49) black infants who died within a 12-month period The selection of controls was not clearly presented

BREASTFEEDING DEFINITION None

OUTCOME MEASURES Mortality

RESULTS Thirty-three percent of the infants who died had not been breastfed compared to 7% of the controls (p<0 001) However, these figures were not adjusted for reverse causality or potential confounding factors Cases were more likely to have had a number of problems that were associated with risk of mortality such as low birth weight, a larger family size, a father with lower education, a father in prison, an incomplete immunization record, or a family with social problems They were also less likely to have belonged to a nuclear family

METHODOLOGICAL ISSUES This is a methodologically weak study that does not control for many factors that may be related to both infant feeding mode and risk of mortality The study does not account for reverse causality

Singh K, Srivastava P The effect of colostrum on infant mortality Urban rural differentials Health and Population 1992,15(3&4) 94–100

COUNTRY India

SETTING Urban and rural
DESIGN Cross-sectional survey n = 826 infants

BREASTFEEDING DEFINITIONS Knowledge and use of colostrum

OUTCOME MEASURES Neonatal and post-neonatal mortality

RESULTS Total neonatal mortality was 5 8% Total post-neonatal mortality was 5 4% Knowledge and use of colostrum was significantly related to setting More than half of urban mothers did know about and feed colostrum to their newborns In contrast, in rural areas nearly three-quarters of mothers did know about and feed colostrum to their newborns To examine the

association between colostrum use and mortality, the data are stratified by three socioeconomic groups, (high, medium, and low) and urban rural settings In the urban high socioeconomic group, no neonatal deaths were found in the group that used colostrum and 4 26% of neonates died in the group that did not use colostrum Comparable post-neonatal deaths were 1 67% and 5 32% In the rural high socioeconomic group, no neonatal deaths were found among the group that used colostrum and 8 2% of neonates died in the group that did not use colostrum In the urban middle socioeconomic group, 2 17% of neonates died in the group that used colostrum compared to 5 69% of neonates in the group that did not use colostrum Comparable post-neonatal deaths were 3 7% and 4 29% In the rural low socioeconomic group, 10% of neonates died in the group that used colostrum compared to 17 39% of neonates in the group that did not use colostrum Comparable post-neonatal deaths were 0 and 3 4% Tests of significance were not provided

METHODOLOGICAL ISSUES. The authors failed to control for reverse causality Little information is provided about how mortality data were collected Although analyses were stratified by socioeconomic status, other potential confounding factors were not controlled

Hanson LA, Ashraf R, Zaman S, et al., Breast feeding is a natural contraceptive and prevents disease and death in infants, linking infant mortality and birth rates Acta Paediatr 1994,83 3–6

COUNTRY Pakistan

SETTING Urban and rural

DESIGN Review article

BREASTFEEDING DEFINITIONS: Not provided

OUTCOME MEASURES Mortality

RESULTS: This article is a review of the relationships between the contraceptive effect of breastfeeding and the protective effect of breastfeeding on child morbidity It describes how breastfeeding links infant mortality to birth rates It also discusses the effect of changing patterns of breastfeeding No new data are presented A strong argument is made for the promotion of breastfeeding as a mechanism to reduce both mortality and birth rates

3 Infant/Child Growth and Nutrition (because of the positive effects of longer birth intervals)

No relevant articles were found in the search on this topic

4. Effect of Breastfeeding on Child Development and Adult Outcomes
4.1 Effect of Breastfeeding on Intellectual Development

Lucus A, Morley R, Cole TJ, Gore SM A randomized multicentre study of human milk versus formula and later development in preterm infants Archives Dis Child 1994,70 F141-F146

COUNTRY England

DESIGN Prospective Children (n=502) who were preterm and < 1850 g at birth and followed for 18 months

BREASTFEEDING DEFINITION Banked breastmilk versus special preterm formula (Trial A) Banked breastmilk and expressed maternal breastmilk versus preterm formula and expressed maternal breastmilk (Trial B) Both treatments were provided to the infants by nasogastric tube

OUTCOME MEASURE Bayley psychomotor and mental development indices at 18 months of age

RESULTS This study was a randomized trial comparing the effect of preterm formula or banked donated breastmilk The design is particularly important as it permits the effect of breastmilk to be evaluated in a manner that is not confounded by social and educational differences between mothers who chose to breastfeed and those who do not Two separate studies were conducted and the results reported in the following several articles In the first three-center study, infants whose mothers chose not to breastfeed were randomized to receive a special high protein and calorie preterm formula or banked donor breastmilk (Trial A) Infants whose mothers chose to provide expressed breastmilk were randomly assigned to receive as supplements the preterm formula or banked donor breastmilk to supplement maternal donor breastmilk as needed (Trial B) In Trial B, the proportion of breastmilk provided by the mother ranged from 0 to 100%, with a median of 53% There were no differences in the proportion of maternal breastmilk provided between the two treatment groups In a separate two-center study, infants whose mothers chose not to breastfeed were randomized to receive a regular term formula or banked donor breastmilk (Trial A) Infants whose mothers chose to provide expressed breastmilk were randomly assigned to receive term formula or banked donor breastmilk to supplement maternal breastmilk as needed (Trial B) Thus within studies, the trials A and B can be treated independently or combined to compare the preterm or term formulas versus the banked breastmilk as the sole diet or in combination with maternal banked breastmilk Banked breastmilk was judged to have a low

energy content as compared to the preterm formula and the dietary requirements of preterm infants Children who were fed the special preterm formula had better outcomes in motor and mental development at 18 months of age as compared to children who received a standard formula (see next article) Thus, the formula used in the present study was the "best" available There were no significant developmental effects at 18 months between the children receiving the preterm formula compared to the banked breastmilk as either the sole diet (Trial A) or in combination with the expressed maternal breastmilk (Trial B) Male children who had received preterm formula had a 7 6 point advantage on the Bayley psychomotor development test than male children receiving banked breastmilk However, the confidence intervals for this effect crossed 1 and hence were not statistically significant When the children fed banked breastmilk and standard formula were compared (using data from both studies and hence breaking the randomized design), children fed banked breastmilk had significantly higher scores In this non-randomized comparison, children fed banked breastmilk scored 8 8 points higher on the Bayley index of psychomotor development as compared to those fed standard formula The differences for mental development favored children fed banked breastmilk compared to children receiving term formula but these differences did not reach statistical significance

METHODOLOGICAL ISSUES Interviewers who administered the Bayley Developmental Tests were blinded as to the infant feeding status of the children Although the design was intended to control for the process of self-selection in choice of infant feeding mode, the most interesting results of the study were the comparisons that broke this design and compared the banked breastmilk to term formula, which were treatments from two different studies The extent to which results from very low birth weight infants are representative of normal weight infants is unknown

Lucus A, Morley R, Cole TJ, Gore SM, Lucas PJ, et al., Early diet in preterm babies and developmental status at 18 months The Lancet 1990,335 1477–1481

COUNTRY England

DESIGN Prospective Children (n=377) who were preterm and < 1850 g at birth and followed for 18 months

BREASTFEEDING DEFINITION Term formula versus special preterm formula as the entire diet or as supplements to expressed maternal breastmilk Both breastmilk and formula were fed by nasogastric tube

OUTCOME MEASURE Bayley psychomotor and mental development indices at 18 months of age

RESULTS The focus of the article is on the results comparing the two formulas described in the previous study This comparison breaks the randomized design as it compares results from two different studies The results showed that infants who received only a special preterm formula as compared to only regular full term formula had significantly higher scores on the Bayley Scales of Mental Development and Psychomotor Development The scores for motor development were 15 points higher in infants receiving the preterm formula and for infants small for gestational age the difference was 23 points, which corresponds to nearly 1 5 standard deviation Infants fed the preterm formula had a 6 point advantage in mental development, which was significant at the $p<0$ 1 level However, a posterai power calculations show that the sample size was too small to permit detection of this advantage at the 5% level with a power of 80%, and the authors suggest that a significant effect on mental development may have been missed These results were attenuated and no longer significant when the children who had also received at least 50% of their dietary intake from their mother's expressed breastmilk in addition to the formula were included in the analysis Male infants and those born small for gestational age were particularly vulnerable to the effects of early nutrition on later mental and motor development The focus of this article is on the comparison of two infant formulas and the authors do not comment on the results that show the attenuation of significant differences between the formulas when at least 50% of the diet is provide by human milk However, this latter finding would suggest that the nutrient quality of breastmilk, despite its relatively low energy and protein content compared to the preterm formula, compensates for the low nutrient quality of the term formula

METHODOLOGICAL ISSUES The comparisons between preterm and term formula involve non-randomized treatments from two different studies It is possible that differences between the children and their families in the two studies, which occurred in different locations, may have confounded some of the results presented

Lucus A, Morley R, Cole TJ, Lister G, Lesson-Payne C Breast milk and subsequent intelligence quotient in children born preterm. The Lancet 1992,339 261–264

COUNTRY England

DESIGN Prospective Children (n=300) who were preterm and < 1850 g at birth and followed for about 8 years

BREASTFEEDING DEFINITION Maternal expressed breastmilk exclusively or in combination with formula versus formula Proportion of total intake provided by maternal breastmilk

OUTCOME MEASURE Intelligence quotient (IQ) at 7 to 8 years of age

RESULTS This study examined whether having been fed breastmilk through a nasogastric tube early in life was associated with intelligence quotient at 7 to 8 years of age Because breastmilk

was delivered to the infant by nasogastric tube, the authors were able to examine the effect of breastmilk on subsequent intelligence rather than the process of breastfeeding The results show a significant dose-response in the proportion of breastmilk provided to the infant and intelligence ($p<0$ 05) The effect was greatest for the verbal scale where a 9 point difference was found between those who consumed 100 percent breastmilk compared to those infants who consumed no breastmilk Children of mothers who chose to provide breastmilk but were unable to do so had intelligence quotients similar to children whose mothers did not choose to provide breastmilk Overall, differences in intelligence quotient between those children who received some breastmilk and those who received none was 8 3 points The data were adjusted for maternal education, social class, days the infant was on a ventilator, and infant sex, which were also associated with intelligence quotient The effect of early breastmilk feeding, however, was stronger than any of these factors The effects of early breastmilk feeding on intelligence quotient in preterm infants are larger than those for full term infants The authors suggest that preterm infants are especially vulnerable to early nutrition

METHODOLOGICAL ISSUES: Mothers who provided breastmilk were of higher social class and educational level, which may be associated with parenting attributes that are not completely captured by these two measures The authors state that the results could be explained by differences between the groups in parenting skills or genetics even after adjustment for social class and maternal education

Morrow-Tlucak M, Haude RH, Ernhart CB Breastfeeding and cognitive development in the first 2 years of life Social Sci Med 1988,26(6).635–639

COUNTRY. USA

DESIGN Prospective Inner city children (n=229) who were considered at risk for developmental delay

BREASTFEEDING DEFINITION Duration of breastfeeding as a linear variable or categorized as follows 0, < 4 months, and > 4 months

OUTCOME MEASURE· Bayley Motor Development Test at 6 months, 1 and 2 years, and the Home Observation for Measurement of the Environment at 1 and 2 years

RESULTS This study examined whether breastfeeding was associated with differences in mental and motor development during the first 2 years of life The results show that breastfeeding was associated with significantly increased scores on the Bayley Mental Development Index At 12 and 24 months scores were about 2 5 points higher for children breastfed > 4 months as compared to those breastfed < 4 months ($p<0$ 001) Differences at 6 months were in the direction of favoring breastfeeding, but failed to reach statistical significance Mothers who breastfed were

more likely to be of higher education, older, and married Because these are also characteristics that might independently and positively influence child development, they were controlled for in the analysis

METHODOLOGICAL ISSUES The authors state that there are two explanations for the findings 1) that breastfeeding has a direct beneficial effect on child cognitive development or 2) that the observed differences are due to uncontrolled maternal social factors

Rodgers B Feeding in infancy and later ability and attainment A longitudinal study Develop Med Child Neurol 1978;20·421–426

COUNTRY. England

DESIGN Prospective Survey sample of live births (n = 5362) followed for 15 years

BREASTFEEDING DEFINITION Duration of any breastfeeding and duration of bottle-feeding

OUTCOME MEASURE Tests of picture intelligence and mechanical word reading at 8 years of age and scores for reading attainment, non-verbal ability, and mathematical attainment at 15 years of age

RESULTS This study examined whether breastfeeding was associated with differences in mental and motor development at 8 and 15 years in a cohort of children followed prospectively from birth Breastfeeding was found to be more common in families of higher social-class, higher educational levels, and in families that showed greater interest in the child's primary education Multivariate analyses were performed to control for these potentially confounding factors The results show that breastfeeding was associated with significantly increased scores in four of the five outcomes examined These included picture intelligence in children eight years of age (1 76 points), and non-verbal ability (1 76 points), mathematics (1 55 points), and sentence completion (1 73 points) in children 15 years of age

METHODOLOGICAL ISSUES Although the authors controlled for all known potential confounding factors, the fact that breastfeeding was associated with other familial attributes that contribute toward intellectual development makes it difficult to rule out uncontrolled confounding in the reported associations

