Extracted from: *Population and Development Review* 1984;10 Suppl:25–45.

# An Analytical Framework for the Study of Child Survival in Developing Countries

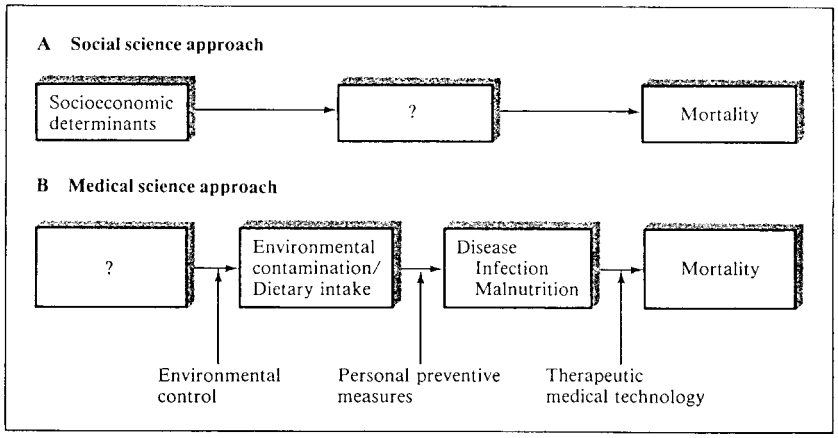
W. Henry Mosley
Lincoln C. Chen

This essay proposes a new analytical framework for the study of the determinants of child survival in developing countries. The approach incorporates both social and biological variables and integrates research methods employed by social and medical scientists. It also provides for the measurement of morbidity and mortality in a single variable. The framework is based on the premise that all social and economic determinants of child mortality necessarily operate through a common set of biological mechanisms, or proximate determinants, to exert an impact on mortality.[1] The framework is intended to advance research on social policy and medical interventions to improve child survival.

Traditionally, social science research on child mortality has focused on the association between socioeconomic status and levels and patterns of mortality in populations (Figure 1A). Correlations between mortality and socioeconomic characteristics are used to generate causal inferences about the mortality determinants. Income and maternal education, for example, are two commonly measured correlates (and inferred causal determinants) of child mortality in developing country populations. Specific medical causes of death are generally not addressed by social scientists, and the mechanisms by which socioeconomic determinants operate to produce the observed mortality differentials remain largely an unexplained "black box."

Medical research focuses primarily on the biological processes of diseases, less frequently on mortality per se. The differing assumptions and methods are classified in Figure 1B. Studies of cause of death attribute mortality to specific disease processes (such as infections or malnutrition), using information obtained from death reports or clinical case records. Clinical trials assess the therapeutic effect of a particular medical technology. Field intervention studies measure the effectiveness of personal preventive measures on

FIGURE 1 Conceptual models of social science and medical science approaches to research on child survival



levels of morbidity and mortality in a population. Epidemiological studies may define mechanisms of disease transmission in the environment—for example, the connection between environmental contamination (polluted drinking water) and disease (cholera). Intervention studies alter the environment to reduce disease transmission (as with malaria vector control). Nutrition research focuses on breastfeeding, dietary practices, and food availability as they relate to nutritional status.

The dependent variable most commonly measured in medical research is morbidity, that is, the manifestations of disease processes among survivors—usually calculated as the incidence and prevalence of disease states in a population. The ultimate consequences of disease for mortality in populations at large tend to be neglected, and socioeconomic determinants are generally ignored or dealt with only superficially.

While both the social and medical sciences have made major contributions to our understanding of child mortality in developing countries, the differing concerns and methodologies have compartmentalized such knowledge and constrained the development of potentially more useful approaches to understanding child survival. An even more critical problem is that the selection of a particular research approach usually results in policy and program recommendations biased along disciplinary lines. A new analytical approach incorporating both social and medical science methodologies into a coherent analytical framework of child survival therefore is clearly needed.

## The proximate determinants framework

The development of a proximate determinants approach to the study of child survival presented here[2] is based on several premises:

1 In an optimal setting, over 97 percent of newborn infants can be expected to survive through the first five years of life.

2 Reduction in this survival probability in any society is due to the operation of social, economic, biological, and environmental forces.

3 Socioeconomic determinants (independent variables) must operate through more basic proximate determinants that in turn influence the risk of disease and the outcome of disease processes.

