2.   EFFECT OF BREASTFEEDING ON INFANT MORTALITY

The most important benefit of breastfeeding is the infant's immediate survival. Literature on breastfeeding's effect on infant mortality from diarrheal infection, respiratory infection, and other causes is summarized below.

2.1   Effect of Breastfeeding on Diarrheal Mortality

Arifeen S, Black RE, Antelman G, Baqui A, Caulfield L, Becker S. Exclusive breastfeeding reduces acute respiratory infection and diarrhea deaths among infants in Dhaka slums. Pediatr 2001;108:e67.

COUNTRY: Bangladesh

SETTING: Urban slums

DESIGN: Prospective n = 1,677 infants enrolled at birth and visited at home at 1, 3, 6, 9, and 12 months

BREASTFEEDING DEFINITION: Exclusively breastfed, predominantly breastfed, partially breastfed, and not breastfed, during the first 4 months, based on 7-day recall at each visit

OUTCOME MEASURES: Deaths due to specific causes, including diarrhea, based on verbal autopsy at the subsequent visit

RESULTS: There were 180 infant deaths (107 per 1,000 live births), 26 (14%) due to diarrhea and another 10 (6%) due to diarrhea plus acute respiratory infections. Proportional hazards regression was used to relate infant feeding method at the previous visit (up to month 3) to subsequent infant diarrheal death, adjusting for birth weight and parity. Many other confounding variables were tested for significance and excluded. Infants who were partially breastfed or not breastfed had a risk of diarrheal death 3.94 times greater (95% CI: 1.47–10.57) than exclusively breastfed infants. The risk of death due to diarrhea among predominantly breastfed infants was also higher but not statistically different from that of exclusively breastfed infants (hazard ratio: 2.22; CI: 0.67–7.37).

METHODOLOGICAL ISSUES: Appropriate definition of breastfeeding, control for a variety of potentially confounding variables, and efforts to control for reverse causality by excluding deaths near birth make this a methodologically strong study. The failure to find a protective effect of exclusive breastfeeding relative to predominant breastfeeding is explained as a problem of small sample size.

Betran AP, Onis M, Lauer JA, Villar J. Ecological study of effect of breast feeding on infant mortality in Latin America. Br Med J 2001;323:1–5.

COUNTRY: Latin America and the Caribbean (LAC)

SETTING: Urban and rural

DESIGN: Ecological study

BREASTFEEDING DEFINITION: Exclusive breastfeeding means the child receives no liquids or solids other than breastmilk, except vitamins, mineral supplements, or medicines. Partial breastfeeding means the child receives some breastmilk, regardless of how much.

OUTCOME MEASURE: Mortality rates due to diarrheal disease and acute respiratory infections during the first year of life

RESULTS: In Latin America and the Caribbean, exclusive breastfeeding for the first 3 months of life and partial breastfeeding for the remainder of the first year, can prevent 55% of infant deaths related to diarrheal disease and acute respiratory infection. Among infants aged 0–3 months, 66% of the deaths from both diseases were prevented by exclusive breastfeeding, while 32% of deaths among those aged 4–11 months were prevented by partial breastfeeding. Overall, 13.9% of all-causes infant mortality in Latin America and the Caribbean (approximately 52,000 deaths a year) could be prevented by exclusive breastfeeding for the first 3 months of life and partial breastfeeding for the remainder of infancy. Overall Latin American and Caribbean estimates of preventable mortality from diarrheal disease for infants 0–3 months and 4–11 months were 0.78 and 0.33, respectively, and the estimates from acute respiratory infection were 0.57 and 0.31 for infants aged 0–3 months and 4–11 months, respectively. In Latin America and the Caribbean, 7.1% and 6.8% of deaths of infants aged 0–11 months caused by diarrheal disease and acute respiratory infection, respectively, could be prevented by exclusive breastfeeding for at least the first 3 months and partial breastfeeding thereafter for the remainder of the first year.