Green LC, Lucas A, Livingstone MBE, et al , Relationship between early diet and subsequent cognitive performance during adolescence Biochem Soc Trans 1995,23 376S

COUNTRY England

DESIGN Retrospective, n=432 subjects aged 11 to 16 years

BREASTFEEDING DEFINITION. Breastfed versus not breastfed as assessed by medical records Duration of breastfeeding (1–12 weeks and > 12 weeks)

OUTCOME MEASURE Cognitive ability as assessed by the Raven Standard Progressive Matrices and subtests of the Primary Mental Abilities test

RESULTS: This study examined whether breastfeeding was associated with differences in IQ between 11 and 16 years of age Breastfeeding was associated with social class with 29% of women in social class 1 (the lowest class) and 2 breastfeeding and 83% of women with high levels of education breastfeeding First born children were also significantly more likely to be breastfed Unadjusted results show breastfeeding to be significantly and positively associated with IQ scores However, these differences disappeared when analyses were adjusted for potential confounding factors In these analyses, social class, birth rank, and maternal age were significant The effect of breastfeeding duration was also assessed for the following breastfeeding categories 1) 1–12 weeks and > 12 weeks No significant differences in birth weight, gestational age, birth rank, child's sex, maternal age, maternal education, and social class were found between the two groups A significant 6 point advantage in verbal IQ and a 5 4 point advantage in reasoning IQ was found after adjustment for potential confounding factors for infants breastfed for > 12 weeks

METHODOLOGICAL ISSUES Authors controlled for known potential confounding factors, which explained the differences between groups One strength of the study is that it looks at the relationship between breastfeeding duration and development This is likely to better control for familial factors that are associated with maternal decisions to breastfeed and also contribute toward child development

Fergusson DM, Beautrais AL, Silva PA Breast-feeding and cognitive development in the first seven years of life Soc Sci Med 1982,16 1705–1708

COUNTRY New Zealand

DESIGN Prospective, birth cohort of children assessed at age 3 (n=1037), age 5 (n=997), and age 7 years (n=954)

BREASTFEEDING DEFINITION Breastfed > 4 months, breastfed < 4 months, bottle fed

OUTCOME MEASURE Measures of intelligence at 3, 5, and 7 years The 3-year-old measure was based on the Peabody Picture Vocabulary Test, the 5 year measure on the Stanford Binet Intelligence Scale, and the 7 year measure on the Weschler Child Intelligence Scale Measures of language development were also given at the 3 ages Measures of articulation were given at ages 5 and 7 years

RESULTS This study examined whether breastfeeding was associated with differences in 11 indicators of intelligence and language development at ages 3, 5, and 7 years The unadjusted results show that there was a tendency for test scores to vary with the duration of breastfeeding among children breastfed 4 months or longer On tests that had a standard deviation of 10, scores among these children were 1 90 to 5 55 (mean=3 84) points higher than bottle-fed children When the data were adjusted for 7 covariates (maternal intelligence, maternal educational level, maternal training in child rearing, child experience, family socioeconomic status, child's birth weight and gestational age) breastfeeding was still significantly associated with higher scores There was no sex-breastfeeding interaction, which indicates that sexes do not respond differently to the effect of breastfeeding on intelligence Adjusted scores were attenuated markedly as compared to unadjusted scores, with the magnitude of the differences reduced to 0 82 to 2 71 (mean=1 89) points

METHODOLOGICAL ISSUES The authors conclude that breastfeeding may be associated with very small improvements in intelligence and language development Alternatively, the difference may have been due to the effects of other confounding factors not entered into the analysis

Rogan WJ, Gladen BC Breast-feeding and cognitive development Early Hum Dev 1993,31 181–193

COUNTRY USA

DESIGN Prospective, birth cohort of children assessed at different ages up to age 5 years (initial n=855)

BREASTFEEDING DEFINITION Breastfeeding duration divided into four categories (short, medium, long, very long), bottle feeding

OUTCOME MEASURE Bayley Scales of Infant Development at 6, 12, 18, and 24 months Subscales of both Mental and Psychomotor development McCarthy Scales at 3, 4, and 5 years Report cards at third grade

RESULTS This study examined whether breastfeeding was associated with differences in mental and motor skills at various age intervals up to 5 years of age and with school performance in third grade The unadjusted results show that there was a tendency for the Bayley Mental Development Index to be higher among breastfed infants as compared to bottle fed infants and to be higher among those breastfed infants breastfed for longer durations After adjustment for potential confounding factors, children breastfed the shortest had scores 1 to 3 points lower than those bottle-fed and 3 to 7 points lower than those breastfed the longest Differences, however, were only significant at 24 months of age The results from the Psychomotor Development Index were similar with a tendency for slightly higher scores among children breastfed for longer durations and with differences among groups significant only at 24 months With respect to the McCarthy Scale, children breastfed the longest had a tendency toward higher scores (2 to 4 points) as compared to children breastfed the shortest These differences were significant at 3 and 4 years, but only marginally so at 5 years Duration of breastfeeding was marginally associated with both English and math grades at third grade However, after adjustment for potential confounding factors, the differences for English were only marginally significant and were not significant for math The difference between children bottle fed and breastfed the shortest was 0 17 points and between children breastfed the shortest and breastfed the longest the difference was 0 06 points The authors conclude that there were small but significant advantages for breastfed children on some subscales of the Bayley and McCarthy at all time points from 2 through 5 years of age This advantage was more consistent for cognitive than motor skills (which is consistent with other studies)

METHODOLOGICAL ISSUES Although the authors controlled for all known potential confounding variables, mothers who chose to breastfeed also had characteristics associated with child development that may explain the results

Pollock JI Long-term associations with infant feeding in a clinically advantaged population of babies Develop Med Child Neurol 1994,36 429–440

COUNTRY England

DESIGN Prospective/retrospective, n=3838 children born with a one-week period in 1970 and assessed at five and ten years of age

BREASTFEEDING DEFINITION Exclusive breastfeeding for three months or more versus bottle-fed

OUTCOME MEASURES· Health, physical, and developmental assessments at 5 years and intellectual assessment at 10 years

RESULTS· This is a reasonably rigorous study that compared the physical, health and developmental differences between two cohorts of children, those who had been exclusively breastfed for three or more months and those who had been bottle-fed Comparison groups were selected to minimize the selection of a disadvantaged bottle-fed group The potential confounding effect of 76 variables was assessed and a hierarchical regression procedure was used to identify and include in the final model potential confounding factors Adjusted odds ratios and their 99% confidence intervals were presented Exclusive breastfeeding was positively associated with both maternal and paternal education and maternal attendance at prenatal classes and negatively associated with maternal smoking At five years of age, a total of 22 factors related to medical history, physical, and mental development were assessed The three intellectual development tests administered were a picture-based vocabulary test, drawing a human figure, and copying a simple design The authors estimate that using the two-tailed threshold for significance the expected number of chance associations was 0 2 Of these 22 factors, only the picture vocabulary test was significantly and positively associated with exclusive breastfeeding At 10 years of age, a total of 24 medical, 7 physical, and 8 intellectual factors were assessed The expected number of significant chance associations was 0 4 None of the medical or physical factors was associated with infant feeding mode Exclusively breastfed children scored significantly higher on four of the tests for intellectual development Linear regression on actual scores showed that exclusively breastfed infants scored 2 6 to 3 5 points higher in a population mean of 100 on the British Ability Scales for word definitions (involving retrieval and application of knowledge) , matrices, similarities (involving reasoning skills), and total score (measuring overall perceptual and cognitive ability)

The authors conclude that the study supports the hypothesis that some aspects of intellectual attainment can be demonstrated to be superior among children who were exclusively breastfed for at least three months compared to their bottle-fed counterparts—after early clinically disadvantaged bottle fed children were excluded from the analysis and remaining potential confounding factors were controlled

METHODOLOGICAL ISSUES As with the other studies in this area, breastfeeding was associated with other factors also associated with improved child development and uncontrolled confounding may explain the results found

Anonymous Breastfeeding and child development at five years Nutr Reviews 1985,43 173–174

COUNTRY England

DESIGN Prospective/retrospective, n=about 8,400 children born with a one-week period in 1970 and assessed at five years of age

BREASTFEEDING DEFINITION. Not breastfed, breastfed < 1 month, 1–3 months, > 3 months

OUTCOME MEASURE. The English Picture Vocabulary Test, Copying designs, and the Rutter Child Behavior Score This article is a brief review of a study by B Taylor and J Wadsworth entitled "Breastfeeding and child development at five years" Dev Med Child Neurol 1984,26 73–80 The source article for this review uses the same birth cohort described in the previous study and the follow-up data at five years of age The results show that the duration of breastfeeding was associated with improved scores on the three tests but that after controlling for potential confounding factors the association with the Rutter Score became non linear and only marginally significant The associations with the other two tests were attenuated but remained significant The reviewer suggests that the effects of breastfeeding on development are likely to be small and the author suggests perhaps statistically as well as clinically insignificant

Florey CDV, Leech AM, Blackhall AA Infant feeding and mental and motor development at 18 months of age in first born singletons Inter J Epidem 1995,S21–S26

COUNTRY Scotland

DESIGN Population-based prospective/retrospective

BREASTFEEDING DEFINITION. Breastfed versus bottle-fed as assessed from hospital discharge records and home health visits

OUTCOME MEASURE Bayley Mental and Motor Developmental Indices

RESULTS The study population consisted of 846 first born singletons born during a one-month period in 1986 of whom 592 were assessed for mental and motor development at 18 months of

age Potential confounding factors controlled in the analysis included partner's social class, maternal age, height, education, cigarette and alcohol consumption during pregnancy, and the infant's sex, birth weight, gestational age, and placental weight Unadjusted analyses showed that whole distribution of scores for mental outcomes for bottle fed children shifted to the left, which suggests that whatever is influencing scores affects children over the entire range of mental abilities The unadjusted mean difference was 7 7 points (110 2 for breastfed and 102 5 for bottle-fed children) No consistent difference was found for the motor development indices Regression analyses, which controlled for potential confounding factors showed a significant difference in mental developmental indices of between 3 7 and 5 7 points depending on the source of the infant feeding data, which was not completely concordant for all children

METHODOLOGICAL ISSUES. Breastfeeding is poorly defined and it is not clear what the duration of breastfeeding was among the breastfed cohort Nonetheless, these data were not collected as part of the study on mental and motor development but were available from birth and early health records Also, one psychologist performed all the tests and was blinded to the infant feeding mode

Uauy R, de Andraca I Human milk and breastfeeding for optimal mental development J Nutr 1995,125 2278S–2289S

de Andraca I, Uauy R Breastfeeding for optimal mental development The alpha and omega in human milk. World Review of Nutr Diet 1995,78 1–27

These review articles summarize the results of many of the studies summarized in this annotated bibliography They also discuss specific breastmilk components, particularly essential fatty acids and research results that examine possible mechanisms whereby breastmilk may have an effect on later intelligence The article concludes that all results comparing breastfeeding with bottle feeding need to be interpreted cautiously because of the potential for confounding They suggest that the effects of breastfeeding are complex and related to both the nutritional properties of breastmilk and the emotional and bonding factors associated with the process of breastfeeding, and their interaction The article concludes that the challenge in future studies will be to establish a conceptual framework that enables these separate and interactive effects to be disentangled Also, that breastfeeding should be considered best unless proven otherwise and that it is particularly important in developing countries and among underprivileged communities in developed countries

4 Effect of Breastfeeding on Child Development and Adult Outcomes
4.2 Effect of Breastfeeding on Risk of Cancer

Davis MK, Civets DA, Graudard BI. Infant feeding and childhood cancer The Lancet 1988,August 13 365–368

COUNTRY: USA

DESIGN Case-control, cases (n=201) were children diagnosed with childhood cancer Controls (n=181) of similar age, sex, and area of residence were randomly selected from the community

BREASTFEEDING DEFINITION: Duration of any breastfeeding categorized as follows no breastfeeding, breastfed < 6 months, breastfed > 6 months

OUTCOME MEASURE Childhood cancer

RESULTS This study examined whether having been breastfed was associated with a decreased risk of childhood cancer The results show that compared to children that had been breastfed > 6 months children who were not breastfed or breastfed for < 6 months had significantly higher risk of developing cancer (p=0 023) As compared to breastfeeding > 6 months the crude odds ratios for no breastfeeding or breastfeeding < 6 months were 1 8 and 1 9, respectively The authors state that adjusted odds ratios were similar Increased risk was largely the results of increased risk for lymphoma Compared to children who had been breastfed > 6 months, children who had not been breastfed or breastfed < 6 months had 5 to 8 times greater risk of developing lymphoma (unadjusted p value = 0 023) However, when adjusted for maternal education, the p value increased to 0 1

METHODOLOGICAL ISSUES Young children > 1 5 years of age were excluded from the study to avoid the possibility of reverse causality The small number of cases made it difficult to evaluate the effect of maternal education, which was associated with breastfeeding and cancer risk