4 Specific diseases and nutrient deficiencies observed in a surviving population may be viewed as biological indicators of the operations of the proximate determinants.

5 Growth faltering and ultimately mortality in children (the dependent variable) are the cumulative consequences of multiple disease processes (including their biosocial interactions). Only infrequently is a child's death the result of a single isolated disease episode.

The key to the model is the identification of a set of proximate determinants, or intermediate variables, that directly influence the risk of morbidity and mortality. All social and economic determinants must operate through these variables to affect child survival.[3] The proximate determinants are grouped into five categories:

— Maternal factors: age; parity; birth interval.
— Environmental contamination: air; food/water/fingers; skin/soil/inanimate objects; insect vectors.
— Nutrient deficiency: calories; protein; micronutrients (vitamins and minerals).
— Injury: accidental; intentional.
— Personal illness control: personal preventive measures; medical treatment.

...

FIGURE 2 Operation of the five groups of proximate determinants on the health dynamics of a population

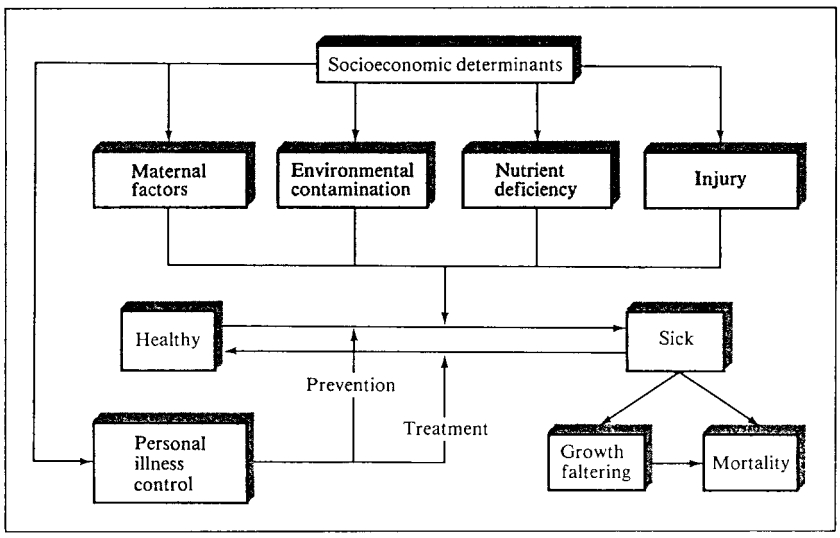



Figure 2 depicts a framework showing how these five groups of proximate determinants operate on the health dynamics of a population. All proximate determinates in the first four groups influence the rate of shift of healthy individuals toward sickness. The personal illness control factors influence both the rate of illness (through prevention) and the rate of recovery (through treatment). Specific states of sickness (infection or nutrient deficiency) are basically transitory: ultimately there is either complete recovery or irreversible consequences manifested by increasing degrees of permanent growth faltering (or other disability among the survivors) and/or death.[4]

A novel aspect of this conceptual model is its definition of a specific disease state in an individual as an indicator of the operation of the proximate determinants rather than as a "cause" of illness and death. This is not to undervalue the usefulness of etiology-specific classification of disease and death for the development of rational therapeutic and preventive interventions. Rather, the aim is to emphasize the social as well as medical roots of the problem. This in fact is the standard approach of epidemiology, which begins with a biological problem in the host and then searches for its social determinants in order to develop rational control measures. The strategic approach to child survival research implied by this framework parallels methods used in the epidemiology of the chronic diseases rather than of the acute diseases. Chronic diseases such as heart disease are typically multifactorial in causality, have long latency periods between disease exposure and manifestation, and are powerfully influenced by lifestyle and socioeconomic circumstances.

...

## The dependent variable

Typically, social scientists examine mortality as the dependent variable. This has strength because deaths are definitive events that may be easily measured and aggregated. An exclusive focus on mortality, however, handicaps research because death is a rare event, the measurement of which necessitates the study of large populations or the cumulation of the morality experience of smaller populations over long periods. With few exceptions, social scientists pay scant attention to the health status of survivors. In contrast, medical scientists typically focus on the diseases or nutritional status of survivors. This approach permits intensive study of smaller populations; it has the shortcoming, however, that past deaths among the birth cohorts being studied are often not taken into account. A logical question, then, is how to combine counts of the dead with observations on the living into a unified scale or index of the health status

of a population. The model proposed here combines the level of growth faltering among survivors with the level of mortality of the respective birth cohort to create such an index.