METHODOLOGICAL ISSUES: To study the potential of exclusive breastfeeding during the first 4 months of life and partial breastfeeding thereafter, infants were divided into 2 age groups: 0–3 months and 4–11 months. Exclusive breastfeeding, partial breastfeeding, and no breastfeeding were considered for the first age group, and partial breastfeeding and no breastfeeding were considered for the second age group. Attributable risks derived from the published literature were used to calculate the fraction of deaths from diarrheal disease and acute respiratory infection that could be prevented by exclusive or partial breastfeeding. Simple least squares regressions were used to predict cause-specific mortality at 4 months of age. Sensitivity analyses were performed on a series of variables to allow for possible errors in estimation or modeling assumptions.

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WHO Collaborative Study Team on the Role of Breastfeeding on the Prevention of Infant Mortality Effect of breastfeeding on infant and child mortality due to infectious diseases in less developed countries: A pooled analysis. Lancet 2000;355:451–5.

COUNTRIES: Brazil, Pakistan, Philippines

SETTING: Urban and rural

DESIGN: Meta-analysis of case-control and prospective studies

BREASTFEEDING DEFINITION: Breastfeeding versus not breastfeeding

OUTCOME MEASURE: All-cause infant mortality and mortality from diarrhea or acute respiratory infection

RESULTS: During infancy, data were available from only three countries (Brazil, Pakistan, and the Philippines) because the vast majority of women in the African studies breastfed throughout the first year of life. In the first 6 months of life, the odds ratio (OR) for mortality from infectious disease among nonbreastfed infants was 3.5 (95% CI: 2.4–5.0). Risk of mortality from diarrhea was substantially greater (OR 6.1, 95% CI: 4.1–9.0) compared with acute respiratory infection (OR 2.4, 95% CI: 1.6–3.5). In the second 6

months of life, similar levels of protection were observed against both causes of death. The OR for mortality from diarrhea was 1.9 (95% CI: 1.2–3.1), and for acute respiratory infection, it was 2.5 (95% CI: 1.4–4.6). Therefore, while the protective effect of breastfeeding against diarrhea declined with age, the protective effect against acute respiratory infection remained constant. The protective effect during the second year of life was not consistent. The largest effect was seen in Ghana (OR 7.9, 95% CI: 1.2–53.2), but was based on only 7 deaths. In Senegal, the OR was 2.0 (95% CI: 1.4–3.1). None of the other ORs was significant. Data were not available for Brazil, which only had data on infancy.

METHODOLOGICAL ISSUES: The authors addressed confounding and reverse causality by excluding all deaths in the first week of life and excluding from most analyses deaths not due to infectious diseases. In the case-control studies, breastfeeding status 7 days before death was used for cases.

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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 Epidemiol 1996;143:1142–8.

COUNTRY: The Philippines

SETTING: Urban

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

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 than among children 12–23 months. Potentially confounding factors included those associated with both mortality and major risk factors, including 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.

METHODOLOGICAL ISSUES: This is a methodologically strong study. Only infants > 4 days old are included to avoid 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.

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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 3 causes: acute diarrhea, persistent diarrhea, and dysentery in 2 urban areas in Brazil. 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 occurred most often. 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 of death due to acute diarrhea were 4.0 and 21 for any breastfeeding and no breastfeeding, respectively. The age-adjusted relative risks of death due to persistent diarrhea were 4.3 and 10.0, for any breastfeeding and no breastfeeding, respectively. The age-adjusted relative risk for dysentery failed to reach statistical significance.

METHODOLOGICAL ISSUES: The study was restricted to infants between the ages of 7 days and 364 days to avoid including neonatal deaths that were not likely related to infant feeding mode. Infant feeding mode was the one before the onset of fatal illness to avoid the problem of reverse causality. Because of small sample size for each of the 3 outcomes examined, risks were only adjusted for age and not for other potentially confounding factors.

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

(The results of this study were the same as the one cited below; therefore, we chose only to summarize one of the articles while making reference to both).

