Human Milk, Nutrition, and the World Resource Crisis

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Recent international conferences in Bucharest and Rome have highlighted the world's problems concerning food supplies and population pressures, and have suggested some ways to try to deal with these complex issues. Concerns have mostly been with increasing basic food supplies, especially the world's key cereal grains and legumes, with improving the economic lot of underdeveloped countries, and with devising population policies appropriate for different ecologies and cultures. However, a key biological food and child-spacing system has not been given sufficient attention—human milk and the process of breast feeding. This is in part because human milk is not usually considered when food is discussed, because it is neither grown nor purchased. Likewise, the contraceptive effect of breast feeding has been dismissed by the Western world as an old wive's tale until recently.

Considerations

To put the role of human milk and breast feeding in perspective, it is necessary to emphasize nine areas of consideration:

1) Human milk poses none of the testing, marketing, or distribution problems of new foods. Lactation is one of the most ancient mammalian characteristics—dating back some 200 million years to the earliest egg-laying species, and hence preceding the evolution of placental gestation (*1*). In man, the consumption of animal milk is relatively recent, dating back less than 10,000 years; even today animal milk forms a culturally acceptable part of the diet for only some of mankind. The widespread use of infant formulas based on cow's milk in the Western world is a development of only the last 50 to 70 years, made possible by revolutions in dairy farming and food technology (*2*).

2) Malnutrition has its greatest effect on physiologically vulnerable groups, especially young children who make up over 10 percent of the world's population. In resource-poor, technically less developed countries, protein-calorie malnutrition (PCM) of early childhood is widespread. Severe syndromes, such as kwashiorkor and marasmus, are found in 1 to 7 percent of some populations of young children, while up to two-thirds may be affected by less severe but nevertheless debilitating forms (Figs. 1 to 4) (*2, 3*). Protein-calorie malnutrition is the world's dominant nutritional problem, often associated with deficiencies of other nutrients such as vitamin A. It has been estimated that there are about 10 to 20 million young children with severe syndromes of kwashiorkor or marasmus at any one time—most of whom will die without treatment. With deterioration of the economic, social, or agricultural situation, the numbers affected rise, particularly if famine conditions develop—as currently in the drought-ridden Sahelian belt of Africa and in 1975 in Tamil Nadu, or in oil-deprived Bangladesh.

Conversely, infantile obesity ("PCM plus") is becoming a problem in more affluent Westernized populations (*4*). All societies have children affected by both PCM and PCM plus, but in widely different proportions. In the United States, the main problem is infantile obesity, although PCM occurs more than often appreciated in children in disadvantaged communities. In many Asian, African, and Latin American countries, the situation is the mirror image, with a large percentage of children with PCM of some degree of severity.

Recently, the pattern of malnutrition has altered in many developing countries as a result of large-scale, precipitate urbanization—the "urban avalanche" (*5*)—and the accompanying decline in breast feeding. Under these circumstances the main syndrome has become nutritional marasmus, almost always associated with diarrheal disease, in the first year of life (*6, 7*). Human milk is highly protective against marasmus and the associated infective diarrhea, conditions resulting from bottle-feeding attempted in home where poverty and grossly inadequate hygiene lead to the use of overdilute, contaminated formula.

The public health significance of the marasmus-diarrhea syndrome was clear in results of the long-term Inter-American Investigation of Mortality in Childhood undertaken in ten countries in the Americas under the auspices of the Pan American Health Organization and published in 1973. Nutritional deficiency was found to be the most serious health problem, with substantial protection from both malnutrition and diarrheal disease afforded by breast feeding (*8*). Also, the biologically normal continuation of lactation into the second year or later (currently termed "prolonged" breast feeding) supplies a small, but significant, supplement to the critical weaning or transitional diet, and hence assists in the prevention of kwashiorkor.

Conversely, infantile obesity is much more common in the bottle-fed infants in communities where home hygiene is good and the purchase of formula not limited by funds. The quantity and composition are under the mother's control, so that calorie overdosage can occur. By contrast, breast feeding is a supply and demand phenomenon involving only the nursing dyad, with the volume regulated by the infant's appetite and thirst.

3) All mammalian milks have highly specific biochemical compositions. The complexity of the nutrients present in human milk has been underemphasized in pediatric textbooks, where comparisons of the proximate principles—protein, fat, and lactose—are usually the most that are given.