This approach requires clarification. Customarily, growth faltering in a cohort of children is called "malnutrition," and this, in turn, leads to the inference that it is simply the consequence of dietary deficiency. There is now abundant evidence that growth faltering is due to many factors and that it may be more appropriately considered a nonspecific indicator of health status.[5] Thus, combining a measure of growth faltering with mortality can generate a single dependent variable that can be scaled over all members of the population of interest (both survivors and deceased). Doing so reduces one bias common to medical research and strengthens the explanatory power of social research.

To assess the validity of integrating the level of growth faltering and mortality into a common indicator of health status, we first examine the current procedure for scaling "malnutrition" in children (Morley and Woodland, 1979). Children are weighed and their actual weight-for-age is compared with the expected (median) weight-for-age based on standard growth charts (Jelliffe, 1967; American Public Health Association, 1981). Typically, each child's weight is expressed as a percentage of the expected weight-for-age. The degree of growth faltering is a function of the negative deviation from the median.[6] The classification system proposed by Gómez includes three grades of malnutrition: Grade I: 75–89 percent of standard weight-for-age; Grade II: 60–74 percent; Grade III: below 60 percent (Gómez et al., 1955). Since one standard deviation of the normal weight distribution is usually about 10–11 percent of the median weight-for-age, Gómez Grade I malnutrition overlaps somewhat with the normal range.[7]

The significance of weight-for-age as an indicator of general health status derives from prospective studies in Bangladesh, India, and New Guinea. Measurements of cohorts of children under age 3 years were taken at one point in time, the cohorts were followed prospectively for periods of one to two years, and mortality rates were calculated by weight-for-age groups. The results, summarized in Figure 3, show a consistent increase of death risk with lower weight-for-age. Use of a logarithmic scale illustrates what has long been recognized in newborns, namely, the near exponential increase of mortality risk with greater negative deviations from an expected normal weight (Federici and Terrenato, 1980).[8] The figure also shows a plot of early neonatal deaths by birth weight, which follows much the same pattern.

Based on this pattern of mortality risks among survivors by weight-for-age, our suggested method of incorporating child deaths into a common "health status index" is to assign the child deaths a "score" of Grade IV. A variable so constructed can be useful as a relative measure of the current health status of a population cohort, and since this measure reflects cumulative past morbidity experience, it may be suitable for single-round retrospective surveys searching for determinants of child survival.

...

## Proximate determinants

In order to achieve maximum analytical value, the proximate determinants should not only serve as indicators of the various mechanisms producing growth faltering and death; they also should be measurable in population-based research. In some cases the proximate determinants are measurable directly, in other cases indirectly.

...

## Socioeconomic determinants

We next examine a range of socioeconomic determinants (independent variables) and illustrate how they operate through the proximate determinants to influence the level of growth faltering and mortality. The socioeconomic determinants are grouped into three broad categories of variables that are commonly followed in the social science literature.[9]

- Individual-level variables: individual productivity (fathers, mothers); traditions/norms/attitudes.
- Household-level variables: income/wealth.
- Community-level variables: ecological setting; political economy; health system.

...

As the preceding discussion suggests, the task of delineating and scaling the impact of the socioeconomic variables on the proximate determinants of child health and mortality falls to a wide range of social science disciplines, both those that observe populations and institutions at large and those that quantify economic transactions and the effects of income factors on family goals and outcomes. The need for a multidisciplinary approach to understanding and alleviating child mortality is clear.

## Discussion

The purpose of an analytical framework in the study of child survival is to clarify our understanding of the many factors involved in the family's production of healthy children in order to provide a foundation for formulating health policies and strategies. The significance of the proximate determinants model does not lie in simply a listing of the multiplicity of variables of interest or in concerns with scaling and measurement of these factors: many field surveys already address these topics. Rather, the key advantage of the model lies in the organization of seemingly disparate measures of environmental conditions; of dietary, reproductive, and health care practices; and of disease states into a coherent framework in which they are linked to one another and to child survival on the one hand and to socioeconomic factors on the other. The value of the framework is its parsimony. By limiting the proximate determinants to 14 specific factors grouped into five broad categories, we are able to arrive at a scheme that makes feasible the integrated analysis of the biological and social determinants of mortality.