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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) before 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 5 potentially confounding factors, which were not specified in the paper. The adjusted odds ratio (OR) was 2.7 ($p < 0.001$). 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 it was still significant among older children. The adjusted ORs 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. The adjusted ORs for weight-for-age ≤ 50% and > 50% of the National Center for Health Statistics (NCHS) median were 5.7 and 2.2, respectively. For children of low height-for-age, the adjusted ORs for height-for-age < 85% and > 85% of the NCHS median were 4.3 and 2.4, respectively. Breastfeeding also was more protective for children with protracted diarrhea. The adjusted ORs 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, nutritional status, and duration of disease. Inferences that can be made from this study may be limited because hospitalized populations are not representative of the general population.

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Victora CG, Smith PG, Patrick J, et al. Infant feeding and deaths due to diarrhea: A case-control study. Amer J Epidemiol 1989;129:1032–41.

COUNTRY: Brazil

SETTING: Urban

DESIGN: Matched case-control: cases (n = 170) were infants who had died from diarrhea, and controls (n = 340) with a similar age distribution were selected from the community. 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. Breastfeeding was associated in a dose-response manner with risk of mortality with the lowest risk among exclusively breastfed infants, intermediate risk among partially breastfed infants, and the greatest risk among nonbreastfed infants. Compared with 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, after adjusting for age and other potentially confounding factors.

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 days and 364 days to avoid including neonatal deaths that were unlikely to be related to infant feeding mode. The infant feeding mode studied was the one before the onset of fatal

illness to avoid the problem of reverse causality. Many potentially confounding variables were controlled. The study also was strengthened by using a second control group of infants who had died from noninfectious diseases.

Feachem RG, Koblinsky MA. Interventions for the control of diarrhoeal diseases among young children: Promotion of breast-feeding. Bull WHO 1984;62(2):271–91.

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 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 relationship between infant feeding mode and risk of death from diarrheal disease was found, with exclusively breastfed infants having the lowest risk, partially breastfed infants an intermediate risk, and bottle-fed infants the highest risk. For example, among infants aged 0–5 months, the relative risk of death for nonbreastfed versus exclusively breastfed infants was 25; for partially breastfed versus exclusively breastfed infants, it was 8.6; and for nonbreastfed versus partially breastfed infants, it was 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 risk for exclusively breastfed compared with nonbreastfed is 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 risk of death from diarrhea is 2 to 6 times greater than 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, compared with formula-fed infants.

METHODOLOGICAL ISSUES: The results reported here are old, all but one from before 1947, and limited in quality. Many do not control for potentially 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, compared with infants today who are being fed formula.

Robinson M. Infant morbidity and mortality: A study of 3266 infants. Lancet 1951(April 7):788–94.

COUNTRY: England

SETTING: Urban and rural

DESIGN: Review of hospital records: n = 3,266 infants that had been followed between 1 and 7 months of age

BREASTFEEDING DEFINITION: Exclusive breastfeeding (n = 971), partially bottle-fed (n = 1,441), 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 month 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 from diarrhea specifically. The unadjusted overall mortality rate per 1,000 was 10.2 for exclusively breastfed, 25.7 for partially breastfed, and 57.3 for bottle-fed infants. The unadjusted diarrhea mortality rate per 1,000 was 0 for exclusively breastfed, 2.0 for partially breastfed, and 7.0 for bottle-fed infants.

METHODOLOGICAL ISSUES: The results in this study are not adjusted for potentially confounding factors that may be associated with both infant feeding method and risk of mortality. However, the author did exclude from the analysis infants who died within the first 2 weeks of life or who died from causes not associated with infant feeding method (birth anomalies, accidents). The author also controlled for reverse causality by using the infant feeding method before the onset of fatal illness rather than the feeding mode at the time of death.

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2.2   Effect of Breastfeeding on Respiratory Infection Mortality

Arifeen S, Black RE, Atbeknab G, Baqui A, Caulfield L, Becker S. Exclusive breastfeeding reduces acute respiratory infection and diarrhea deaths among infants in Dhaka slums. Pediatrics 2001;108(4):e67.