Freudenheim JL, Marshall JR, Graham S, Laughlin R, Vena JE, Bandera E, Muti P, Swanson M, Nemoto T Exposure to breastmilk in infancy and the risk of breast cancer Epidemiology 1994,5 324–331

COUNTRY USA

DESIGN Case-control Cases (n=528) were women newly diagnosed with breast cancer, controls (n=602) were randomly selected from the community and frequently matched for age

BREASTFEEDING DEFINITION Any breastfeeding (yes, no) Breastfeeding histories as an infant were obtained from the subjects

RESULTS This study examined whether having been breastfed as an infant reduced a woman's risk of breast cancer The results show that having been breastfed was associated with a significantly decreased risk The adjusted odds ratio was 0 74 (95 percent confidence interval = 0 56–0 99) The difference was found for both pre- and post-menopausal women The authors conclude that early nutriture in general and bottle feeding in particular may relate to the development of breast cancer in adult women

METHODOLOGICAL ISSUES The participation of eligible cases and controls was low (about 50 percent) Furthermore, only about half of the cases and controls knew whether they had been breastfed as infants Thus, this study cannot be considered truly community-based The authors controlled for all known confounding factors

Potischman N, Brinton LA, Coates RJ, Malone DE, Schoenberg JB Letter re Fruedenheim et al , Epidemiology 1995,6(2) 199–200

COUNTRY USA

DESIGN Case-control Cases (n = 380) newly identified with premenopausal breast cancer, controls (n = 311) randomly selected from the community

BREASTFEEDING DEFINITION Any breastfeeding (yes, no) Breastfeeding histories were obtained from subject's mothers

RESULTS This study examined whether having been breastfed as an infant reduced a woman's risk of premenopausal breast cancer The results show that having been breastfed as an infant was associated with reduced risk The magnitude of the reduction in risk was identical to that found in Fruedenheim et al , for premenopausal women (odds ratio = 0 76, 95 percent confidence

interval = 0 54–1 08) The results show that having been breastfed was weakly protective for the development of breast cancer as an adult

METHODOLOGICAL ISSUES As with the study by Fruedenheim et al , the response rate for cases and control was low

4. Effect of Breastfeeding on Child Development and Adult Outcomes
4.3 Effect of Breastfeeding on Other Outcomes

Samuelsson U, Johansson C, Ludvigsson J. Breast-feeding seems to play a marginal role in the prevention of insulin-dependent diabetes mellitus Diabetes Research and Clinical Practice 1993,19 203–210

COUNTRY Sweden

DESIGN Case-control, Cases (n = 297) were diabetic children < 15 years, controls (n = 792) were matched by age, sex, and place of residence

BREASTFEEDING DEFINITION Duration of exclusive breastfeeding and any breastfeeding

RESULTS This study examined whether having been breastfed was associated with decreased risk of childhood insulin dependent diabetes The results show that there was no significant difference in breastfeeding history on risk of developing diabetes In a subgroup analysis it was found that children diagnosed during the winter tended to have older mothers and to have been breastfed for a shorter period of time as compared to controls The authors suggest that among these "epidemic" type cases that breastfeeding might have a weak protective effect

METHODOLOGICAL ISSUES. The authors examined the data for many different subgroup effects and found a slight association for one of these (winter diagnosis, older mothers, and shorter duration of breastfeeding) They did not discuss the mechanism by which the subgroup with these characteristics might be at greater risk Overall, this study does little to establish an association between diabetes and breastfeeding

Coalesce S, Griffiths A, Corey M, Smith C, Sherman P Infant feeding practices and ulcerative colitis in childhood BMJ 1991,302 1580–1581

COUNTRY Canada

DESIGN Case-control Cases (n = 93) were children with ulcerative colitis, controls (n=138) were unaffected biological siblings

BREASTFEEDING DEFINITION Duration of exclusive breastfeeding and any breastfeeding, and age of introduction of solids

RESULTS The study examined whether having been breastfed was associated with decreased risk of ulcerative colitis The results show that infant feeding practices were not associated with risk of disease development

METHODOLOGICAL ISSUES The small sample size may have precluded finding meaningful differences, however, the authors did not perform ex post power calculations to determine the power of their study to have detected a significant difference

Koletzo S, Sherman P, Corey M, Griffiths A, Smith C Role of infant feeding practices in development of Chron's disease in childhood. BMJ 1989,298 1617–1618

COUNTRY Canada

DESIGN Case-control Cases (n = 114) were children < 18 years with Chron's disease, controls (n=180) were unaffected biological siblings

BREASTFEEDING DEFINITION Duration of exclusive breastfeeding or any breastfeeding,

RESULTS This study examined whether having been breastfed as an infant was associated with the risk of developing Chron's disease The results show that lack of breastfeeding was a significant risk factor for disease development Compared to children who had been breastfed, children who had not been breastfed had three times the risk (p< 0 002) Having had diarrhea in infancy was an independent risk factor

METHODOLOGICAL ISSUES The authors did not control for the possibility of reverse causality, e g that the disease could influence infant feeding patterns Biological siblings were used as controls and women tend to have similar infant feeding patterns across their children Thus, the issue of why infants who later became ill were fed differently than their siblings merits investigation and discussion, which was lacking in the article

Saarinen UM, Kajosarri M Breastfeeding as prophylaxis against atopic disease Prospective follow-up study until 17 years old. The Lancet 1995 (October 21),346 1065–1069

COUNTRY Finland

DESIGN. Prospective, n=236 of which 150 were followed until 17 years of age

BREASTFEEDING DEFINITION Breastfeeding duration categorized as follows 1) > 6 months, 2) 1–6 months, 3) < 1 month or no breastfeeding

OUTCOME MEASURE. Atopic eczema, food allergy, respiratory allergy A child was considered atopic if any of these three measures was diagnosed

RESULTS This study examined the association between infant feeding mode and various atopic diseases Children were followed from birth and seen frequently during infancy and again at 1, 3, 5, 10, and 17 years of age The results show that the prevalence of atopy throughout the follow-up period was significantly highest in the group that had little or no breastfeeding The prevalence of eczema was lowest in the group breastfed the longest at ages 1 and 3 years The prevalence of food allergy was highest in the group that had little or no breastfeeding between 1 and 3 years Respiratory allergy was most prevalent in the group that had little or no breastfeeding The prevalence of respiratory allergy at 17 years of age for children breastfed the longest was 42 compared to 65 among children breastfed the shortest or not at all The authors conclude that breastfeeding is prophylactic against atopic disease throughout childhood and adolescence

METHODOLOGICAL ISSUES The prevalence of respiratory allergy is very high even among the breastfed children, which the authors do not discuss

Wingard DL, Criqui MH, Edelstein SL, Tucker J, et al , Is breast-feeding in infancy associated with adult longevity? Amer J Public Health 1994,84(9).1458–1462)

COUNTRY: USA

DESIGN: Prospective population-based Subjects (n=1170) were followed more than 65 years and cause-specific mortality documented

BREASTFEEDING DEFINITION Duration of breastfeeding categorized as follows 0, 1–5, 6–11, 12–36 months Breastfeeding information was obtained from the subject's parents within 10 years of the child's birth

RESULTS This study examined whether breastfeeding is associated with increased longevity in adulthood After adjustment for all known confounding factors, the results show a weak association between having been breastfed and increased longevity among men No association was found for women Breastfeeding was not associated with death from cardiovascular disease for either sex Death from accidental injury was inversely associated with breastfeeding and showed a dose-response with duration of breastfeeding in men only This finding is probably the result of chance as there is no biologically plausible explanation for why having been breastfed as an infant would reduce risk of death from injury Overall the results do not provide strong evidence that breastfeeding is related to adult longevity

METHODOLOGICAL ISSUES This sample was restricted to middle class children with access to health care Therefore, differences in health care are unlikely to explain the findings The study controlled for many potential confounding factors

5. Effect of Breastfeeding on Maternal Health
5.1 Effect of Breastfeeding on Breast Cancer

Byers T, Graham S, Rzepka T, Marshall J Lactation and breast cancer Amer J Epidemio 1985,121(5)·664–674

COUNTRY USA

DESIGN Case-control Cases = 453 newly diagnosed cases, controls = 1365 women selected randomly in the community

BREASTFEEDING DEFINITION Duration of breastfeeding, number of infants breastfed, reasons for stopping breastfeeding

RESULTS The results show a negative association between breastfeeding and breast cancer among premenopausal women only The relative risk per 12 months of lactation was 0 6 ($p<0$ 01) A dose-response was detected with increasing durations of breastfeeding (p for trend = 0 07) Women's reports of insufficient milk were associated with increased risk for breast cancer, especially in premenopausal women

METHODOLOGICAL ISSUES This is the first study to raise the issue that a third factor may be related to both difficulty in breastfeeding, which is perceived by mothers to be insufficient milk, and breast cancer If this were the case then breastfeeding would not be protective of breast cancer, but rather a marker that the third factor related to breast cancer is not present Many subsequent studies have attempted to address failure to breastfeed as a physiological marker of risk rather than as a behavioral choice

Newcomb PA, Storer BE, Longnecker MP, et al , Lactation and a reduced risk of premenopausal breast cancer New England Journal Med 1994,330(2) 81–7

COUNTRY: USA

DESIGN Case-control (Multicenter study) Cases = 6888 (81% of eligible women), Controls = 8,216 (82% of eligible controls)

BREASTFEEDING DEFINITION Duration of breastfeeding (prior to cancer diagnosis), reasons for stopping breastfeeding, medications used to prevent lactation, age at first lactation

RESULTS Among all parous women who had ever lactated, the estimated relative risk for breast cancer was 0 97, a non significant difference Among premenopausal women, a history of breastfeeding was associated with a slight decrease in risk of breast cancer The relative risk is 0 78 with 95% confidence intervals of 0 66 to 0 91 Total duration of breastfeeding was associated with a decrease in risk of breast cancer ($p<0$ 001) only among premenopausal women Compared to women that never lactated, a cumulative total of > 24 months of breastfeeding was associated with a relative risk of 0 72 Age at first lactation had an independent effect on risk of breast cancer Younger ages at first lactation were associated with a decreased risk (p for trend was 0 003) The authors conclude "If women who do not breastfeed or who breastfeed for < 3 months were to do so for 4 to 12 month, breast cancer among parous premenopausal women could be reduced by 11 percent, judging from current rates If all women with children lactated for 24 months or longer, however, then the incidence might be reduced by nearly 25 percent This reduction would be even greater among women who first lactate at an early age "

METHODOLOGICAL ISSUES: The study had sufficient statistical power to detect differences in risk among premenopausal women

Suskind V, Schofield F, Rice D, Bain C. Breast cancer and breastfeeding Results from an Australian case-control study Amer J Epidemio 1989,130(2).229–236

COUNTRY Australia

DESIGN. Case-control, Cases = 459, Control = 1091

BREASTFEEDING DEFINITION Total duration of breastfeeding, average duration per live born child, total number of children breastfed, average number of children breastfed, and length of time the first live born child was breastfed

RESULTS A weak inverse association between history of breastfeeding and breast cancer was found All confidence intervals for both univariate and multivariate analyses included unity and no overall tests of association between breastfeeding and disease yielded significant results

METHODOLOGICAL ISSUES The study had limited statistical power to detect differences, particularly for premenopausal women

Yoo K-Y, Tajima K, Kuroishi T, Hirose K, et al , Independent protective effect of lactation against breast cancer A case-control study in Japan Amer J Epidemio 1992,135(7) 726–733

COUNTRY Japan

DESIGN Case-control Cases=521 confirmed by histological and clinical exam, controls = 521 women with no history of breast cancer selected from the hospital

BREASTFEEDING DEFINITION History of breastfeeding (yes, no), total number of breastfeeding children, average months of breastfeeding/child

RESULTS Among parous women, the adjusted odds ratio of breast cancer among women with a positive history of breastfeeding was 0 62 (95% confidence interval 0 37–1 04) relative to no breastfeeding A significant trend of decreased risk of breast cancer with increase average months of breastfeeding was observed ($p<0$ 05) among premenopausal women only Premenopausal women who had lactated for 7 to 9 months showed the lowest risk of breast cancer (adjusted odds ratio= 0 39, 95% confidence interval 0 15–0 97)

METHODOLOGICAL ISSUES Controls were selected from a hospital-based population and hence may not be representative of the community Good simultaneous adjustment for age, parity, and menopausal status The study also restricted the analyses to parous women, which is important because of the importance of age of first pregnancy on risk of breast cancer

London SJ, Colditz GA, Stampfer MJ, et al , Lactation and risk of breast cancer in a cohort of US women Amer J Epidemio 1990,132(1) 17–26

COUNTRY USA

DESIGN Prospective for cancer outcomes, however breastfeeding history was obtained retrospectively n=89,413 parous female nurses aged 30 to 55 years

BREASTFEEDING DEFINITION Never breastfed, breastfed for the following lengths of time <1 month, 1–3 month, 4–6 month, 7–11 month, 12–17 month, 18–23 month, 24–35 month, 36–47 month, > 48 month, unknown