The analytical model implies a major reorientation in research approaches by both health and social scientists looking at child mortality. Specifically, it suggests that child mortality should be studied more as a chronic disease process with multifactorial origins than as an acute, single-cause phenomenon. Use of the model should facilitate specification of the different orders of causality and possible interactions among the socioeconomic determinants. Regarding the dependent variable, the degree of physical deterioration (growth faltering) among surviving children in a population is combined with the mortality experience into a nonspecific measure of the level of adverse conditions facing the population.

There are numerous situations in which a multidisciplinary approach to the study of child survival could provide guidance for health policymakers in the developing world. For example, in many developing countries large differences in infant and child mortality have been observed between various regions, or between mothers with different educational or social characteristics within a given area. In-depth investigation to connect these ecological or socioeconomic factors to specific proximate determinants can give policymakers insights into health-related development strategies that could reduce these differentials.

A rewarding opportunity for multidisciplinary research using this model is provided by "natural experiments," that is, situations in which health or social interventions are being introduced into large populations. For example, rural or urban development projects may change the ecological setting and/or provide additional income-earning opportunities for men and women. Typically these are presumed to lead to improved health in the family, though, in fact, the consequences for child welfare may be mixed. Research in conjunction with such interventions can not only assess the overall health impact of alternative development strategies, but also more sharply define which among a number of specific factors amenable to change by health policymakers are of greatest consequence for child survival.

## Notes

1 The terms proximate determinants, intermediate variables, and mechanisms may be used interchangeably.

2 The framework presented here is slightly modified from its original form as developed in Mosley (1983). Specifically, "nutrient availability" factors have been renamed "nutrient deficiency" factors, and the factors of "vitamins" and "minerals" have been combined to "micronutrients."

3 There are two alternative approaches to solving this problem. One requires a detailed classification of all known causes of disease and death in every individual in order to make inferences about the social factors contributing to mortality. This approach was used by Puffer and Serrano (1975) in studying mortality among 36,000 children in the Americas. A second approach, proposed here, is to search for and identify several basic mechanisms common to all diseases of interest and through which all socioeconomic determinants must operate.

4 Noteworthy in this framework are biological interactions among the proximate determinants. The effects of the proximate determinant "nutrient deficiency" is modulated by the physiological factors of appetite, absorption, and metabolism. Similarly, the effects generated by "environmental contamination" are influenced by the host's ability to resist infection. In this latter case, host resistance may be compromised by injury, low birth weight, or immaturity at birth. Host defenses may be strengthened by improved nutrition and by vaccines. Also implicit in the framework are the biological mechanisms of synergism between malnutrition and infection. Infections reduce appetite and cause unnecessary metabolic wastage of nutrients, thereby precipitating or aggravating malnutrition; malnutrition, in turn, reduces host resistance, thereby increasing the risk of more severe disease outcomes due to infection.

5 Typically, body wasting and growth retardation are called "malnutrition." While this is the biological situation at the cellular or somatic level, the term "malnutrition" also implies the existence of a specific "cause" of the condition (lack of sufficient food). This assumption commonly leads to a particular public health intervention (feeding programs). There is a growing body of evidence that the level of "malnutrition" among children is as much dependent on maternal health factors and infections as it is on the nutrient deficiency. It is thus more appropriate to consider the levels of physical stunting and wasting in cohorts of children as nonspecific indicators of health status (as is the case with the level of mortality) rather than as a specific indicator of dietary deficiency (Mata, 1978; Cole and Parkin, 1977).

6 For simplicity, the discussion will deal only with weight-for-age measurements, although similar findings have been shown for measures of height-for-age and arm circumference (Chen et al., 1980; Sommer and Loewenstein, 1975; Heywood, 1982).

7 More recent recommendations have proposed that the difference between the observed and expected weight-for-age be expressed in standard deviation units (z score). As noted above, one standard deviation equals roughly 10–11 percent of the expected weight-for-age (Waterlow et al., 1977).

8 The absolute levels and differences between studies shown in Figure 3 are not comparable because of different study designs, treatments available, and so on.

