

Repercussions of Lactation on Nutritional Status of Mother and Infant

J.-P. HABICHT, H. DELGADO, C. YARBROUGH and R. E. KLEIN

Institute of Nutrition of Central America and Panama (INCAP), Guatemala

Knowledge about the nutritional repercussions of lactation is important to formulate recommendations about breast-feeding or artificial-feeding practices. From this point of view, the protein-calorie nutritional repercussions are the most important, and I will focus on these aspects. Recent reviews [HARFOUCHE, 1970; JELLIFFE and JELLIFFE, 1971] have dealt with other effects of human lactation on the well-being of mother and child. Thus, I will not talk about vitamin and mineral nutrition, which also affect, importantly, advice about the introduction of ancillary foods. Finally, I would like to illustrate here that 'best' lactation practices depend as much upon socio-economic constraints as they do on biological truth.

From the point of view of protein-calorie nutrition, there is no doubt that mother's milk may be adequately substituted by other foods during infancy [LEVIN *et al.*, 1959]. This fact is the economic basis of the infant formula industry. Thus, the nutritional value of breast milk over formula feeding is usually not invoked to encourage breast-feeding in wealthy areas. Rather, the recent increased breast-feeding found in the upper classes of developed countries is due to a belief that it is psychologically more beneficial to both mother and child [NEWTON, 1971], and that mother's milk has health-promoting factors not found in human breast-milk substitutes [MATA and WYATT, 1971; BULLEN *et al.*, 1972].

On the other hand, prolonged breast-feeding was the only form of infant feeding until recently, and proved completely adequate for the preservation of the species. Further, it is still the most prevalent method in the world.

Thus, we have conflicting evidence about the need for breast-feeding. The question that we face today is whether this prolonged breast-feeding should be encouraged or should we be encouraging early weaning and the

use of breast milk substitutes. In practice, we must examine women in different environments to elucidate these questions.

If the mother is a wage-earner and continued work precludes breast-feeding, it appears that weaning is economically desirable when the increment in family income due to the mother's return to work is greater than the cost for infant care and feeding. In Guatemalan extended families, where the incremental cost for infant care is small, the break-even point will be when 30 c/day can be devoted to infant feeding (table I). This is about 10 *times* the cost of mothers' milk, if the protein and calories in the breast milk are derived from tortillas¹. The disproportionally great expense of artificial feeding is, however, of indifference to the wage-earning mother, because earnings in excess of the break-even point for adequate nutrition of her infant can be applied to better her own and the family's nutrition.

By not including maternal nutrients converted to breast milk in the calculations, and by rounding upwards in the estimates of table I, I have tended to overestimate the break-even point. In Guatemala City, most jobs in which women cannot breast-feed at the same time pay more than \$9 take-home salary per month. I would presume that similar analysis of food costs and salaries in other countries would reveal that, where opportunities for cash employment exist, the economic pressures will favor artificial infant feeding in the poorer levels of society. In fact, DUGDALE [1970], in Malaya, has shown that wage-earning non-lactating mothers manage to have better-fed babies than those mothers who forego earning wages and stay at home to breast-feed their infants. I fear that, in these families, the psychological benefits from breast-feeding and the health-promoting factors in mother's milk will not prevail over the above economic considerations. If these facts are correct, maybe we should devote more energy to developing cheaper, more hygienic, infant artificial-feeding methods, and teaching these mothers how to use these methods. Indeed, recent reports of major deterioration in infant health due to bottle-feeding come from studies on people in underdeveloped areas, such as those of MAYNARD and HAMMES [1970] in Eskimos and of GRANTHAM-MCGREGOR and BACK [1970] in Jamaica, while more developed areas show no such difference, i.e., Italy [CRISTIANINI and DE GRESS, 1970] and Czechoslovakia [KUBÁT *et al.*, 1970]. This probably reflects inappropriate bottle-feeding practices in the underdeveloped areas, more than an innate superiority of the breast over the bottle.

1 Six 'tortillas', at 50 g each, cost 3 c and contain (FLORES *et al.*, 1971) about 590 calories and 12.6 g of protein (NPU = 50), which are about the correct proportion [THOMSON *et al.*, 1970] for 800 ml of milk.

Table I. Cost of breast-milk substitution

<i>Capital costs amortized over a year:</i>		Cost/day
Thermos bottle, 1 l	\$ 4.00	2 c
8 glass bottles with nipples	\$ 2.00	2 c
<i>Running costs:</i>		
1 glass bottle breakage/month	25 c/month	1 c
Heat for bottle sterilization and infant food preparation (gas or firewood \times 1 h/day)		10 c
<i>Breast-milk substitutes:</i>		
Incaparina (2 c) + sugar (2 c)	4 c	
Powdered milk (13 c) + sugar (2 c)	15 c	4 c–21 c
Commercial infant formula	21 c	
Total		17 c–34 c/day

The next question is, if it is not cost-effective to wean to earn wages, how long should one breast-feed? From the point of view of infant growth, this depends upon the proportion of protein to calories in his supplementary foods, and the cost of these foods. At one extreme are the conditions where the staple is maize and black beans, such that the proportion of protein (corrected for biological value of 100) to calories is 1.3 g/100 calories, while human milk is almost 2 g/100 calories. Adults can burn-off enough calories so that the protein concentration of corn alone is sufficient to cover their protein requirements if all their calories come from corn, while for young children this is not possible [ARROYAVE, 1972].