The composition of mammalian milks seems to reflect teleonomy—that is, adaptation to species-specific physiological needs to ensure optimal growth, development, and survival. For example, the creamlike milk (40 to 50 percent fat) and powerful milk ejection reflex of the blue whale mirror the needs for a concentrated secretion adapted to the high calorie requirements of the huge calf (7 meters long) in a cold environment, for relatively

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← *Courtesy* FDA Consumer (*Food and Drug Administration, Rockville, Maryland, June 1974*)

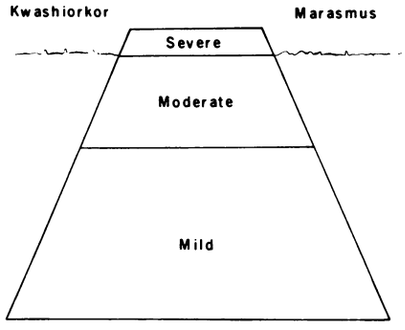


Fig. 1. Protein-calorie malnutrition of early childhood (PCM)—a public health "iceberg." Severe syndromes, such as kwashiorkor and marasmus, are easily identifiable. Mild to moderate cases occur much more frequently and can only be detected by body measurements, especially by serial weighing.

rapid underwater nursing between breaths, and for the mother's conservation of water.

In the case of human milk, the most significant of the many differences from cow's milk appears to be the abundant supply of nutrients most needed for the rapid growth and development of the central nervous system, including the brain. Particularly high levels of lactose, cystine (*9*), and cholesterol, and specific patterns of polyenoic fatty acids (*10*) are found in human milk.

4) Much illness in early childhood, especially in developing countries, is related to infection, which occurs more easily in children with PCM and which in turn makes malnutrition worse (*11*).

The considerable protective effect afforded by breast feeding has been recognized for decades, but has been considered to be related simply to cleanliness and lack of opportunity for contamination. However, recent work has demonstrated that human milk has anti-infective properties, because of the presence of secretory immunoglobulin A, lysozyme, the bifidus factor (*12*), lactoferrin, and other substances. The protective effect of milk is evident especially in relation to intestinal infections, including diarrheal disease due to *Escherichia coli* and other organisms, enteroviruses, and moniliasis (*Candida albicans*) (*13*).

5) Recent studies indicate that the traditional belief that unsupplemented breast feeding has a contraceptive, child-spacing effect is true, and is related to the anovulatory effect of prolactin (and other hormones) secreted by the anterior pituitary in response to the baby's sucking (Fig. 5) (*14*). The existence of this biological system is not surprising, as it parallels the spacing of offspring that occurs in other mammals as a consequence of mating or rutting seasons.

On a worldwide basis, lactation contraception (*15*) probably has a numerically greater rate of protection from pregnancy, measured in women-months per year, than has currently been achieved by technological devices (*16*). Conversely, the decline of breast feeding in periurban areas in developing countries has an anticontraceptive effect, increasing the birthrate and adding to problems of food shortage.

6) The economic significance of declining breast feeding has an impact at both family and national levels. For example, calculations in Los Angeles in December 1974 showed that bottle feeding for a 3-month-old infant would cost 50 to 75 cents per day as compared with 17 to 21 cents for the extra amounts of everyday foods (in the United States, a peanut butter sandwich and a glass of milk) needed to supply the additional 500 calories and 20 grams of protein suggested by the 1974 recommended dietary daily allowance for a lactating woman.

In developing countries, the economic significance is much more serious. To purchase an adequate quantity of formula is impossible for the majority of families, as it requires one-quarter to one-third of a worker's income. In other words, bottle feeding will inevitably be attempted with very dilute feedings, given in an unclean bottle, with marasmus and diarrheal disease (and often death) as frequent consequences. Similar but less extreme concerns also exist in poor communities in industrialized countries, including the United States.

Human milk should be recognized as a national resource in economic, agronomic, and nutritional planning (*17*). For example, the recorded decline in breast feeding in Singapore between the 1950's and 1960's required an approximate expenditure by families or agencies of the equivalent of $1.8 million to purchase substitute formulas, while in 1968 in the Philippines, the expense was about $33 million (*18*). In Kenya, it was estimated that the $11.5 million loss in breast milk was equivalent to two-thirds of the health budget or one-fifth of the average economic aid (*19*).