9 Schultz (1979) and Palloni (1981) provide a basis for the organization of socioeconomic determinants in our discussion.

## References

See the *Bulletin* web site at URL: www.who.int/bulletin

## References


Aaby, Peter, Judith Bukh, Ida Marie Lisse, and Arjon J. Smith. 1981. "Measles vaccination and child mortality," *Lancet* 2: 93.

American Public Health Association. 1981. *Growth Monitoring of Preschool Children: Practical Considerations for Primary Health Care Projects*. Primary Health Care Issues, Series I, No. 3. Washington, D.C.: APHA.

Arriaga, Edward, and Kingsley Davis. 1969. "The pattern of mortality change in Latin America," *Demography* 6: 223–242.

Asaad, Marie, and S. Katsha. 1981. "Villagers' participation in the formal and informal health services in an Egyptian delta village," Regional Papers, The Population Council, Cairo.

Behm, Hugo. 1979. "Socioeconomic determinants of mortality in Latin America," *Proceedings of the Meeting on Socioeconomic Determinants and Consequences of Mortality,* Mexico City, 19–25 June. New York and Geneva: UN and WHO.

Belloc, Nedra. 1980. "Personal behavior affecting mortality" in *Biological and Social Aspects of Mortality and Length of Life,* ed. Samuel H. Preston, pp. 449–477. Liège: International Union for the Scientific Study of Population.

Birdsall, N., and W. P. Greevey. 1978. "The second sex in the Third World: Is female poverty a development issue?" Summary of Workshop on Women in Poverty, International Center for Research on Women, Washington, D.C.

Bongaarts, John. 1978. "A framework for analyzing the proximate determinants of fertility," *Population and Development Review* 4, no. 1 (March): 105–132.

Briscoe, John. 1983. "Water supply and health in developing countries: Selective primary health care revisited." Paper presented at the *International Conference on Oral Rehydration Therapy,* USAID, WHO, UNICEF, and International Centre for Diarrheal Disease Research, Washington, D.C., 7–10 June.

Caldwell, John C. 1979. "Education as a factor in mortality decline: An examination of Nigerian data," *Proceedings of the Meeting on Socioeconomic Determinants and Consequences of Mortality,* Mexico City, 19–25 June. New York and Geneva: United Nations and World Health Organization.

Chambers, Robert. 1979. "Health, agriculture and rural poverty: Why seasons matter," Discussion Paper No. 148, Institute of Development Studies, University of Sussex, Brighton, England.

Chen, Lincoln. 1981a. "Child survival: Levels, trends, determinants." Paper presented for chapter on "Supply of Children" in *Determinants of Fertility in Developing Countries: A Summary of Knowledge*. Washington, D.C.: Committee on Population and Demography, National Academy of Sciences.

———. 1981b. "Diarrhea and malnutrition: Interactions, mechanisms, and interventions." Paper presented for *Workshop on Interactions of Diarrhea and Malnutrition,* Bellagio, Italy, 11–15 May. U.N. University World Hunger Programme, Rockefeller Foundation, Ford Foundation and International Center for Diarrheal Disease Research, Bangladesh.

———, A. K. M. Alauddin Chowdhury, and Sandra L. Huffman. 1979. "Seasonal dimensions of energy-protein malnutrition in rural Bangladesh: The role of agriculture, dietary practices and infection," *Ecology of Food and Nutrition* 8: 175–187.

———, A. K. M. Alauddin Chowdhury, and Sandra L. Huffman. 1980. "Anthropometric assessment of energy-protein malnutrition and subsequent risk of mortality among preschool children," *American Journal of Clinical Nutrition* 33: 1836–1845.

———, E. Huq, and S. D'Souza. 1981. "Sex bias in the family allocation of food and health care in rural Bangladesh," *Population and Development Review* 7, no. 1 (March): 55–70.

Chowdhury, A. K. M. Alauddin, and Lincoln Chen. 1977. "The interaction of nutrition, infection, and mortality during recent food crises in Bangladesh," *Food Research Institute Studies* 16: 2.

Cole, T. J., and J. M. Parkin. 1977. "Infection and its effect on growth of young children: A comparison of the Gambia and Uganda," *Transactions of the Royal Society of Tropical Medicine and Hygiene* 71: 196–198.