RESULTS. No association between lactation and risk of breast cancer was found

METHODOLOGICAL ISSUES Controlled for the possibility that breast cancer reduced breastfeeding Short breastfeeding duration among the population (only 6% breastfeeding > 24 month) may have reduced statistical power

Brinton LA, Potischman NA, Swanson CA, Schoenberg JB, et al., Breastfeeding and cancer risk Cancer Causes and Control 1995;6 199–208

COUNTRY USA

DESIGN. Case-control with a focus on premenopausal women (< 45 y) Cases = 1,211 newly diagnosed with breast cancer (86% of eligible cases) Controls = 1,120 contacted in the community through random digit dialing (67% of eligible)

BREASTFEEDING DEFINITION Duration of exclusive breastfeeding, any breastfeeding, why breastfeeding discontinued, medications to inhibit breastfeeding

RESULTS The overall findings are consistent with studies that have shown breastfeeding to be a weak protective factor for breast cancer The relative risk for > 2 week of breastfeeding versus no breastfeeding was 0 87 (95% confidence interval 0 7–1 0) Longer durations were associated with decreased risk The relative risk for > 36 months was 0 72 (95% confidence interval 0 5–1 1) The relative risk for > 72 week was 0 67 (95% confidence interval 0 4–1 1) (p for trend = 0 04) Subjects who were young at first lactation (< 22 yrs) had lowest risk Breastfeeding was associated with a greater reduction in risk among subjects with a family history of breast cancer (p for interaction = 0 03)

METHODOLOGICAL ISSUES The study lacked statistical power in that durations of breastfeeding were short among most subjects

Brinton LA, Hoover R, Fraumeni JF Reproductive factors in the aetiology of breast cancer Br J Cancer 1983,47 757–762

COUNTRY USA

DESIGN Case-control Cases = 1,362, Controls = 1,250

BREASTFEEDING DEFINITION Any breastfeeding, number of breastfeeding children

RESULTS The results show no association between breastfeeding history and risk of breast cancer The adjusted relative risk is 0 94, with 95% confidence intervals that cross one

METHODOLOGICAL ISSUES No information on breastfeeding duration was available Small sample size may have limited statistical power

Romieu I, Hernandez-Avila M Lazcano E, Lopez L, Romero-Jaime R Breast cancer and lactation history in Mexican women Amer J Epidemio 1966,143(6).543–552

COUNTRY Mexico

DESIGN Case-control Cases (n = 349) were newly diagnosed with breast cancer Controls (n = 1,005) were selected from the general population Lactation history was obtained prior to diagnosis of breast cancer

BREASTFEEDING DEFINITION· Total duration of breastfeeding, ever breastfed, duration of breastfeeding for first and second live born children

RESULTS The results show that breastfeeding was protective against breast cancer for both pre- and post-menopausal women Parous women who had ever breastfed had a cancer risk of 0 47 (95% confidence interval = 0 30–0 73) compared to parous women who had never breastfed Duration of lactation was also associated with a reduction in breast cancer risk (test for trend $p<0$ 005) This protective effect was stronger in post-menopausal women Among pre-menopausal women no increase in protection was found after 3 months of breastfeeding The duration of breastfeeding was particularly important for first born children The duration of breastfeeding for the second child was smaller and significant only among post-menopausal women

METHODOLOGICAL ISSUES The high proportions of pre-menopausal women and long durations of breastfeeding among study subjects resulted in a large degree of statistical power to test the associations of interest

Layde PM, Webster LA, Baughman AL, et al , The independent associations of parity, age at first full term pregnancy, and duration of breastfeeding with risk of breast cancer J Clin Epidemiol 1989,42(10) 963–973

COUNTRY USA, multi-center

DESIGN Case-control Cases (n = 4,599) were newly diagnosed with breast cancer Controls (n = 4,536) were women of similar age selected at random from the community

BREASTFEEDING DEFINITION Total duration of breastfeeding

RESULTS The results show that compared to parous women who never breastfed, breastfeeding was protective against breast cancer A dose-response was found with decreased risk with increasing duration of breastfeeding (p for trend < 0 01) The odds ratio for never having breastfed compared to breastfeeding for more than 24 months was 0 67

METHODOLOGICAL ISSUES. This study controlled for many potential confounding factors and tested for interactions

Rosero-Bixy L, Oberle MW, Lee NC Reproductive history and breast cancer in a population of high fertility, Costa Rica, 1984–1985 Int J Cancer 1987,40.747–754

COUNTRY Costa Rica

DESIGN Case-control Cases (n = 171) were interviewed within three years of diagnosis Controls (n = 826) were selected from the general population

BREASTFEEDING DEFINITION Total duration of breastfeeding

RESULTS The results show that after controlling for parity that the duration of breastfeeding had no association with risk of breast cancer

METHODOLOGICAL ISSUES There were a small number of cases, which may have limited statistical power to detect an association

Ing R, Ho JHC, Petrakis NL Unilateral breast-feeding and breast cancer The Lancet 1977 (July 16) 124–127

COUNTRY Hong Kong

DESIGN Retrospective (n=2403) Chinese breast cancer patients including 73 women who had breastfed from one breast only

BREASTFEEDING DEFINITION Number of children breastfed, average duration of breastfeeding, history of breastfeeding with only one breast, relative use of both breasts during breastfeeding

RESULTS The unsuckled breast among women who only breastfed on one side had a fourfold increase in cancer risk in postmenopausal older women (> 55 years of age)

METHODOLOGICAL ISSUES· Tests of significance are not provided

Thomas DB, Noonan EA and the WHO Collaborative Study of Neoplasia and Steroid Contraceptives Inter J Epidemio 1993,22(4) 619–626

COUNTRY Multi-national case-control study (Australia, Germany, Israel, Chile, China, Colombia, Kenya, Mexico, The Philippines, Thailand)

DESIGN. Case-control Cases (n=2336) were newly diagnosed breast cancer patients Controls (n=14,900) were selected from the hospital for reasons other than gynecological or associated with use of oral contraceptives

BREASTFEEDING DEFINITION Duration of breastfeeding Women who breastfed < 3 months were used as the reference group

RESULTS No significant protective effect of breastfeeding was found for any of the models examined These models included pre- and post-menopausal women, age of diagnosis, women with different numbers of live births, or mean number of months that a women breastfed/child In pre-menopausal women and those with two or more live births, most risk estimates associated with breastfeeding > 6 months, relative to women who breastfed < 3 months were > unity, but the 95% confidence intervals included one

METHODOLOGICAL ISSUES The authors used as a reference group women who had breastfed < 3 months to avoid potential confounding associated with unidentified risk factors that might occur if the comparison group consisted of women who had lactation failure However, to avoid this bias the authors may have inadvertently minimized their ability to find an effect in that many

studies have shown that the protective effect of breastfeeding in pre-menopausal women occurs with short breastfeeding durations and is not increased with longer durations

MacMahon B, Purde M, Cramer D, Hint E Association of Breast Cancer Risk with Age at first and Subsequent Births A Study in the Population of the Estonian Republic J National Cancer Institute 1982;69(5) 1035–1038.

COUNTRY: Estonia

DESIGN Case-control Cases = 362 newly diagnosed cases, controls = 694 women participating in a gynecological screening program

BREASTFEEDING DEFINITION: Duration of breastfeeding categorized as follows 0, 1–6, 7–12, 13–24, > 25 months

RESULTS Breastfeeding duration did not have any effect breast cancer

METHODOLOGICAL ISSUES This study may have lacked statistical power to detect an effect because of the relatively short durations of breastfeeding Nearly half of both cases and controls had only one child and only 17 percent had more than 2 children > one quarter of the cases breastfed for longer than 12 month

Valaoras VG, MacMahon B, Trichopoulos D, Polychronopoulou A Lactation and reproductive histories of breast cancer patients in greater Athens, 1965–69 Int J Cancer 1969,4 350–363.

COUNTRY Greece

DESIGN Case-control Cases (n=799) were newly diagnosed breast cancer patients Controls (n=2,470) were selected from the hospital

BREASTFEEDING DEFINITION: Number of parous women who never breastfed, mean duration of breastfeeding among those children who breastfed, number of women who breastfed > 24 months

RESULTS Although the associations are in the direction of a protective effect of breastfeeding, the differences are small and not statistically significant, even for long durations of breastfeeding

METHODOLOGICAL ISSUES Use of hospital-based controls may have introduced undetected bias in the study

Mayberry RM Age-specific patterns of association between breast cancer and risk factors in Black women, ages 20 to 39 and 40 to 54 Ann Epidemiol 1994,4.205–213

COUNTRY USA

DESIGN Case-control Among women < 40 years of age, cases (n=177) were compared to controls (n=137) Among women 40 to 54 years of age cases (n=313) were compared to controls (n=348)

BREASTFEEDING DEFINITION Total months of breastfeeding defined as follows > 8 months, 4–7 months, and < 4 months

RESULTS The adjusted odds ratio showed no association between breastfeeding and risk of breast cancer

METHODOLOGICAL ISSUES Small sample size may have limited the statistical power to detect an association

MacMahon B, Lin TM, Lowe CR et al., Lactation and cancer of the breast A summary of an international study Bull World Health Organ 1970,42 185–194

COUNTRY Multi-country (USA, England, Greece, Slovenia, Yugoslavia, Brazil, Tokyo, Taiwan)

DESIGN Case-control Cases (n=4,395) were newly diagnosed breast cancer patients Controls (n=12,888) were selected from the hospital

BREASTFEEDING DEFINITION Number of parous women who never breastfed, mean duration of breastfeeding among those children who breastfed, number of women with long lifetime histories of lactation (the precise cutoff depended on the country)

RESULTS. No consistent differences in duration of lactation were found between women with breast cancer and those without breast cancer, after controlling for parity

METHODOLOGICAL ISSUES Use of hospital-based controls may have introduced undetected bias in the study

Raksasook S The relationship of breast cancer with parity and breast feeding in Thai women Southeast Asian J Surgery 1985,8(1) 23–30

COUNTRY: Thailand

DESIGN. Case-control Women were divided into three groups 1) normal (n=825), 2) benign breast disease (n=162), and, 3) breast cancer (n=109)

BREASTFEEDING DEFINITION Ever breastfed, duration of breastfeeding

RESULTS· In contrast to all the other studies reviewed, women with breast cancer were less likely to have breastfed as compared to controls, however, this association was not significant Breastfeeding in the control and benign breast disease groups was between 1 and 6 months duration in contrast to a duration of 7–12 months in the breast cancer group

METHODOLOGICAL ISSUES Use of hospital-based controls may have introduced undetected bias in the study

Kelsey JL, Gammon MK, John EM Reproductive factors and breast cancer Epidemiol Reviews 1993,15(1)·36–47

COUNTRY.

DESIGN Review article of existing studies

BREASTFEEDING DEFINITION Varies by study

RESULTS. This review article concludes that breastfeeding may reduce risk of breast cancer among women under 50 years of age Of the 10 case-control studies reviewed, eight found an association between breastfeeding and reduced risk and two failed to show an effect Five of these studies found a small protective effect of ever breastfeeding but no trend of decreased risk with increased breastfeeding duration Three studies found decreased risk in both pre- and post-menopausal women Where a protective effect was found, the adjusted odds ratios ranged from 0 21 to 0 77 Of concern is the fact that two large prospective cohort studies have failed to find an association between breastfeeding and breast cancer risk Although it would have been helpful, the authors do not discuss the difference in findings between case-control and prospective cohort studies Cohort studies are generally considered to be stronger than case-control studies and the fact that two have now failed to confirm the protective effect found in case-control studies is troubling

MacMahon B, Feinleib M Breast cancer in relation to nursing and menopausal history J Nat Cancer Inst. 1960,24 733–753

COUNTRY USA

DESIGN Case-control Cases (n=340) were selected from current cancer lists Controls (n=340) were general surgical patients matched for eight variables

BREASTFEEDING DEFINITION Total duration of breastfeeding, average duration of breastfeeding per child, proportion of mothers who have never breastfed, proportion of children who have been breastfed

RESULTS No consistent differences in duration of lactation were found between women with breast cancer and those without breast cancer, after controlling for potential confounding factors

METHODOLOGICAL ISSUES Use of hospital-based controls may have introduced undetected bias in the study

5. The Effect of Breastfeeding on Maternal Health
5.2 Effect of Breastfeeding on Ovarian Cancer

Gwinn ML, Lee NC, Rhodes PH, Layde PM, Rubin GL Pregnancy, breast feeding, and oral contraceptives and the risk of epithelial ovarian cancer J Clin Epidemio 1990,43(6) 559–568

COUNTRY USA

DESIGN: Case-control, n = 436 cases and 3833 controls randomly selected from the community

BREASTFEEDING DEFINITION Total months of breastfeeding

RESULTS Among parous women, breastfeeding was protective of ovarian cancer The relative risk was 0 6 with 95% confidence intervals of 0 5 to 0 9 Further reductions in risk were seen in women who had breastfed for > 24 month Each months of breastfeeding was associated with a reduced risk of 2 4 percent Most of the protection due to breastfeeding occurred with the first exposure