SEE: Study description, Section 2.1, page 52

OUTCOME MEASURES: Deaths due to specific causes, including acute respiratory infections (ARIs), based on verbal autopsy at the subsequent visit

RESULTS: There were 180 infant deaths (107 per 1,000 live births), 39 (22%) due to ARI and another 10 (6%) due to ARI plus diarrhea. Proportional hazards regression was used to relate infant feeding method at the previous visit (up to month 3) to subsequent infant ARI death, adjusting for birth weight, income, education, and parity. Many other confounding variables were tested for significance and excluded. Infants who were partially breastfed or not breastfed had a risk of ARI death 2.40 times greater (95% CI: 1.14–5.04) than exclusively breastfed infants. The risk of death due to ARI among predominantly breastfed infants was not statistically different from that of exclusively breastfed infants.

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Betran AP, Onis M, Lauer JA, Villar J. Ecological study of effect of breast feeding on infant mortality in Latin America. Br Med J 2001;323:1–5.

SEE: Study description, Section 2.1, page 52

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WHO Collaborative Study Team on the role of breastfeeding on the prevention of infant mortality. Lancet 2000;355:451–5.

SEE: Study description, Section 2.1, page 53

Victora CG, Kirkwood BR, Ashworth A, et al. Potential interventions for the prevention of childhood pneumonia in developing countries: Improving nutrition. Am J Clin Nutr 1999;70:309-320.

COUNTRY: Brazil, the Philippines, Tanzania

SETTING: Various settings

DESIGN: Review

BREASTFEEDING DEFINITION: Exclusive breastfeeding, partial breastfeeding (breast-milk and nonbreastmilk) or no breastfeeding

OUTCOME MEASURES: Mortality from acute lower respiratory infection (ALRI) and relationship to a number of different nutritional factors, such as low birth weight, protein-energy malnutrition, and lack of breastfeeding

RESULTS: The weighted average of the relative risk of pneumonia deaths due to lack of breastfeeding was 2.0. Data from a population-based study from Brazil showed that children < 12 months who were not breastfed had a relative risk of dying from ALRI of 3.6; infants who were partially breastfed had a relative risk of 1.6. Data from a community-based cohort study in the Philippines failed to show an association between breastfeeding and ALRI mortality in children < 24 months, but a case-control study from Tanzania showed a relative risk of 1.7 for nonbreastfed children, aged 0–59 months. Furthermore, in Rwanda, a study reported that nonbreastfed children were twice as likely to die from pneumonia than were breastfed children. In addition, low birth weight and malnutrition (underweight) are also important risk factors for pneumonia and ALRI morbidity and mortality in the developing world.

METHODOLOGICAL ISSUES: The review was limited to developing countries or low-income populations from developed countries. Many studies reviewed here are limited by reverse causality, confounding, and self-selection bias.

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 Epidemiol 1996;143:1142–8.

SEE: Study description, Section 2.1, page 54

OUTCOME MEASURES: Death due to 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: 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 nonbreastfeeding on risk of death from acute lower respiratory infection. However, among infants aged 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 nonbreastfeeding on the risk of death from combined diarrhea and acute lower respiratory infection in the older age group.

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Victora CG, Smith PG, Barros FC, Vaughan JP, Fuchs SC. Risk factors for deaths due to respiratory infections among Brazilian infants. Int J Epidem 1989;918–25.

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. See results for diarrheal mortality in Section 2.1, page 55.

RESULTS: This study examined the association between infant feeding mode and mortality from respiratory infection in 2 urban areas in Brazil. Exclusive breastfeeding was the reference group. Breastfeeding was associated with a reduced risk of death from respiratory infections; however, the magnitude of the association was smaller than for diarrhea-related deaths. Compared with exclusive breastfeeding, the relative risk for any breastfeeding was 1.6. However, the confidence intervals span 1, so the finding was not statistically significant. In contrast, compared with 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 to be related to infant feeding mode. Infant feeding mode was that before the onset of fatal illness to avoid the problem of reverse causality. Potentially confounding variables were controlled.

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Victora CG, Vaughan JP, Lombardi C, et al. Evidence for protection by breast-feeding against infant deaths from infectious diseases in Brazil. Lancet 1987 (August 8):319–21

(The results of this study were the same as the one reported above; therefore, we chose to summarize only one of them, while making reference to both.)

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Robinson M. Infant morbidity and mortality: A study of 3266 infants. Lancet 1951(April 7):788–94.