Davis, Kingsley. 1951. *The Population of India and Pakistan*. Princeton: Princeton University Press.

———, and Judith Blake. 1956. "Social structure and fertility: An analytic framework," *Economic Development and Cultural Change* 4: 211–235.

Engle, P. L. 1981. "Maternal care, maternal substitutes, and children's welfare in developed and developing countries." Paper prepared for Policy Roundtable, International Center for Research on Women, Washington, D.C.

Fabrega, H. 1972. "Medical anthropology," in *Biennial Review of Anthropology*, ed. B. Siegel, pp. 167–229. Stanford: Stanford University Press.

Federici, Nora, and Luciano Terrenato. 1980. "Biological determinants of early life mortality," in *Biological and Social Aspects of Mortality and the Length of Life*, ed. Samuel H. Preston, pp. 331–362. Liège: International Union for the Scientific Study of Population.

Gómez, G., R. Ramos-Galvin, J. Cravioto, and S. Frenk. 1955. "Malnutrition in infancy and childhood with special reference to kwashiorker," in *Advances in Pediatrics*, vol. 7, pp. 131–169. New York: Yearbook Publications.

Grant, James P. 1982. "The state of the world's children 1982–1983." New York: UNICEF.

Gray, R. H. 1974. "The decline of mortality in Ceylon and the demographic effects of malaria control," *Population Studies* 28: 205–229.

Heywood, Peter. 1982. "The functional significance of malnutrition—growth and prospective risk of death in the highlands of Papua New Guinea," *Journal of Food and Nutrition* 39, no. 1: 13–19.

Jellife, Derrick B. 1967. *The Assessment of the Nutrition Status of the Community*, Monograph Series No. 53. Geneva: World Health Organization.

Jolly, Richard, and Maurice King. 1974. "The organization of health services," in *Medical Care in Developing Countries*, ed. Maurice King, pp. 2.1–2.15. Nairobi and Oxford: Oxford University Press.

Kasongo Project Team. 1981. "Influence of measles vaccination on survival pattern of 7–35 month old children in Kasongo, Zaire," *Lancet* 1: 764–763.

Kielmann, A. A., and Colin McCord. 1978. "Weight-for-age as an index of risk for children," *Lancet* 1: 1247–1250.

Kleinman, Arthur, Peter Kunstadter, E. Russell Alexander, and James L. Gale, eds. 1975. *Medicine in Chinese Cultures*. John E. Fogarty International Center, DHEW Publication No. (NIH) 75–653. Washington, D.C.: U.S. Government Printing Office.

Kumar, S. K. 1977. "Composition of economic constraints in child nutrition: Impact of maternal incomes and employment in low income households," Ph.D. Thesis, Cornell University.

Malcolm, L. A. 1974. "Ecological factors relating to child growth and nutritional status," in *Nutrition and Malnutrition Identification and Measurement*, ed. Alexander F. Roche and Frank Falkner, pp. 329–353. New York and London: Plenum Press.

Mata, Leonardo. 1978. *The Children of Santa Maria Cauque: A Prospective Field Study of Health and Growth*. Cambridge, Mass.: M.I.T. Press.

Meegama, Srinivas A. 1981. "The decline in mortality in Sri Lanka in historical perspective," in *International Population Conference, Manila*, vol. 2, pp. 143–164. Liège: International Union for the Scientific Study of Population.

Morley, Davis, and Margaret Woodland. 1979. *See How They Grow—Monitoring Child Growth for Appropriate Health Care in Developing Countries*. London and Basingstoke: The Macmillan Press Ltd.

Mosley, W. Henry. 1980a. "Biological contamination of the environment by man," in *Biological and Social Aspects of Mortality and Length of Life*, ed. Samuel H. Preston, pp. 39–67. Liège: International Union for the Scientific Study of Population.

———. 1980b. "Social determinants of infant and child mortality: Some considerations for an analytical framework," in *Health and Mortality in Infancy and Early Childhood: Report of a Study Group*, pp. 19–43. The Population Council, West Asia and North Africa Region, Cairo.

———. 1983. "Will primary health care reduce infant and child mortality? A critique of some current strategies with special reference to Africa and Asia," *Seminar on Social Policy, Health Policy and Mortality Prospects*, Paris, 28 February–4 March. Paris: Institut National d'Etudes Demographiques (INED).