Risch HA, Weirs NS, Lyon JL, Daling JR, Lift JM Events of reproductive life and the incidence of epithelial ovarian cancer Amer J Epidemio 1983,117(2) 128–139

COUNTRY USA

DESIGN· Case-control, n = 290 cases (68 percent of eligible cases), n = 705 randomly selected from the community and age-matched

BREASTFEEDING DEFINITION Total months of breastfeeding, 0–2 months or >3 months

RESULTS· The estimated relative risk for breastfeeding was 0 79 per year of lactation (p=0 034) Breastfeeding more than 3 months as compared to 2 or less months was inversely associated with ovarian cancer, relative risk = 0 694 and 95% confidence interval 0 503–0 959 (p=0 026) The authors found that the magnitudes of the diminished risk from lactation and other protective exposures (e g pregnancies and oral contraceptives) substantially exceeded those which would have been expected solely on the basis of their inhibition of ovulation This suggests another mechanism by which these events protect against ovarian cancer

METHODOLOGICAL ISSUES Only 67 percent of eligible cases were included, which suggests that the results are not representative of women with advanced cases of cancer The study controlled for all known confounding factors

Rosenblatt KA, Thomas DB, and the WHO Collaborative Study of Neoplasia and Steroid Contraceptives Inter J Epidemio 1993;22.192–197

COUNTRY. Australia, Chile, China, Israel, Mexico, Philippines, Thailand

DESIGN: Case-control Cases = 393 newly diagnosed cases, controls = 2,565 women hospitalized in the same hospital for digestive or nervous system disorders

BREASTFEEDING DEFINITION Duration of breastfeeding

RESULTS The results show that risk of ovarian cancer decreased with increasing duration of breastfeeding, but after adjusting for the number of live births this trend was not significant A significant reduction in risk was found for women who breastfed for at least 2 month, but no further reduction was found with longer term breastfeeding The findings are consistent with those of a meta-analysis of 12 studies that showed a slight reduction in risk associated with short-term breastfeeding and no further reduction in risk associated with longer term lactation (see Whittemore et al , 1992)

METHODOLOGICAL ISSUES Analyses were restricted to parous women only, which is important because pregnancy has an independent protective effect on ovarian cancer risk Potential confounding factors were also controlled

Whittemore AS, Harris R, Itnyre J, and the Collaborative Ovarian Cancer Group. Characteristics relating to ovarian cancer risk Collaborative analysis of 12 US case-control studies Amer J Epidemio 1992;136 1184–1203

COUNTRY USA

DESIGN Case-control Used data from 2,197 ovarian cancer patients and 8,893 controls from 12 case-control studies (6-hospital-based and 6 community-based)

BREASTFEEDING DEFINITION Duration of breastfeeding

RESULTS After adjusting for parity, and oral contraceptive use, parous women who ever had breastfed had a lower risk than did those who never had breastfed The odds ratios were 0 73, 95 percent confidence interval 0 51–1 0 in the hospital studies, and 0 81, 95 percent confidence interval = 0 68–0 95 in the community-based studies The percent risk reduction per month of breastfeeding for the, first 6 months after delivery, exceeds that for breastfeeding after 6 months This suggests that part of the protective effect of breastfeeding may be through suppression of ovulation There was also a trend of decreasing risk with increasing duration of breastfeeding

METHODOLOGICAL ISSUES Analyses were restricted only to parous women, which is important because pregnancy has an independent protective effect on ovarian cancer risk Potential confounding factors were also controlled

Booth M, Beral V, Smith P Risk factors for ovarian cancer A case-control study Br J Cancer 1989,60 592–598

COUNTRY England

DESIGN Case-control Cases (n=235), controls (n=451) were selected from the hospital

BREASTFEEDING DEFINITION Duration of breastfeeding, ever breastfed

RESULTS In contrast to the results from the other studies reviewed, women who had breastfed for more than two years had three times the risk of ovarian cancer compared to women who never breastfed ($p<0.05$)

METHODOLOGICAL ISSUES Controls were selected from the hospital, which may have introduced undetected bias

6. Economic Benefits

Levine RE, Huffman SL The economic value of breastfeeding, the national, public sector, hospital, and household levels· A review of the literature Center to Prevent Childhood Malnutrition, 1990.

COUNTRY Review article

This paper develops a framework for the analysis of the economic value of breastfeeding and to the extent that data are available discusses the actual costs of breastfeeding versus formula feeding from four perspectives 1) national, 2) public sector, 3) hospital, and, 4) household It also identifies data gaps in the literature and recommends future research directions The paper focuses on the economic consequences of infant feeding decisions rather than the economic considerations that are involved in infant feeding decisions The authors argue that the relative costs of breastfeeding and bottle feeding are experienced at distinct levels and differ depending on the perspective being examined It concludes that data are inadequate to provide quantitative estimates of a number of components of their economic framework
At the national level, the elements of costs of breastfeeding include the potential loss of women's productivity and economic contribution (the opportunity cost of breastfeeding because of the time involved and the need for a mother to be in close proximity to her infant) and the potential loss of taxes from the sale of locally-produced breastmilk substitutes The costs of bottle feeding include the aggregate expenditures on breastmilk substitutes and supplies and the infant and child lives lost because of increased morbidity Although no data were available on the costs of breastfeeding, the costs of bottle feeding were well documented in terms of the cost of replacing breastmilk Since, these costs were estimated in different ways and used different assumptions, it is difficult to draw straight forward comparisons (To derive comparable estimates, the cost of breastmilk substitutes would need to be calculated as a function of the numbers of women breastfeeding and the durations of exclusive and partial breastfeeding, the cost of substitutes, which involves assumptions about what the replacement product actually is, and the nutrient cost of producing the breastmilk) Estimates for the replacement costs of breastmilk ranged from $1 8 million in Singapore (based on a decline in breastfeeding prevalence over a nine-year period) to $16 million in the Philippines (based on a decline in breastfeeding prevalence over a ten-year period) Other authors have estimated the cost of breastmilk substitutes if all breastmilk were to be eliminated, such as the estimate of $500 million annually for Indonesia Most of these estimates do not include the nutrient cost to the mother of producing breastmilk

At the public sector level, the costs of breastfeeding include the costs of breastfeeding promotion and the potential loss of tax revenues from local breastmilk substitute manufacturers The costs of bottle feeding include public expenditures for breastmilk substitutes and supplies, public health care costs, family planning costs, and interest on debt incurred by the importation of substitutes The evaluation of public sector costs were limited by the paucity of data on public expenditures related to breastfeeding and need to make assumptions about the health and fertility benefits to derive costs No data were available on the potential loss of tax revenues from local breastmilk substitute manufacturers nor on the debt incurred by the importation of substitutes Breastfeeding promotion campaigns have been associated with costs of $1 to $11 per mother In Indonesia, $40 million per year would be required for diarrhea treatment if breastfeeding prevalence declined by 25% The authors estimate that if breastfeeding currently accounts for a 20% reduction in total world wide fertility that this is worth $65 million In Indonesia, it is estimated that an additional $80 million per year would have to be spent on family planning if breastfeeding were to cease

At the hospital level, the costs of breastfeeding include staff training, education and support of new mothers, and modification of the hospital to permit rooming-in The costs of bottle feeding include staff time for preparation and feeding, expenditures on breastmilk substitutes, bottles, and other equipment, pharmaceutical supplies, and increased hospital stay and health care costs The data available to quantify these costs were not comparable, which made it impossible to arrive at net calculations of costs However, data were available to show that the costs associated with changes in hospital practices are offset by direct savings realized from such changes For example, the following costs were summarized 1) lobbying/conferences ($51 per participant to $600 per participant), 2) staff training ($10 per participant to $860 per participant), 3) lactation counseling $ 35 to $4 00 per participant, and, 4) rooming-in (no cost) The savings were summarized as follows 1) reduced staff time because of rooming-in ($4 20 per delivery to $35 per day), 2) less infant formula ($0 50/delivery to $0 82/delivery), 3) fewer bottles ($0 32 to $0 60), and, 4) less oxytocin ($0 10/delivery to 0 32/delivery)

At the household level, the costs of breastfeeding include maternal time, lost employment opportunities, and increased maternal food consumption to support breastfeeding The costs of bottle feeding include expenditures on formula and other supplies, caretaker's time for bottle preparation and feeding, expenditures on health care for ill children, caretaker's time for care of ill child, loss of the child's potential productivity and economic contribution to the household, and expenditures associated with higher fertility or increased use of contraceptives While data were not available to quantify the opportunity costs of breastfeeding, maternal employment outside the home was related to early supplementation of bottle feeding in some urban settings The time costs of breastfeeding also need to be balanced against the time costs of bottle feeding, which one study has found to be three-times as time-intensive as breastfeeding The costs of increased maternal diet to produce a given volume of breastmilk were > the cost of formula The costs of breastmilk substitutes were well documented and ranged from 8% of the minimum wage in Yemen to 264% of the minimum wage in Nigeria These estimates assume that an adequate amount of formula was provided, which may not be a realistic assumption None of the costs

include the cost of additional supplies needed to bottle feed Data are not available to quantify what may be the most important economic aspects of breastfeeding, which are the lower costs associated with caring for a sick child and purchasing medicines, as well as the costs associated with reduced fertility

Huffman S et al , Assessment of Infant Feeding in Peru Chapter XIV Economic value of breastfeeding Wellstart International

This chapter compares the costs to the public sector of breastfeeding promotion to the costs of inadequate breastfeeding practices in 1991 A workbook for assessing the economic value of breastfeeding in Peru is provided in Appendix 3 of the document Overall the authors estimate that $742,300 was spent in the public sector on breastfeeding promotion and $463,200 was derived from tax revenues from the domestic production of infant formula In contrast, current public sector expenditures on health care costs associated with sub-optimal infant feeding were as follows $946,800 for treatment of diarrhea and acute respiratory infection, $50,400 for institutional bottle feeding, $541,400 for the costs of oxytocin and glucose, and, $35,800 for interest on the external debt for the importation of substitutes Overall, conservative estimates of public expenditures associated with sub-optimal infant feeding cost the public sector over $800,000 per year

The net costs to the public sector include the costs of national and hospital level breastfeeding promotion activities and mass communication campaigns as well as savings derived from tax revenues from domestically produced infant formula The net cost was estimated as $742,000 and is a function of the following estimated costs $606,000 from the Ministry of Health budget, $105,300 from the public sector hospital budgets, $31,000 for mass media campaigns from PAHO, and savings of $463,000 in revenues from the taxes on salaries on infant formula industry workers The costs of inadequate breastfeeding practices were derived estimates of "excess morbidity and mortality" National level mortality data show that of the 7,279 infant deaths or 11% of total deaths were due to diarrhea and 12,131 infant deaths or 31% of total deaths were due to acute respiratory infection Using the relative risks associated with breastfeeding versus bottle feeding for diarrhea and acute respiratory infection, the authors calculated 7,012 excess deaths due to inadequate breastfeeding practices for these two illnesses Calculations of excess morbidity from diarrhea and acute respiratory infection were based on national level data on the prevalence of these illnesses, and the relative risks of becoming ill Treatment costs associated with this excess morbidity were estimated from national level data showing that treatment is sought for 25% of diarrhea cases and 50% of respiratory cases and data on treatment costs for the two illnesses These calculations show the total cost of treating excess cases of diarrhea and acute respiratory infection was $4,733,750 Assuming that 20% of these costs were born by the public sector, the authors calculate that this represented a cost of $946,750 or 3 7% of the MCH budget

The cost of bottle feeding infants in public institutions was estimated to be $58,660 which included a cost of $17,700 for formula for newborns and $40,960 for formula for hospitalized infants Costs for oral glucose tolerance tests and methergine that may be unnecessary for newborns who are breastfed immediately after birth were estimated to be $541 420 The interest for the payment of external debt for the purchase of infant formula, subsidized by the Swiss Government, is $35,777

The monetary value of deaths averted through optimal infant feeding practices and births averted because of lactational amenorrhea was not quantified

Huffman S, Steel A, Toure KM, Middleton E Economic value of breastfeeding in Belize Nuture Center to Prevent Childhood Malnutrition 1992

Country *Belize Nurture Center to Prevent Childhood Malnutrition 1992*

In this working paper, a workbook for assessing the economic value of breastfeeding was used to estimate the economic value of breastfeeding in Belize The total cost of breastfeeding promotion was $84,000 per year and did not include the cost of volunteers who work within the program The costs of bottle feeding include both the direct costs to households and the public sector in terms of formula and supplies and the indirect costs that include excess infant morbidity and mortality and maternal fertility that could be averted through optimal breastfeeding practices The national costs of bottle feeding were estimated to be $516,750 (assuming that 25% of imported dried milk was used for infant feeding) and $62,000 for interest on the external debt National level data on the costs of bottles, teats, and other supplies needed to bottle feed were not available

Based on national level infant feeding data and the number of births per year, the direct household costs of purchasing breastmilk substitutes were estimated to be $716,400 for non breastfed infants and $489,000 for partially breastfed infants