The "nutritional retreat" of declining

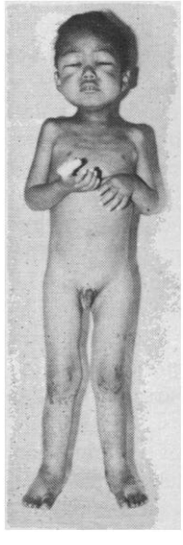


Fig. 2 (left). Kwashiorkor (Guatemala). Kwashiorkor, a major severe syndrome of PCM, usually occurs in the second or third year of life, during the transitional or weaning period, with edema as the cardinal feature. It is caused by a diet that is low in protein but contains carbohydrate calories, together with the metabolic ill effects of repeated bacterial, parasitic, and viral infections. Human milk can have a minor protective effect by supplying a small but significant amount of protein; the main etiologic factor is an inadequate and indigestible weaning diet that is low in protein. [Source: Institute of Nutrition of Central America and Panama] Fig. 3 (right). Nutritional marasmus (India). Nutritional maramus is the other main clinical form of severe PCM, usually occurring in the first year of life. It occurs in infants who are fed overdilute cow's milk formula in contaminated bottles and receive low amounts of protein and calories. Diarrheal disease is almost always present. Severe wasting of both muscle and subcutaneous fat and very low body weight (usually less than 60 percent of standard) are characteristic. Human milk is highly protective against both maramus and diarrheal disease.

lactation can also be visualized in terms of appropriate food production to make good these losses. Thus, if all women in India ceased to breast-feed, and used cow's milk formulas as replacement, an additional 114 million lactating cattle would be needed (*17*).

In addition, the energy cost and loss of raw materials in processing, packing, distributing, preparing, and refrigerating cow's milk formulas should be considered. For example, an infant reared on ready-to-feed formula based on cow's milk will use approximately 150 cans in 6 months of bottle feeding. With 3 million births in the United States in 1974, an overall annual consumption of 450 million usually nonrecyclable cans will result, with a waste of 70,000 tons of tinplate each year.

7) Lactation has declined considerably in periurban areas in many technically less developed, resource-poor countries (Fig. 6). As noted earlier, this is leading to an increasing incidence of infantile marasmus and weanling diarrhea, more marked in city slums than in rural areas. This changing pattern has particularly important biological consequences, because these conditions have not only a high mortality, but also considerable risk of subsequent permanent brain damage in those surviving. There are economic consequences as well, because treatment (if available) can be expensive and prolonged. Thus, the hospital cost of malnutrition in young children, largely related to inadequate lactation, was calculated over a recent decade to be the equivalent of $10 million in the English-speaking Caribbean (*19*).

8) The psychophysiology of human lactation has been the subject of considerable recent investigation, facilitated by the isolation of human prolactin in 1971 and the development of techniques of radioimmunoassay (*20*). Such endocrinological investigations are validating common beliefs and are giving guidance in practical aspects of human lactation (*1*). These studies have indicated the polyvalent role of prolactin (in milk secretion, as a water-conserving antidiuretic, as an anovulatory agent, in psychobiological "motherliness" behavior), and have explored the neurohormonal mechanisms in the key, emotionally labile milk let-down reflex (*1*).

9) Social and psychodynamic factors concerned with the decline in breast feeding in developing countries are being recognized. These are entirely derived from Western influence and include (i) the influence of inappropriate health services (iatrogenic effects) such as inappropriate training of personnel and organization of maternity centers, premature units, and pediatric wards; (ii) the ill effects of exploitive commercial advertising and promotion (*21*) (Fig. 7); and (iii) various psychosocial factors associated with Western-type urbanization, including the fact that some mothers (usually a small percentage) are employed for salary out of the home, the loss of the *doula* (female assistant in childbirth usual in traditional societies) (*22*), the overemphasis of the sexual role of the breasts, and the equating of bottle feeding with modernness and status.

Needs

In light of the considerable new knowledge concerning human milk and breast feeding, which we have discussed briefly, there would appear to be three primary needs in relation to the world situation:

1) Because of its nutritional, antiinfective, contraceptive, and economic significance, human milk must be considered as resource priority in national development policy and in international planning for health, food production, and family planning. As an emergency measure in famine relief, attention should be given to providing food for lactating mothers wherever possible,