SEE: Study description, Section 2.1, page 57

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

RESULTS: 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 1,000 was 10.2 for exclusive breastfeeding, 25.7 for partial breastfeeding, and 57.3 for bottle-fed infants. The unadjusted mortality rate from respiratory infection per 1,000 was 8.2 for exclusively breastfed, 15.9 for partially breastfed, and 31.6 for bottle-fed infants. For otitis media, the unadjusted overall mortality rate per 1,000 was 0 for exclusive breastfeeding, 2.0 for partial breastfeeding, and 8.1 for bottle-fed infants.

2.3   Effect of Breastfeeding on All-Cause Infant Mortality

Arifeen S, Black RE, Antelman G, Baqui A, Caulfield L, Becker S. Exclusive breastfeeding reduces acute respiratory infection and diarrhea deaths among infants in Dhaka slums. Pediatr 2001;108:e67.

SEE: Study description, Section 2.1, page 52

OUTCOME MEASURES: Deaths due to all causes up to 12 months, based on verbal autopsy at the subsequent visit

RESULTS: There were 180 infant deaths (107 per 1,000 live births), including 60 neonatal deaths and 120 postneonatal. Proportional hazards regression was used to relate infant feeding method at the previous visit (up to month 3) to subsequent infant death, adjusting for birth weight, mother's height and parity, household income and religion, and father's education. Other confounding variables were tested for significance and excluded. Infants who were partially breastfed or not breastfed had a risk of death 2.23 times greater (95% CI: 1.45–3.44) than exclusively breastfed infants. The risk of death among predominantly breastfed infants was not statistically different from that of exclusively breastfed infants (hazard ratio: 1.13; CI: 0.65–1.97).

Manda SOM. Birth intervals, breastfeeding and determinants of childhood mortality in Malawi. Social Sci & Med 1999;48:301–12.

COUNTRY: Malawi

SETTING: Nationwide

DESIGN: Retrospective study design using the 1992 Malawi Demographic and Health Survey of 4,838 singleton births of 2,911women aged 15–49 years

BREASTFEEDING DEFINITION: Breastfeeding duration captured in a series of dummy (yes/no) variables to indicate, for children in each of 2 age groups (0–11 months and 12–59 months), if: still breastfed, stopped breastfeeding due to illness, stopped breastfeeding due to other reasons, or breastfeeding information is missing.

OUTCOME MEASURES: Infant mortality (0–11 months) and child mortality (12–59 months)

RESULTS: Proportional hazards model based on Cox were used to determine the association between selected variables and infant and child mortality. Children who had never breastfed or had stopped breastfeeding because of illness (theirs or their mothers') were 4.3 times more likely to experience infant mortality than children who continued to breastfeed. Stopping breastfeeding because of weaning or maternal pregnancy during the subject's first 12 months significantly increased infant mortality by a factor of 8.26. The effects of breastfeeding on child mortality were less notable.

METHODOLOGICAL ISSUES: Nearly all children were breastfed during the first year, unless they died or were ill (depending on the type of illness). This produces an almost perfect correlation between breastfeeding and child survival, especially during infancy. Therefore, estimates of the effects of stopping breastfeeding for other reasons are based on small numbers and may be unstable.

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Terra de Souza AC, Cufino E, Peterson KE, et al. Variations in infant mortality rates among municipalities in the state of Ceará, Northeast Brazil: An ecological analysis. Int J Epidem 1999;28:267–75.

COUNTRY: Brazil

SETTING: Urban and rural

DESIGN: Ecological design comparing 140 municipalities

BREASTFEEDING DEFINITION: Exclusive breastfeeding for the first 4 months of life

OUTCOME MEASURES: Infant mortality rate defined as the ratio of infant deaths to live births in the 30-month study period

RESULTS: Crude analyses show an inverse association with the percentage of infants who were exclusively breastfed for the first 4 months of life and average infant mortality rate (β = -0.62, p = 0.0005, R^2 = 9.3). The association was not affected after controlling for the percentage of infants with adequate weight gain. In the adjusted analysis, a 10-point increase in percent of infants exclusively breastfed would result in 5.9 fewer infants deaths per 1,000 live births. Forty-one percent of the variance in municipality-level infant mortality rates was explained by percent of exclusively breastfed infants, up-to-date prenatal care, low household income, female illiteracy rate, inadequate water supply, urbanization, and per capita gross national product.