Estimates of the annual hospital cost of bottle feeding in the main hospital where one-third of all births occur was $175,000

Indirect costs associated with excess morbidity from diarrhea and acute respiratory infection were not estimated However, national data on the prevalence of these illnesses, the treatment rate/illness episode, and the cost of treatment of each illness suggest substantial costs associated with excess morbidity Costs associated with reduced fertility and environmental damage were not quantified

Almroth S, Greiner T. FAO Food and Nutrition Paper The economic value of breast-feeding Food and Agriculture Organization, Rome, Italy 1979

COUNTRY Ivory Coast and Ghana

This report summarizes the costs of breastfeeding and bottle feeding in two African countries The costs associated with breastfeeding related to increased maternal nutrient intake and opportunity costs Those associated with bottle feeding were related to the purchase of breastmilk substitutes, and other supplies and time were quantified at both the household and national level Due to data limitations, the same estimates for household costs were used for both countries Of interest is the methodology used to estimate the time costs of breastfeeding and formula feeding, which was based on national level data on wages and assumptions about the amount of time needed to prepare safe bottles and observations on the length of time spent breastfeeding The results show that the cost of increased maternal consumption to produce breastmilk ranged from $51 to $100 over a two-year period depending on the foods chosen The costs of formula feeding over an equivalent period were based on the costs of substitutes, supplies, and fuel and ranged from $310 to $390 depending on the type of substitute chosen The estimated opportunity costs for breastfeeding and artificial feeding were $210 and $600 over the two year period, respectively Thus, breastfeeding rather than artificial feeding for two years could save the average family between $600 to $730

At the national level the authors show that imports of breastmilk substitutes accounted for only one percent of the total volume of breastmilk produced Estimates were made for the economic impact of a hypothetical change in feeding patterns in terms of increases in cost and foreign exchange used to purchase substitutes Estimates of the number of children malnourished as a result of sub-optimal practices were calculated The actual costs of rehabilitation were not made The authors note that the indirect costs of bottle feeding that are most important at the national level because of increased morbidity and fertility cannot be quantified in monetary terms Overall this paper contributes to the theoretical development of a model to estimate economic impacts In particular, it points out that the costs and benefits of breastfeeding differ at different levels of analysis and attempts to quantify the opportunity cost of breastfeeding and bottle-feeding The data used are outdated and no longer useful

Melville BF Letter to the editor Can low income women in developing countries afford artificial feeding? J Trop Pediatr 1991,37.141–142

COUNTRY Jamaica

This letter examines the monthly cost of artificially feeding a three-month-old infant and expresses the results as a percentage of the net monthly salaries for selected jobs Data were

collected during the first four months of 1990 The cost was calculated at $43 30/month (with over 90% of the cost from purchasing infant formula) The cost of bottles, cooking pot for sterilization, and fuel added another $3 40/month These costs constituted 90%, 78%, 36%, 22%, and 26% of monthly salaries for a household helper or minimum wage worker, community health aide, clerk, registered nurse, and teacher, respectively The authors estimate that the economic cost of lost breastmilk because of the 17 percentage point drop in the number of women fully breastfeeding at 6 weeks resulted in over $200,000 worth of foreign exchange The authors also cite a study showing that artificial feeding costs as much as feeding a family of five with the basic food basket This article discussed the risks of contaminated and diluted formulas to infant health but does not quantify these risks

Rohde JE Mother milk and the Indonesian economy A major national resource Indian J Pediatr 1981,48 125–132

Rohde JE Mother milk and the Indonesian economy A major national resource J Trop Pediatr 1982,28 166–174

COUNTRY: Indonesia

These articles estimate the economic value of breastmilk to the Indonesian economy and conclude that breastfeeding currently contributes $520 million/year to the economy, which amounts to 10% of all exports, 2 5% of the total national budget, and about 1 5% of gross national product To arrive at these estimates, the author estimates the following 1) the volume of breastmilk produced by breastfeeding mothers/year, 2) the cost of purchasing the extra nutrients (calories and protein) to produce this breastmilk, 3) the cost of purchasing an equivalent volume of formula, 4) the cost of reduced medical treatment for diarrhea cases prevented/year, and, 5) the cost of increased family planning services/year needed to replace the contraceptive effect of lactational amenorrhea provided by current breastfeeding practices The volume of breastmilk produced per year is estimated by multiplying the average daily milk volume by the duration of breastfeeding for urban and rural women This volume of milk is compared to the cost of purchasing infant formula, which would be about $500 million To arrive at the net value of this breastmilk, the protein and calorie cost of producing this breastmilk is subtracted Using a figure for the efficiency of conversion of 90% for calories and 55% for protein, and rice and tempe as the food source, the author calculates that it costs about 1 million/year to produce breastmilk Thus, the net value of breastmilk produced/year was calculated at $400 million The cost of bottles, teats, fuel, formula spoilage, or refrigeration are not included in these costs Nor are the opportunity costs associated with breastfeeding or formula feeding, which the author argues to be similar

The author estimates the cost of reduced medical treatment for diarrhea by assuming that a 25% reduction in the prevalence of breastfeeding would double the total cases of diarrhea, which

currently accounted for one-third of pediatric admissions to the hospital Applying the cost per diarrhea treatment, the author estimates that $40 million/year is saved by current breastfeeding practices An estimate that is argued to be very conservative

The cost of increased family planning services per year needed to replace the contraceptive effect of lactational amenorrhea is calculated as a function of current mean durations lactational amenorrhea for urban and rural women and the number of urban and rural women currently breastfeeding, which provides an estimate of the couple-protection years provided This estimate shows that 4 5 million couple years of contraception are provided annually Using the cost of providing a year of contraceptive protection, an annual cost of $80 million in savings is estimated

McKigney J. Economic aspects Amer J Clin Nurtr 1971;24 1005–1012

COUNTRY Jamaica

This article compares the cost of purchasing infant formula to the nutrient costs of producing an equivalent amount of breastmilk Three different diets are used to estimate the cost of producing breastmilk, a low, intermediate, and high cost diet Likewise, three different artificial infant feeding modes are used for estimating the cost of infant formula The estimates show that the cost of breastfeeding ranges from $0 54 to $3 78 per week while the cost of purchasing an equivalent amount of breastmilk ranges from $0 76 to $5 54 per week The author argues that there is a definite nutrient cost advantage for breastfeeding as compared to artificial feeding, which although small on a weekly basis, is significant on an annual basis, especially for poor families These estimates also used an extra 1000/day calories needed to support lactation rather than the current figure of 600/day, which would reduce the nutrient cost of breastfeeding by another 40% The author suggests that "economy" in the nutrient cost of breastfeeding can be achieved by purchasing cheaper foods, which would not have nutritional costs to the mother However, "economy" in infant artificial feeding can only be achieved through over dilution of formula, which would have serious adverse effects on the infant

Lamm E, Delaney J, Dwyer J. Economy in the feeding of infants Pediatric Clinics of North America 1977,24(1)·71–84

COUNTRY USA

This article examined the cost of feeding various breastmilk substitutes during infancy versus the cost of feeding a breastfeeding mother The costs of breastmilk substitutes ranged from $133/year for evaporated milk-corn syrup to $276/year for ready-to-serve Similac The costs of

purchasing food to meet the additional daily recommended dietary intakes for a lactating woman ranged from $156 to $281/year, depending on the diet chosen Food costs associated with breastfeeding depend on the choice of foods purchased to meet the caloric demands of lactation The costs associated with breastmilk substitutes depend on type and form of the product and source of supply rather than brand name Powdered or concentrated formulas are less expensive than ready-to-serve formulas Overall, food costs of different infant feeding patterns vary by as much as 100%, however, according to the data presented in this paper the ranges are similar for formula and breastfed infants Both this and the previous article look at the costs of breastfeeding based on theoretical estimates of what lactating women need to consume to meet the additional recommended dietary allowances for lactating women rather than on the additional calories that lactating women actually consume To the extent that breastfeeding women actually consume fewer additional calories/day than recommended, this would reduce the cost of the foods needed to provide those calories

The calculation for the cost of feeding formula, ignores the cost of bottles, sterilizers, fuel, soap and other items needed to serve formulas in a safe and hygienic manner The cost of mother's time for both breastfeeding and formula feeding are not addressed The article does not address the medical and time costs associated with different morbidity rates between breastfed and bottle-fed infants

Larsen SA, Homer DR Relation of breast versus bottle feeding to hospitalization for gastroenteritis in a middle-class U S population J Pediatr 1978,92(3) 417–418

COUNTRY USA

This article compared incidence of breastfeeding in children hospitalized for gastroenteritis with a larger population of healthy children discharged from the nursery Subjects were members of Kaiser-Permanente health maintenance organization All infants admitted to the hospital with acute gastroenteritis between 1973–1975 were identified (n=107) Infant feeding method, defined as breastfeeding versus bottle-feeding, was ascertained from medical records or by contacting the parents To test the significance of infant feeding mode and risk of hospitalization, only those infants under 6 months of age born in the Kaiser-Permanente hospital were used in the analysis (n=35) To determine the prevalence of breastfeeding by age in the general Kaiser-Permanente population, a random sample of 10% of births during the study period were selected for follow-up This random sample survey showed that the prevalence of breastfeeding among infants < 6 months of age in the non hospitalized population was 28% Both age and infant feeding mode were associated with hospitalization The results show that of the 35 infants admitted to the hospital, only one was being breastfed at time of admission The lower than predicted incidence of hospitalization in the breastfed infants was significant at the p<0 01 level The authors do not report actual relative risks of hospitalization nor the cost of hospitalization, which are needed to quantify the economic benefits of breastfeeding

Jarosz LA Breast-feeding versus formula. Cost comparison Hawaii Med J 1993,52(1) 14–17

Country USA

This article compares the cost of two months of either exclusive breastfeeding or formula-feeding of a hypothetical healthy, full-term newborn in Hawaii Calculations are based on several assumptions 1) infant weight at 1 month and 2 months, which are based on NCHS medians for male infants, 2) dietary energy needs, which are assumed to be similar to and based on requirements set forth by the National Academy of Sciences, 3) the energy content of artificial formula, and, 4) the cost of the maternal diet to produce the infant's energy requirements in breastmilk, using an assumed efficiency of converting this food into breastmilk of 80% Two different food spending plans specified by the US Department of Agriculture were used, a thrifty plan and a moderate plan Food items were priced and the lowest-priced brand of each formula type (powder, concentrate, etc) was used to calculate formula costs Also, the lowest price brand was used to price maternal foods A total of 36 different artificial milks and 29 maternal foods were priced The results show that even the moderate maternal dietary plan was 39% less expensive than the cheapest formula The difference in cost increased substantially when higher priced formulas were used For example, the lowest price concentrated formula cost twice as much as the moderate food plan and three times as much as the thrifty food plan over the two-month period

Tuttle CR, Dewey KG Potential cost savings for Medi-Cal, AFDC, Food Stamps, and WIC programs associated with increasing breast-feeding among low-income Hmong women in California. J Amer Diet Assoc 996,96·885–890

COUNTRY USA

This article calculates the theoretical savings because of decreased use of formula, decreased morbidity, and decreased fertility on public welfare costs The implications for four public welfare programs were analyzed for cost 1) Medicaid in California, 2) Aid to Families with Dependent Children, 3) Food Stamps, and 4) Women, Infants, and Children The authors report a substantial savings associated with breastfeeding The total savings per family over a 7 5 year period range from $3,422 to $4,944 or from $4,475 to $6,060 depending on the discount rate used Most of the savings are due to decreased fertility in that the population studied do not use modern contraceptives and have a high fertility rate, with subsequent high public welfare costs These estimates are conservative in that they do not include the cost of maternal perinatal care or delivery or postnatal care associated with increased fertility The savings due to formula costs are minimal because of rebates the State of California receives from formula makers for formula

purchased with WIC vouchers Also, women who partially breastfeed under the WIC program receive both a full set of vouchers for formula and enhanced maternal package of food, which increases the cost of partial breastfeeding to the program

Fallot ME, Boyd JL, Oski FA Breast-feeding reduces incidence of hospital admissions for infections in infants Pediatr 1980,65,1121–1124

COUNTRY USA

This article compares the prevalence of exclusive breastfeeding among infants < 3 months of age in the community with the prevalence of exclusive breastfeeding in similarly aged infants hospitalized during the course of one-year (n=136) The prevalence of exclusive breastfeeding among two groups of infants was examined, those attending a hospital clinic and those attending private practices The prevalence of exclusive breastfeeding was higher among those infants cared for in private practice (38 0%) as compared to those attending a hospital clinic (13 5%) At the time of admission, the prevalence of exclusive breastfeeding among clinic and private practice infants was 8 5% and 13 8%, respectively Of the 136 infants admitted, only 15 were being exclusively breastfed Chi-square analysis showed a significant under representation of exclusively breastfed infants among the hospitalized infants The authors estimate that exclusive breastfeeding could have prevented 75 hospital admissions over one year at a savings of $50,000 This study does not control for other factors that could be related to both infant feeding mode and risk of disease such as exposure to household smoke, use of day care, and other preventive and care giving measures It has also been suggested that physicians may be less likely to hospitalize a breastfed infant

Daga SR, Daga AS Impact of breast milk on the cost-effectiveness of the special care unit for the newborn J Trop Pediatr 1985,31 121–123.