Mott, Frank L. 1979. "Infant mortality in Kenya: Evidence from the Kenya Fertility Survey," Scientific Report No. 32, World Fertility Survey, London.

Nag, Moni. 1983. "Impact of social and economic development on mortality: Comparative study of Kerala and West Bengal," *Economic and Political Weekly* (Bombay) 18, nos. 19–21, Annual Issue (May): 877–900.

National Center for Health Statistics (NCHS). 1972. *A Study of Infant Mortality from Linked Records: Comparison of Neonatal Mortality from Two Cohort Studies.* US Vital and Health Statistics, Series 20, No. 13, USDHEW, Public Health Service, Washington, D.C.

Palloni, Alberto. 1981. "Design problems and data collection strategies in studies of mortality differentials in developing countries," *Seminar on Methodology and Data Collection in Mortality Studies,* Dakar, Senegal, 7–10 July. Liège: International Union for the Scientific Study of Population.

Poffenberger, Thomas. 1981. "Child rearing and social structure in rural India: Toward a cross-cultural definition of child abuse and neglect," in *Child Abuse and Neglect, Cross-Cultural Perspectives,* ed. Jill E. Korbin, pp. 71–95. Berkeley: University of California Press.

Popkin, Barry, M. 1975. "Income, time, the working mother and child nutriture," Discussion Paper No. 75-9, Institute of Economic Development and Research, University of the Philippines, Manila.

Puffer, Ruth Rice, and Carlos V. Serrano. 1973. *Patterns of Mortality in Childhood.* Scientific Publication No. 262. Washington, D.C.: Pan American Health Organization.

Safilios-Rothschild, Constantina. 1980. "The role of the family: A neglected aspect of poverty," in *Implementing Programs of Human Development,* ed. Peter T. Knight, pp. 311–373. World Bank Staff Working Paper No. 403. Washington, D.C.: World Bank.

Schultz, T. Paul. 1979. "Interpretations of relations among mortality, economics of the household, and the health environment," *Proceedings of the Meeting on Socioeconomic Determinants and Consequences of Mortality,* Mexico City, 19–25 June. New York and Geneva: United Nations and World Health Organization.

Scrimshaw, Susan C. M. 1978. "Infant mortality and behavior in the regulation of family size," *Population and Development Review* 4 no. 3 (September): 383–404.

Simmons, George B., Celeste Smucker, Stan Bernstein, and Eric Jensen. 1982. "Post-neonatal mortality in rural India: Applications of an economic model," *Demography* 19: 371–389.

Solimano, Georgio R., and Marty Vine. 1980. "Malnutrition, infection and infant mortality," in *Biological and Social Aspects of Mortality and the Length of Life,* ed. Samuel H. Preston, pp. 83–112. Liège: International Union for the Scientific Study of Population.

Sommer, Al, and Matthew S. Loewenstein. 1975. "Nutritional status and mortality: A prospective evaluation of the QUAC stick," *American Journal of Clinical Nutrition* 28: 287–292.

Teller, C., R. Sibrian, C. Talavera, B. Bent, J. del Canto, and L. Saenz. 1979. "Population and nutrition: Implications of sociodemograhic trends and differentials for food and nutrition policy in Central America and Panama," *Ecology of Food and Nutrition* 8: 95–109.

United Nations Population Division. 1983. "Mortality and health policy: Highlights of the issues in the context of the World Population Plan of Action." Paper prepared for Expert Group on Mortality and Health Policy, Rome, 30 May–3 June. New York: United Nations Secretariat.

Urban Development Department. 1982. "A baseline health and population assessment for the upgrading areas of Amman." A Report to the Municipality of Amman by the Population Council.

Waterlow, J. R., R. Buzina, W. Keller, J. Lane, M. Nichaman, and J. Tanner. 1977. "The presentation and use of height and weight data for comparing the nutritional status of groups of children under the age of five years," *Bulletin of the World Health Organization* 55: 489.

Wood, Charles H. 1982. "The political economy of infant mortality in São Paulo, Brazil," *International Journal of Health Services* 12: 215–229.

World Health Organization and UNICEF. 1978. *Primary Health Care,* Alma Ata Conference. Geneva and New York: WHO and UNICEF.