METHODOLOGICAL ISSUES: Low birth weight, which can affect infant mortality risk and, therefore, be a confounding variable, was not taken into account. A strength of the study is that the unit of analysis (the municipalities) is the same as the unit of potential interventions, thus providing an understanding of the determinants of infant mortality that work at the ecological level.

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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. Exclusive breastfeeding was associated with the lowest rate of mortality (29%), compared with 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 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.

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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 as well as the effect of changing patterns of breastfeeding.

METHODOLOGICAL ISSUES: No definition of breastfeeding (exclusive or partial) is given, and no new data are presented. A strong argument is made for promotion of breastfeeding as a mechanism to reduce both mortality and birth rates.

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Mølbak K, Gottschau A, Aaby P, Højlyng N, Ingholt L, da Silva APJ. Prolonged breast feeding, diarrhoeal disease, and survival of children in Guinea-Bissau. Br Med J 1994;308:1403–6.

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 of breastfed children (95% CI: 1.1–6.2). The risk of death increased to 3.5 times (95% CI: 1.4–8.3) when analyses were 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 than 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 demonstrates the robustness of the findings.

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Shahidullah M. Breast-feeding and child survival in Matlab, Bangladesh. J Biosoc Sci 1994;26:143–54.

COUNTRY: Bangladesh

SETTING: Rural

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

BREASTFEEDING DEFINITION: Duration of unsupplemented and supplemented breast-feeding. 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 on mortality risk. Important demographic and socioeconomic indicators were also included as control variables: parity, sex of child, maternal education, and preceding birth interval. 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 became pregnant again, the index child was 4.4 times more likely to die than 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 of these events had nearly 9 times the risk of death as a child who had not experienced these events. Overall, it was not the duration of any breastfeeding but 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 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 11 discrete age intervals were created for the analysis, but the results are not presented by age.

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Srivastava SP, Sharma VK, Jha SP. Mortality patterns in breast versus artificially fed term babies in early infancy: A longitudinal study. Indian Pediatr 1994;31:1393–6.

COUNTRY: India

SETTING: Urban

DESIGN: Hospital-based follow-up of 1,000 term infants, half of whom were breastfed and half 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 1,000 term infants of whom half were breastfed and half were bottle-fed, but provided no other information about the selection criteria.

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 feeding of colostrum

OUTCOME MEASURES: Neonatal and postneonatal mortality

RESULTS: Total neonatal mortality was 6.6%; total postneonatal mortality was 5.1%. Knowledge and use of colostrum was significantly related to setting. More than half of urban mothers did not know about or feed colostrum to their newborns. In contrast, in rural areas, nearly three-quarters of mothers knew about or fed colostrum to their newborns. To examine the association between colostrum and mortality, the data were stratified by 3 socioeconomic groups (high, medium, and low) in each of two settings (urban and rural). In the urban high socioeconomic group, no neonatal deaths were found in the group that received colostrum, and 4.26% of neonates died in the group that did not receive colostrum. Comparable postneonatal deaths were 1.67% and 5.32%. In the rural, high socioeconomic group, no neonatal deaths were found among the group that received colostrum, and 8.2% of neonates died in the group that did not receive colostrum. Comparable postneonatal deaths were 0% and 1.64%.

In the urban middle socioeconomic group, 2.17% of neonates died in the group that received colostrum, compared with 5.69% of neonates in the group that did not receive

colostrum. Comparable postneonatal deaths were 4.35% and 7.32%. In the rural middle socioeconomic group, 3.7% of neonates died in the group that received colostrum, compared with 4.91% of neonates who did not receive colostrum. Comparable postneonatal deaths were 3.7% and 4.29%. In the urban low socioeconomic group, 10% of neonates died in the group that received colostrum, compared with 17.39% of neonates in the group that did not receive colostrum. Comparable postneonatal deaths were 0 and 13.04%. In the rural low socioeconomic group, none of the neonates who received colostrum died, compared with 11.36% of neonates who did not receive colostrum. Comparable postneonatal deaths were 0% and 3.41%. Tests of significance were not provided. As a general conclusion, 1.72% of urban neonates and 2.59% of urban postneonates who received colostrum died, compared with 6.25% and 7.08% who did not receive colostrum. Comparable rural neonatal and postneonatal deaths were 1.69% and 1.69%, respectively, for infants who received colostrum, and 7.37% and 3.53%, respectively, for infants who did not receive colostrum.