COUNTRY India

This article evaluates the cost-effectiveness of a special care unit for low birth weight newborns over two one-year periods 1) one during which newborns were breastfed from 8 am until 8 pm and formula fed during the night and 2) one during which over 95% of infants were exclusively breastfed and the remaining 5% were given breastmilk for most of their feeds Only mortality after 3 days was considered A reduction in costs associated with the purchase of formula and medicines from $0 75 to $0 40 per bed per day was found The average stay in the hospital declined from 11 4 to 9 06 days Total mortality declined from 38% to 16% as did the mortality rate by birth weight category The authors argue that the improvements seen were due to increased breastfeeding as no new diagnostic or therapeutic equipment was purchased and that

the time period was too short for improvements in staff experience to have resulted in reduced mortality

Cohen R, Mrtek MB, Mrtek RG Comparison of maternal absenteeism and infant illness rates among breast-feeding and formula-feeding women in two corporations Amer J Health Promote 1995,10 148–153

COUNTRY: USA

This study used an observational design to study the effect of infant feeding practices on infant illness and maternal absenteeism over a one-year period Two groups of women were studied 1) those employed at a utility company and 2) those employed at an aeronautics corporation Both companies had on-site lactation programs A total of 101 mother/infant pairs were studied in which breastfeeding was the feeding mode in 59 of the cases and bottle feeding was the feeding mode in 42 cases Entry into the study was voluntary, therefore, the results lack external validity Because the associations found did not differ by company, the companies are combined for presentation of results Breastfeeding mothers had higher levels of education and salaries as compared to formula feeding mothers For example, over 80% of breastfeeding mothers earned more than $30,000 per year compared to 40% among the formula feeding mothers Over 26% of the breastfeeding mothers earned more than $60,000 compared to 15% of the formula feeding mothers Ethnic background was also significantly related to feeding mode 74% of the formula-feeding mothers were Asian or Hispanic while only 28% of the breastfeeding mothers were Asian or Hispanic The results show a significant six-fold difference in the risk of becoming ill between breastfed and formula fed infants A total of 28% (28 out of 101) of the study infants experienced no illness during the study period This "well babies" group consisted of 86% breastfed infants (n=24) and 14% formula-fed infants (n=4) A total of 205 episodes of illness was reported among the remaining 73 infants Of these, the rates are significantly different from those expected if there was not association between infant feeding mode and illness An insignificant difference was found by feeding mode for mild illnesses that did not require mothers to miss work (74% of all episodes for breastfed infants and 57% of all episodes for formula fed infants) However, of the 40 episodes that caused a one-day absence, absences were two-times as frequent among the formula-feeding mothers as compared to the breastfeeding mothers (26% versus 11% ($p<0$ 05) No difference in feeding mode was found for the remaining 26 episodes of serious illness that resulted in significantly longer days of maternal absenteeism

This study does not control for other factors which may be related to both infant feeding mode, infant illness, and maternal absenteeism such as household smoking and child care arrangements

***Gryboski KL Maternal and non-maternal time-allocation to infant care, and care during infant illness in rural Java*, Indonesia Soc Sci Med 1996,43 209–219**

COUNTRY Indonesia

The time costs of breastfeeding as well as time costs for caring for ill infants have emerged as important considerations in quantifying the economic value of breastfeeding This paper describes maternal and non-maternal time allocation to infant care during symptom free days and ill days A longitudinal design of repeated household visits and observation was used to record the time spent in daily tasks The results show that infants were fed by caretakers other than the mother or by caretakers in addition to the mother on one-third of all study days The paper does not present the data in such a way that the proportion of time spent feeding or devoted to ill infants can be related to feeding mode The author does show that within infants, there was no significant difference between well and sick days in the time spent breastfeeding or the frequency of breastfeeding, mothers remunerative work outside or inside the home, or minutes of infant care either by the mother or other care givers

Cohen RJ, Haddix K, Hurtado E, Dewey KG Maternal activity budgets Feasibility of exclusive breastfeeding for six months among urban women in Honduras Soc Sci Med 1995,41 527–536

COUNTRY: Honduras

In this study, data from two 12-hour in-home observations at 19 and 24 weeks postpartum are used to estimate maternal time costs of exclusive breastfeeding versus partial breastfeeding infants 4 to 6 months of age Two groups of partially breastfeeding women were considered those that maintained nursing frequency similar to that of an exclusively breastfeeding woman and those that did not The results show that the time spent breastfeeding was similar in both groups of women and averaged about 75 minutes per 12 hour period One exception was that multiparous women in the exclusive breastfeeding group spent more time breastfeeding at 24 weeks compared to women in the partial breastfeeding group When total time spent feeding an infant was considered (breastfeeding plus preparing and feeding solids) partially breastfeeding women spent more time compared to exclusively breastfeeding women, except for multiparous women at 24 weeks For example, at 19 weeks exclusively breastfeeding primiparous women spent 71±27 minutes breastfeeding compared to 99±40 and 108±38 minutes in the two partially breastfeeding groups ($p<0.01$) This comparison underestimates the time spent preparing baby food as primiparous women were provided baby food in jars and did not have to prepare it from scratch Time spent in other activities shows that both exclusively and partially breastfeeding women spent about 2 to 3 hours per 12 hour period resting, chatting or watching television However, mothers expressed a preference for partial breastfeeding because they perceived it to be less time-demanding The authors conclude that time barriers were not a constraint to

exclusive breastfeeding in this population, but that they were perceived to be a barrier Such perceptions would be important to address in programs to promote exclusive breastfeeding

Davis P. Time allocation and infant-feeding pattern Women's work in the informal sector in Kampala, Uganda. Wellstart International's Expanded Promotion of Breastfeeding Working Paper 1996

COUNTRY Uganda

This paper describes the relationship between time spent in infant feeding and market work activities among women in the informal sector in Kampala, Uganda The results show that women spent a large proportion of time breastfeeding their infants Out of a 14 hour day, an average of 3 7 hours was spent breastfeeding infants of all ages and 5 4 hours was spent breastfeeding infants under the age of 4 months In contrast, mothers spent negligible amounts of time feeding other foods, which is explained by the fact that this was usually done by someone other than the mother The amount of time spent breastfeeding (categorized as high, medium, and low) was inversely and significantly related to the proportions of time spent in market activities However, the amount of time spent in market activities (categorized as high, medium, and low) was not associated with the proportion of time spent breastfeeding This is because the proportion of time spent in market activities and breastfeeding varied markedly by specific activity Also, the amount of time spent on household chores was inversely and significantly related to the proportion of time spent in market activities, which suggests that household work presents more of a constraint on time available for market activities than breastfeeding

Horton S, Sanghvi T, Phillips M, Fiedler J, Perez-Escamilla R, Lutter C, Rivera A, Segall-Correa AM Breastfeeding promotion and priority setting in health Health Policy and Planning 1996,11(2)·156–68

COUNTRY Brazil, Honduras, Mexico

This paper examines the cost-effectiveness of hospital-based breastfeeding promotion programs Effectiveness estimates are based on three hospital-based programs in Brazil, Honduras, and Mexico Costs were determined by estimating the costs associated with training, maternity ward education and support, prenatal education, postnatal education, and equipment Savings were determined by estimating the reductions in purchase of formula and changes in birthing procedures and drug use Cost-effectiveness calculations were based on estimated reductions in mortality from acute respiratory infections and diarrhea Based on estimated mortality reductions, the costs per disability-adjusted-life-year (DALY) gained through increases in breastfeeding were estimated to range from $4 to $19, which were comparable to those gained

from reductions in measles and rotavirus infection and > those for oral rehydration therapy The cost of breastfeeding promotion per birth ranged from $0 30 to $0 40 when the savings due to the elimination of formula are included and from $2 to $3 when the savings due to the elimination of formula can no longer be used to offset the cost of breastfeeding promotion

7. Environmental Benefits

Radford A The ecological impact of bottle feeding Baby Milk Action Coalition 1991 Mimeo

Radford A Breastmilk A world resource World Alliance for Breastfeeding Action Penang, Malaysia. Undated Mimeo

These papers summarize the ecological impact of bottle feeding and provide some quantitative data from some countries The estimates used to calculate cost estimates are not well described and derive from different countries so that overall national and/or global costs cannot be estimated Breastfeeding is viewed as an ecologically sound activity as it requires no packaging, transport, or results in wastage as the mother produces exactly the amount of milk the infant consumes Breastfeeding is also viewed as a natural, renewable resource

Bottle-feeding is associated with a large number of items, most of which are not recycled and result in environmental damage to produce These items are related to those involving waste, the dairy industry, processing and transport, inappropriate use of land and resources, and population Items related to waste include the following 1) tin plate for the production of milk tins, 2) plastics, rubber, and silicon for the production of bottles and teats, 3) increased use of feminine hygiene products, and, 4) clean water and sterilizing fluids Examples given in this category of items include 4 5 million plastic bottles sold in Pakistan in 1987, the 3,000 tons of paper that would be saved on feminine hygiene products if every mother in England were to breastfeed her infant, and the 73 kg of fire wood needed to sterilize water to formula feed an infant for one year The environmental costs of the dairy industry are illustrated with respect to the number of cows it would take to replace current breastmilk production For example, the author cites a study showing that it would take 135 million cows in India to replace current breastmilk output Cows also need pasture, which requires cutting of trees with the resultant deforestation and erosion Cattle also produce 100 million tons of methane per year, which is an estimated 20% of total annual methane emissions Nitrate fertilizers used in dairy feed production also can contaminant ground water

Processing of infant formula is done under high temperature conditions, which requires fuel and may result in air pollution Transport of formula in the international market also results in air pollution and fuel use

Bottle-feeding also contributes to inappropriate use of land and resources External debt is increased from imported formula and supplies For example, in Mozambique it was estimated that a 20% increase in bottle feeding over a two-year period would cost $10 million for the importation of formula It was also calculated that the fuel required to boil water would use up the entire resources from a major forestry project

Excess health care costs associated with bottle feeding are also discussed The contraceptive effects of breastfeeding are discussed briefly

IV. Tables

1. Infant Health

Table 1.1 The Effect of Breastfeeding on Diarrhea

Author	Country	Design	BF Practices	Effect Size	Comment
Popkin et al, 1989	Philippines urban/rural	Prospective	< 6 mo EBF BF & liquids BF & foods No BF Partial BF No BF	 1 2–3 5–13 5–17 > 6 mo not significant	Adjusted relative risks for diarrhea Risk greatest for infants < 2 mo RR for infants > 6 mo not significant
Brown et al, 1989	Peru urban	Prospective	< 6 mo EBF BF & liquids BF & milk BF &solids No BF > 6 mo Partial BF No BF	 1 1 2–1 4 1 3–1 8 1 6–1 8 2 8–3 1 1 1 2–1 5	Adjusted relative risks for diarrheal incidence Relative risks are higher for prevalence
Morrow et al, 1992	Mexico urban	Prospective	< 18 mo EBF Partial BF No BF	 1 3 5	Adjusted rate ratios for incidence of giardia infection
Mahmood et al, 1989	Iraq urban	Case-control	< 6 mo EBF Partial BF No BF > 6 mo Partial BF No BF	 1 0 3–12 1 36 7 not significant	Adjusted relative risks for hospitalization for severe diarrhea

Table 1 1 The Effect of Breastfeeding on Diarrhea					
Author	**Country**	**Design**	**BF Practices**	**Effect Size**	**Comment**
Clemens et al , 1993	Bangladesh rural	Case-control	< 12 mo EBF Partial BF No BF 12–24 mo Partial BF No BF	 0 06 0 44 1 1 2 9	Relative risk for severe rotavirus diarrhea Overall no protective effect of BF for severe rotavirus infection in first two yrs Authors suggest that BF temporally postponed rather then prevented infection
Cozily et al , 1990	Ethiopia rural	Cross-sectional	< 6 mo EBF Partial BF	 1 5	Unadjusted relative risks of developing diarrhea Effect only significant in the age groups 2–4 mo and 4–6 mo
Mergraud et al , 1990	Algeria urban	Case-control	< 6 mo EBF Partial BF	0 1 1	Odds ratio for presence of campylobacter is stool Few infants > 6 mo breastfed
Ruben et al , 1990	Denmark	Prospective	< 12 mo EBF and BF>FF versus FF>BF and FF	not significant	Misclassification may be a problem Large drop-out rate
Howie et al , 1990	Scotland	Prospective/ retrospective	< 24 mo BF>13 mo BF<13 mo	 6 6–16 8% reduced incidence reference group	Only study to show a protective effect after BF ceased
Campbell and Latham, 1988	Mexico	Prospective	< 8 mo	not reported	Breastfeeding had a significant protective effect, but magnitude cannot be quantified from data presented