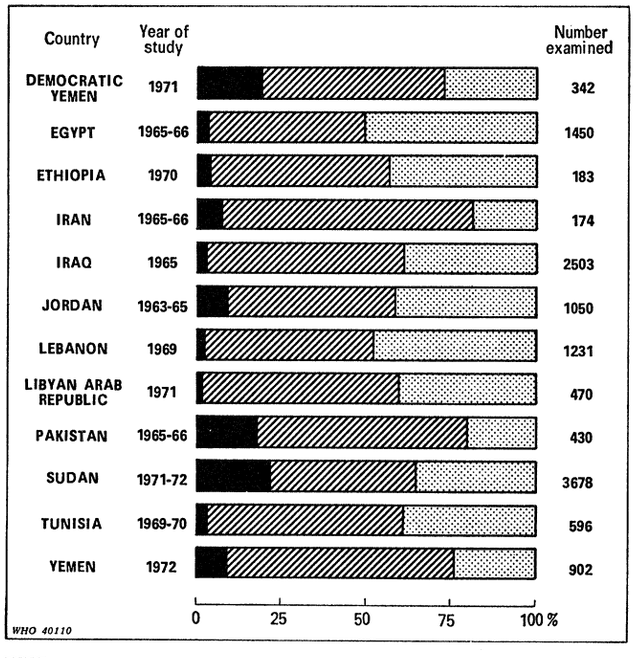
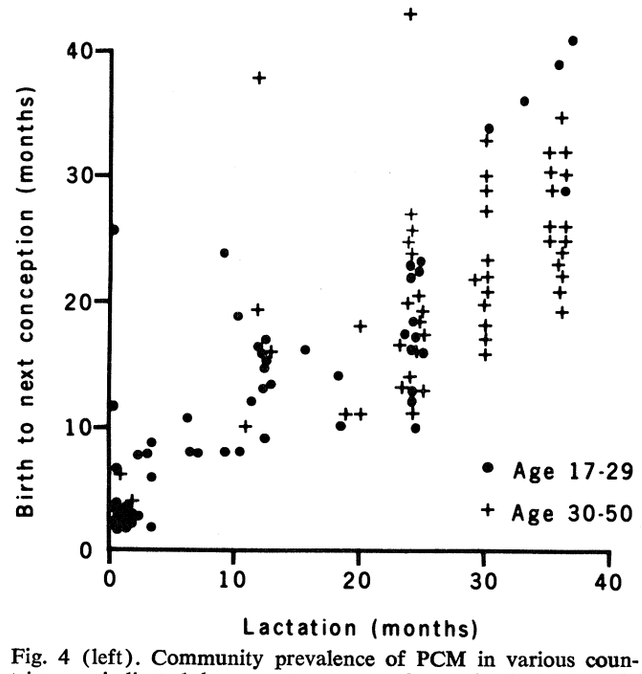


Fig. 4 (left). Community prevalence of PCM in various countries, as indicated by recent surveys of preschool children in the Eastern Mediterranean. [Source: Rao (*26*)] Fig. 5 (right). Lactation and fertility in Igloolik Eskimo women, Canada. Birth to conception intervals are related to duration of lactation and are decreasing for younger women (17 to 29 years old) compared with those 30 to 50 years old. [Source: Hildes and Schaefer (*27*)]



rather than to distributing formula (*23*). This position has been recently endorsed by the World Health Organization, the Food and Agriculture Organization, and the Protein Advisory Group of the United Nations.

2) Appropriate campaigns for lactation promotion must be developed (and evaluated) as components of national food and nutrition policy. Several countries are initiating such programs, which can be based on current knowledge of the psychophysiology and social dynamics involved in lactation and can be guided by practical information that has come to light from the analysis of the successful activities of spontaneous, voluntary mothers' groups such as La Leche League International in the United States (*24*), the Nursing Mothers Association of Australia, and *Ammehjelp* in Norway. Difficulties in mounting such campaigns will probably be considerable, but no wide-spectrum attempt has been made in the past.

3) Much-needed centers for research on rice, wheat, tropical vegetables, and other foods have been successfully developed in recent years in various countries. Likewise, there is an equally urgent need for establishment of an international lactation center to collect and disseminate information and to undertake and encourage research, with special emphasis on applied studies, particularly the effectiveness of promotional programs. Such a center would also be of value to so-called developed countries, where recent research (*1*) has been directed to the significance of human milk and breast feeding in relation to some metabolic disorders (infantile obesity, hypernatremia), the rearing of prematures (inability to metabolize cystine, necrotizing enterocolitis), allergy in early childhood, mother-child relationships (child abuse by mother, personality development of infant), maternal disease (breast cancer, fibrocystic disease,) and possible effects in later life (atheroma).

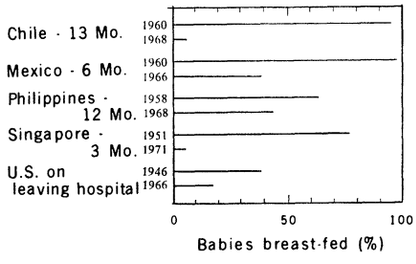


Fig. 6. Extent of breast feeding in selected countries, 1946 to 1966. Recent information suggests the increasing incidence of breast feeding commencing in the middle-class educated women in the United States, Australia, Norway, and other European countries. [Source: original references in Berg (*18*)]

Fig. 7. Commercial advertising. One major factor in the decline in lactation in poorer communities in developing countries is the forceful and unrealistic advertising of unaffordable formulas by modern motivational techniques. Cartoon by Richard Wilson satirizes this widespread situation. [Source: *Pan/Oxfam* (newspaper of the World Food Conference, Rome), 4 November 1974]

Conclusion

In developing countries, many approaches to community problems of pediatric nutrition and to food supply in general have been narrow, unrelated to cultural practices, and dependent for continuity on complicated interrelationships of politics, economics, and world trade. They have had little relationship to local needs or existing feeding patterns. A classic instance was the widespread distribution of dried skimmed milk in the decades following World War II. Likewise, the obvious need for child spacing and family planning is usually considered too much in terms of motivation and effective delivery of technological devices.