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 potentially confounding factors were not controlled. For various reasons, information about colostrum use could not be obtained from 8.3% of urban mothers and 10.7% of rural mothers.

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Awathi S, Malik GK, Misra PK. Mortality patterns in breast versus artificially fed term babies in early infancy: A longitudinal study. Indian Pediatr 1991;28:243–8.

COUNTRY: India

SETTING: Urban

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

BREASTFEEDING DEFINITION: Breastfed versus artificially fed

OUTCOME MEASURES: Neonatal mortality and postneonatal mortality (1–6 months only)

RESULTS: This study examined the association between infant feeding mode (breastfeeding versus formula feeding) and neonatal and postneonatal morbidity (through 6 months only) among normal and low birth weight infants. Results are not adjusted for potentially confounding factors or reverse causality, which may be a particular problem among low birth weight infants. 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 postneonatal 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 (66%) infants studied for the entire 6 months. Moreover, they also excluded breastfed infants who switched into the formula-feeding category during the study.

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Briend A, Bari A. Breastfeeding improves survival, but not nutritional status, of 12–35 months old children in rural Bangladesh. Eur J Clin Nutr 1989;43:603–8.

COUNTRY: Bangladesh

SETTING: Rural

DESIGN: Prospective: n=1,087 children aged 12–35 months followed monthly for 2 years

BREASTFEEDING DEFINITION: Breastfed versus weaned

OUTCOME MEASURE: Mortality

RESULTS: This study examined the association among infant feeding mode, nutritional status, and mortality among children. It is one of the few studies identified that looks at children beyond 1 year of age. The unit of analysis was child-months. Children who were breastfed had a significantly lower weight for age than children who were weaned. However, despite their better nutritional status, weaned children had a relative risk of dying of 2.6, compared with 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 with similarly malnourished children who were breastfed. Although the estimates were not adjusted for potentially 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—the possibility that the infant's health determined infant feeding practices. Although the authors argue that the poorest mothers breastfed the longest, so the unadjusted relative risks are likely to be an underestimate, the analysis does not control for potentially confounding factors.

Molteno CD, Kibel MA. Postneonatal mortality in the Matroosberg Divisional Council area of the Case Western Health Region. South African Med J 1989;75:575–8.

COUNTRY: South Africa

SETTING: Urban

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

BREASTFEEDING DEFINITION: None

OUTCOME MEASURES: Mortality

RESULTS: Of the infants who died, 33% had not been breastfed, compared with 7% of controls (p < 0.001). However, these figures were not adjusted for reverse causality or potentially 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 less education, a father in prison, an incomplete immunization

record, or a family with social problems. They also were less likely to have belonged to a nuclear family.

METHODOLOGICAL ISSUES: This study does not control for many factors that may be related to both infant feeding mode and risk of mortality, nor does it take steps to avoid reverse causality.

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Retherford RD, Choe MK, Thapa S, Gbuhaju BB. To what extent does breastfeeding explain birth-interval effects on early childhood mortality? Demography 1989; 26(3):439–50.

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 aged < 18 months, the effect of breastfeeding on mortality was significant and large. The relative risk associated with 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 it does have a substantial effect on child mortality. The authors interpret this finding to indicate that as long as a child is breastfed, he or she receives adequate nourishment and is not dependent on the 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 determined by socioeconomic status.

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

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Habicht J-P, DaVanzo J, Butz WP. Mother's milk and sewage: Their interactive effects on infant mortality. Pediatrics 1988;81(3):456–61.