Table 1.1 The Effect of Breastfeeding on Diarrhea					
Author	**Country**	**Design**	**BF Practices**	**Effect Size**	**Comment**
VanDerslice et al , 1994	Philippines	Prospective	< 6 mo EBF Full BF Partial BF No BF	 1 1 13 25	Predicted probabilities of diarrhea Adjusted for potential confounding factors
Paine and Coble, 1982	USA	Retrospective	< 6 mo BF No BF	1 5 12 1	Office visits/100 infant mo of observation
Fergusson et al , 1978	New Zealand	Prospective	< 4 mo EBF No BF	 1 31 6	Calculated relative risks for episodes of diarrhea
Cunningham et al , 1977	USA	Retrospective	< 12 mo BF No BF	 3 5 6 9	Episodes/1000 wk of observation Not corrected for age

1. Infant Health

Table 1 2 The Effect of Breastfeeding on Respiratory Infection					
Author	**Country**	**Design**	**BF Practices**	**Effect Size**	**Comment**
Brown et al , 1989	Peru urban	Prospective	< 6 mo EBF BF & liquids BF & milk BF &solids No BF > 6 mo Partial BF No BF	 1 1 8 1 4 2 7 4 1 1 1 2	Adjusted relative risk for incidence of acute respiratory infection
Foman et al , 1984	USA (American Indians)	Retrospective	< 4 mo EBF No BF < 12 mo EBF Bottle-fed	 0 3 1 0 5 1	Calculated relative risks from data presented
Cunningham et al , 1977	USA	Retrosepctive	< 12 mo BF Bottle-fed	 1 1 5 6	Episodes of respiratory infection/1000 wk of observation
Fergusson et al , 1978	Australia	Prospective	< 4 mo EBF No BF	 no effect	
Kumar et al , 1981	India urban/rural	Prospective	Rural 5–12 mo BF BF and bottle	 7 6 16 0	Episodes/100 child mo of observations No effects detected in urban cohort or among rural infants < 4 mo

Table 1.2 The Effect of Breastfeeding on Respiratory Infection

Author	Country	Design	BF Practices	Effect Size	Comment
Wright et al , 1995	USA	Prospective/ retrospective	6 yrs BF < 1 mo No BF	 1 3 03	Adjusted odds ratio of recurrent wheezing at 6 yrs of age for non-atopic children only No effect for atopic children
Dewey et al , 1995	USA	Prospective	<12 mo BF Formula fed <12 mo BF Formula fed	 0 14 0 31 Not significant	Adjusted episodes/100 days at risk
Chen et al , 1988	China	Retrospective	<18 mo Ever BF Never BF	 1 2 11	Adjusted odds ratio for hospitalization
Bohler et al , 1995	Bhutan	Prospective	12–26 mo Partial BF Weaned	 0 63 1	Odds ratio
Pisacane et al , 1995	Italy	Cross-sectional, hospital-based	<6 mo BF No BF <12 mo BF No BF	 0 22 1 Not significant	Odds ratio for hospitalization with pneumonia or bronchiolitis Odds ratio for hospitalization for pertussis-like illness
Wright et al , 1989	USA	Prospective/ retrospective	< 4 mo BF > 1 mo BF < 4 mo	 1 1 7	Adjusted odds ratio of wheezing during infancy Only age interval < 4 mo was significant

1 Infant Health

Table 1.3 The Effect of Breastfeeding on Otitis Media

Author	Country	Design	BF Practices	Effect Size	Comment
Dewey et al , 1995	USA	Prospective	<12 mo BF Formula fed >12 mo BF Formula fed	 0 45 0 53 Not significant	Adjusted episodes/100 days at risk
Duncan et al , 1993	USA	Retrospective review of medical records	< 12 mo BF> 6, suppl > 6 mo BF>4, suppl 4–6 mo BF> 4, suppl < 4 mo No BF or BF< 4 mo	 1 1 73 85 54 72 39 61	Adjusted odds ratios for recurrent otitis media (first column) and acute otitis media (second column)

2. Infant Mortality

Table 2.1 The Effect of Breastfeeding on Diarrheal Mortality

Author	Country	Design	BF Definition	Effect Size	Comment
Victora et al , 1989	Brazil	Case-control	< 2 mo EBF No BF < 12 mo EBF Any BF No BF	 1 23 3 1 4 2 14 2	Adjusted odds ratios presented
Victora et al , 1992	Brazil	Case-control	<12 mo EBF Any BF No BF	 1 3 7 9 6	Age-adjusted relative risks presented
Yoon et al , 1995	Philippines	Prospective	< 5 mo Any BF No BF	 9 7	Adjusted rate ratio presented No associations were found for children 6–11 mo or 12–23 mo
Sachdev et al , 1991	India	Case-control, hospital based	0–6 mo Any BF No BF 7–12 mo Any BF No BF 13–18 mo Any BF No BF	 1 6 0 1 2 6 1 1 8	Adjusted odds ratios presented

2 Infant Mortality

Table 2.2 The Effect of Breastfeeding on Respiratory Infection Mortality

Author	Country	Desing	BF Definition	Measure of Effect	Comment
Yoon et al , 1996	Philippines	Prospective	< 5 mo Any BF No BF	 5 7	Adjusted rate ratio presented No associations were found for children 6–11 mo or 12–23 mo No associations were found for acute lower respiratory infection alone for any age intervals
Victora et al , 1987	Brazil	Case-control	<2 mo EBF Any BF No BF 2–11 mo EBF Any BF No Bf	 1 2 2 4 1 1 1 3 3 4	Adjusted relative risks

2. Infant Mortality

Table 2.3 The Effect of Breastfeeding on All Cause Mortality

Author	Country	Design	BF Definition	Measure of Effect	Comment
Shahidullah, 1994	Bangladesh	Prospective	< 5 y Non suppl BF Suppl BF	 1 2 1	Adjusted mortality risk
Retherford et al , 1989	Nepal	Retrospective	<18 mo No BF Any BF 18–60 mo No BF Any BF	 1 19 1 45	Adjusted relative risks
Plank and Milanesi, 1973	Chile	Retrospective	2–12 mo EBF Any BF Bottle 3–12 mo EBF Any BF Bottle 6–12 mo EBF Any BF Bottle	 29 2 56 0 60 5 13 8 37 5 38 7 10 0 14 0 19 9	Rate/1000 survivors Unadjusted estimates Using EBF as the reference category, the relative risk for 1–12 mo for any or no BF was 3

2. Infant Mortality

Table 2.3 The Effect of Breastfeeding on All Cause Mortality

Author	Country	Design	BF Definition	Measure of Effect	Comment
Habicht et al , 1986	Malaysia	Retrospective	8–28 days Full BF Partial BF 2–6 mo Full BF Partial BF 7–12 mo Full BF Partial BF	 68 6 21 9 24 9 11 2 3 4 1 7	Reduction in deaths per 1000 infants per added mo of breastfeeding Adjusted estimates
Molbak et al , 1994	Guinea-Bissau	Prospective	12–25 mo BF Weaned	 1 3 5	Relative mortality
Briend and Bari, 1989	Bangladesh	Prospective	12–17 mo Any BF No BF 18–23 mo Any BF No BF 24–29 mo Any BF No BF	 1 6 1 1 4 5 1 3 7	Unadjusted relative risks Risks for the 30–36 mo period were not significant

4. Child and Adult Health and Developmental Effects

Table 4.2 The Effect of Breastfeeding on Risk of Cancer

Author	Outcome	Country	Design	BF Definition	Measure of Effect
Davis et al , 1988	Childhood cancer	USA	Case-control	Any BF > 6 mo No BF Any BF < 6 mo	1 1 8 1 9
Fruedenheim et al , 1994	Breast cancer	USA	Case-control	No BF Any BF	1 0 74
Potischman et al , 1995	Premenopausal breast cancer	USA	Case-control	No BF Any BF	1 0 76

5. Maternal Health and Survival

Table 5.1 The Effect of Breastfeeding on Risk of Breast Cancer[1]

Author	Country	Design	BF Definition	Measure of Effect	Comment
Byers et al , 1985	USA	Case-control	Lifetime duration BF > 12 mo BF 7–11 mo BF 1–6 mo BF < 1 mo No BF	 0 21 0 63 0 57 0 98 1	Adjusted relative risks presented for pre-menopausal women only Associations not significant for post-menopausal women Cases more likely than controls to report lactation failure due to insufficient milk
Newcomb et al , 1994	USA	Case-control	BF No BF Lifetime duration >24 mo 13–24 mo 4–12 mo <3 mo 0 < 20 y at first lactation and BF > 6 mo No BF	0 78 1 72 66 78 85 1 0 54 1	Adjusted relative risks presented for pre-menopausal women only Associations not significant for post-menopausal women Younger age at first lactation was associated with reduced risk
Suskind et al , 1989	Australia	Case-control	Any BF No BF	No effect	This study showed no effect for either pre- nor postmenopausal women

5. Maternal Health and Survival

Table 5.1 The Effect of Breastfeeding on Risk of Breast Cancer[1]

Author	Country	Design	BF Definition	Measure of Effect	Comment
Yoo et al , 1992	Japan	Case-control (controls are hospital-based)	Any BF No BF Lifetime duration >13 mo 10–12 mo 7–9 mo 4–6 mo 1–3 mo 0	62 1 0 53 0 59 0 47 0 75 0 71 1	Adjusted odds ratios are presented Most odds ratios have confidence intervals that include 1, however, trends are significant Similar associations found for both pre- and postmenopausal women
London et al , 1990	USA	Prospective (for cancer incidence)/ Retrospective (for BF history)	Associations are examined by BF duration stratified by both age and parity	No effect	No independent association between lactation and risk of breast cancer Associations did not differ by age or menopausal status
Kvale and Heuch, 1989	Norway	Prospective	Associations are examined by BF duration/child and total lifetime duration	No effect	This was a large prospective study that should have had sufficient power to detect meaningful trends

Table 5.1 The Effect of Breastfeeding on Risk of Breast Cancer[1]					
Author	**Country**	**Design**	**BF Definition**	**Measure of Effect**	**Comment**
Brinton et al, 1983	USA	Case-control	Ever BF Yes No	0 94 (0 8–1 1) 1	Adjusted relative risks are presented This study provides little evidence that BF protects against breast cancer

5. Maternal Health and Survival

Table 5.1 The Effect of Breastfeeding on Risk of Breast Cancer[1]

Author	Country	Design	BF Definition	Measure of Effect	Comment
Brinton et al , 1995	USA	Case-control (population-based)	Lifetime duration BF > 2 wk No BF Lifetime duration BF > 72 wk No BF	 0 87 (0 7–1 0) 1 0 67 (0 4–1 1) 1	Adjusted relative risks are presented and are significant The focus of the study was on premenopausal women Women who first BF < 22 y had the greatest reduction in risk
MacMahon et al , 1982	Estonia Republic	Case-control (hospital-based)	Lifetime duration	No effect	Adjusted odds ratios presented
Romieu et al , 1996	Mexico	Case-control (population-based)	Ever BF Yes No Lifetime duration >60 mo 37–60 mo 25–36 mo 13–24 mo 4–12 mo 1–3 mo No BF	 0 54 1 23 27 60 47 59 48 1	Adjusted odds ratios presented Breastfeeding associated with risk of breast cancer for both pre- and post-menopausal women Most of the protective effect was associated with the first live birth
Rosero-Bixby et al , 1987	Costa Rica	Case-control (population-based)	Lifetime duration of BF	No effect	Adjusted relative risks presented
Valaoras et al , 1969	Greece	Case-control (hospital-based)	Lifetime duration, number of women BF > 24 mo	No effect	Relative risks presented that are adjusted for both age and parity

5. Maternal Health and Survival

Table 5.1 The Effect of Breastfeeding on Risk of Breast Cancer[1]					
Author	**Country**	**Design**	**BF Definition**	**Measure of Effect**	**Comment**
Kalache et al , 1980	England	Case-control (hospital-based)	Ever BF, BF>16 wk, mean duration	No effect	Hospital controls Analyses adjusted only for parity

[1]All effects are significant unless otherwise noted

5. Maternal Health and Survival

Table 5 2 The Effect of Breastfeeding on Risk of Ovarian Cancer

Author	Country	Design	BF Definition	Measure of Effect	Comment
Gwinn et al , 1990	USA	Case-control (population-based)	Ever BF Yes No Lifetime duration BF > 24 mo BF 12–23 mo BF 6–11 mo BF 3–5 mo 1–2 mo No BF	 0 6 1 0 3 0 7 0 8 0 8 0 6 1	Adjusted relative risks presented Most protection occurred with first lactation
Risch et al , 1983	USA	Case-control (population-based)	Life duration BF > 3 mo No BF or < 2 mo	 0 69 1	Adjusted relative risks presented
Rosenblatt et al , 1993	Multi-national	Case-control	Duration of BF/pregnancy >13 mo 8–12 mo 3–7 mo 0–2 mo	 0 68 0 80 0 75 1	Adjusted odds ratios presented Most of the reduction in risk occurs with short-term lactation with no further reduction with long-term lactation

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