All approaches of potential value to the solution of these complex world problems are needed. However, there is a need for greater emphasis on breast feeding as a means of economically supplying the specific nutrients required for the young infant, with simultaneous biological contraception and free oral immunization and chemoprophylaxis.

There is an urgent need to develop the conceptual flexibility to search for compromises between technological and biotraditional methods (*25*). In the present context, infant feeding programs can be based on breast feeding and domestic weaning mixtures (*2*) derived from traditional foods, together with supplementary foods, when indicated; contraception can be based on breast feeding together with the use of culturally and economically appropriate technical methods that offer least interference with lactation.

Programs to improve the nutrition of young children will be related to many activities, including increased agricultural production of nutritionally relevant foods, family economic betterment, and the development of adaptive maternal and child health services. The latter should encompass simple surveillance by serial body measurements, prevention and therapy of infections contributing to malnutrition, the availability of low-cost weaning mixtures (as needed for the local situation),

appropriate child spacing, and health education. Human milk and breast feeding deserve to be recognized as vital components of such programs with profound nutritional, anti-infective, economic, and contraceptive significance.

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Nutrition and Infection in National Development

Michael C. Latham

Why is it that the case fatality rates from measles are often 200 times higher in poor developing countries than in the industrialized countries? The main reason is that the malnourished child is often overwhelmed by the infection whereas the well-nourished child can combat it and survive.

Why is it that so many cases of kwashiorkor develop following an infectious disease and so many cases of nutritional marasmus following gastroenteritis? It is well established that infections result in increased nitrogen loss and that diarrhea reduces the absorption of nutrients from the intestinal tract.

Nutritional status thus has an effect on infections, and infections have an effect on malnutrition. These are most important relationships. In developing countries communicable diseases are extremely prevalent and are a major cause of morbidity and mortality, just as they were in Europe and North America at the turn of the century. The majority of children in most developing countries suffer from undernutrition and malnutrition at some time in the first 5 years of life. The problems of infection and malnutrition are closely interrelated (*1*). Yet we tend to introduce, quite independently, programs to control communicable diseases and other efforts to improve nutrition. It would be much more efficient and effective if the twin problems were attacked together. Success in improving the health and reducing the mortality of children is dependent both on control of infectious diseases and improvements in their food intake. It would be beneficial if these were combined with family planning programs. There is increasing evidence to suggest a greater willingness of parents to control their family size when the chances are good that most children born will survive into adulthood. Consideration needs also to be given to providing a stimulating environment for the growing child. The situation in the major industrial cities of Europe and North America 75 years ago was comparable to that in the poorest developing countries today. In New York City in the summer months of 1892, the infant mortality rate was 340 per 1000, and diarrhea accounted for half these deaths (*2*). Improvements in nutrition by the use of milk stations and other means and a reduction in infectious disease served to lower these mortality rates by half in a period of less than 25 years. At the turn of the century in Britain, rickets, combined with infectious diseases, was taking a heavy toll in the insanitary, smoky slums of the industrial cities, and measles was very often a fatal disease among children of poor families, presumably because of poor nutrition (*3*).

The so-called synergistic relationship between malnutrition and infectious diseases is now well accepted, and has been conclusively demonstrated in animal experiments (*4*). The simultaneous presence of both malnutrition and infection will result in an interaction with consequences for the host more serious than the additive effect of the two working independently. Infections make malnutrition worse and poor nutrition increases the severity of infectious diseases.

In experimental animals the interaction between nutrition and infection may not always be synergistic, and at times the reverse situation, known as antagonism, is seen. This occurs in animals with certain severe experimentally induced nutritional deficiencies, in which some infections (especially with certain rickettsiae and viruses) have a less severe effect than in a well-nourished animal. In these cases, the host's poor nutritional status presumably provides an unfavorable environment for the particular organism.

This type of antagonism has not been demonstrated to be of clinical importance in humans, and it is believed to occur rarely if at all. In man, synergism, rather than antagonism, appears to be much more common, especially in relation to the important communicable diseases of childhood and to protein-calorie malnutrition, which is our main concern here.

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