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 among breastfeeding, piped water, toilets and infant mortality. Breastfeeding was highly protective. Compared with breastfeeding, the adjusted relative risks of death due to not breastfeeding were 5.2 if the household had neither a toilet nor 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 were adjusted for a number of potentially confounding factors.

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Thapa S, Short RV, Potts M. Breast feeding, birth spacing and their effects on child survival. Nature 1988;335;679–82.

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. The paper provides estimates of the increase in the total fertility rate if breastfeeding duration were to decline by 25% and 50%. It also includes estimates of the increase in contraceptive prevalence that would be required to offset these declines in breastfeeding duration. For example, the paper estimates that, in Senegal, a 25% decline in breastfeeding duration would require almost a tripling in contraceptive prevalence. It also discusses the effect of birth intervals on child survival using estimates from other studies. The authors estimate that if all mothers could space their births at least 2 years apart, the result would be a 20% reduction in mortality in the first year of life. This reduction corresponds to about a half-million lives saved.

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 birth spacing. The much greater direct effects of breastfeeding on under-5 mortality are not considered. The estimates of reduced infant mortality with increased birth spacing could be the result of reverse causality, with neonatal death leading to an early postpartum pregnancy.

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Habicht J-P, DaVanzo, J, Butz WP. Does breastfeeding really save lives, or are apparent benefits due to biases? Amer J Epidemiol 1986;123(2):279–90.

COUNTRY: Malaysia

SETTING: Urban and rural

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

BREASTFEEDING DEFINITION: Total duration of exclusive breastfeeding and breast-feeding

OUTCOME MEASURE: Infant mortality

RESULTS: The effects of breastfeeding on infant mortality are reported for three subperiods 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, or where breastfeeding stopped because of fatal illness. This sensitivity analysis showed that although the associations remained significant and in the expected direction, the magnitude was reduced, compared with analyses using 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 1,000 infants per added month of full breastfeeding were 68.6, 24.9, and 3.4 for the periods, 8–28 days, 29 days–6 months, and 7–12 months, respectively. The reduction in deaths per 1,000 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 for many potentially confounding factors. Age-related factors having to do with both mortality risk and infant feeding mode were addressed as well.

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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):516–25.

COUNTRY: Malaysia

SETTING: Urban and rural

DESIGN: Retrospective: n = 1,262 women and their 5,471 infants

BREASTFEEDING DEFINITION: Duration of supplemented and unsupplemented breast-feeding

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: 8–28 days, 2–6 months, and 7–12 months. Breastfeeding is significantly associated with mortality, especially in early infancy. Infants who were fully breastfed throughout their first week of life have 16/1,000 fewer deaths during the first month than those not fully breastfed. The estimated

risk difference between unsupplemented breastfeeding the entire first 4 weeks and not breastfeeding at all is 25/1,000 deaths during the interval 2–6 months. In the last 6 months of infancy, infants who were fully breastfed through their first 6 months had 20/1,000 fewer deaths than those not breastfed at all. An interaction among breastfeeding, toilet sanitation, and mortality was found: the risk of death due to not breastfeeding increases in households with poor sanitation.

METHODOLOGICAL ISSUES: This is a methodologically strong study, which controlled for many potentially confounding factors.

Plank SJ, Milanesi ML. Infant feeding and infant mortality in rural Chile. Bull WHO 1973;48:203–10.

COUNTRY: Chile

SETTING: Rural

DESIGN: Cross-sectional survey of n = 1,712 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. Postneonatal deaths were significantly associated with infant feeding mode. Mortality rates are provided for 3 overlapping age groups: 1–12 months, 3–12 months, and 6–12 months. In the 1–12 months age group, the mortality rates 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 mortality rates 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 mortality rates 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 birth weight infants for whom supplementary milk was prescribed medically. The results also showed that those infants given bottles in addition to being breastfed had mortality rates similar to those who received only a bottle. Once bottle feeding began, breastfeeding appeared to offer no protection against mortality. There was an inverse association among infant mortality, family income, environmental factors, and medical care: families with higher incomes, better household sanitation, and greater access to medical care also were 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 likely biased downward because there was no adjustment for the confounding postive association of bottle feeding with higher family income and maternal education. Tests of statistical significance were not provided.