In non-Indian villages studied at INCAP, protein is the limiting nutrient in 2-year-olds because, when protein is supplemented to the diet, these children grow normally [HABICHT *et al.*, 1972 a, b]. Further evidence of deficient protein nutrition is seen in that variations in protein intake, reflected by the urinary urea/creatinine ratio, are negatively correlated with the WHITEHEAD [1964] amino acid ratio in the sera (fig. 1). In lactating women, on the other hand, increment of protein ingestion does not improve this WHITEHEAD amino acid ratio (fig. 1), indicating that protein is not a limiting nutrient for lactating women, even though the protein concentration of the diet is the same as that of the children.

Further, on a similar diet, these women when they were pregnant had as

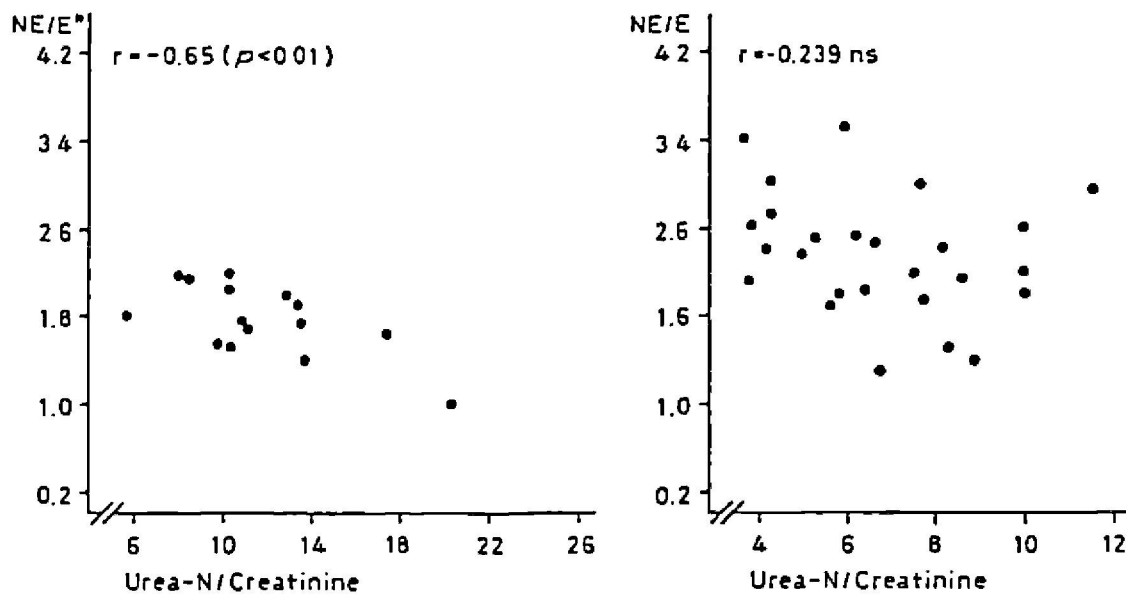


Fig. 1. Association between plasma aminoacid ratio and urinary urea creatinine ratio in 2-year-old children (*left*) and lactating mothers (*right*). *Non-essential/essential as per WHITEHEAD [1964].

their limiting nutrient, calories [LECHTIG *et al.*, 1972 b]. A similar demonstration for lactating women would lead one to conclude that lactating women efficiently concentrate protein. Thus, under these circumstances, when weaning foods are low in protein, children should breast-feed for as long as possible, certainly beyond 2 years.

While the evidence for inadequate protein nutrition in 2-year-olds of these INCAP study villages is clear, the weight gain of breast-fed children is not greater than that of weaned children during the second year of life (fig. 2). Indeed, all are growing inadequately after 6 months of age. Does this mean that from 6 months through weaning calories are the limiting nutrient? If so, this would re-emphasize the importance of introducing new supplementary foods by 4 months, so that by 6 months these supplementary foods are covering the caloric deficit which we suspect appears shortly thereafter in children who only suckle. This universal recommendation for the introduction of supplementary foods should, however, not be misinterpreted, as it often is as an exhortation to cease breast-feeding before 6 months. Further, it is clear that breast-feeding alone is completely adequate for most infants up to 3 months. In these rural villages, our recommendation would be to continue breast-feeding for as long as possible, but to begin adding new foods before the middle of the first year of life.

Thus, for mothers of equally low socio-economic levels, we have two

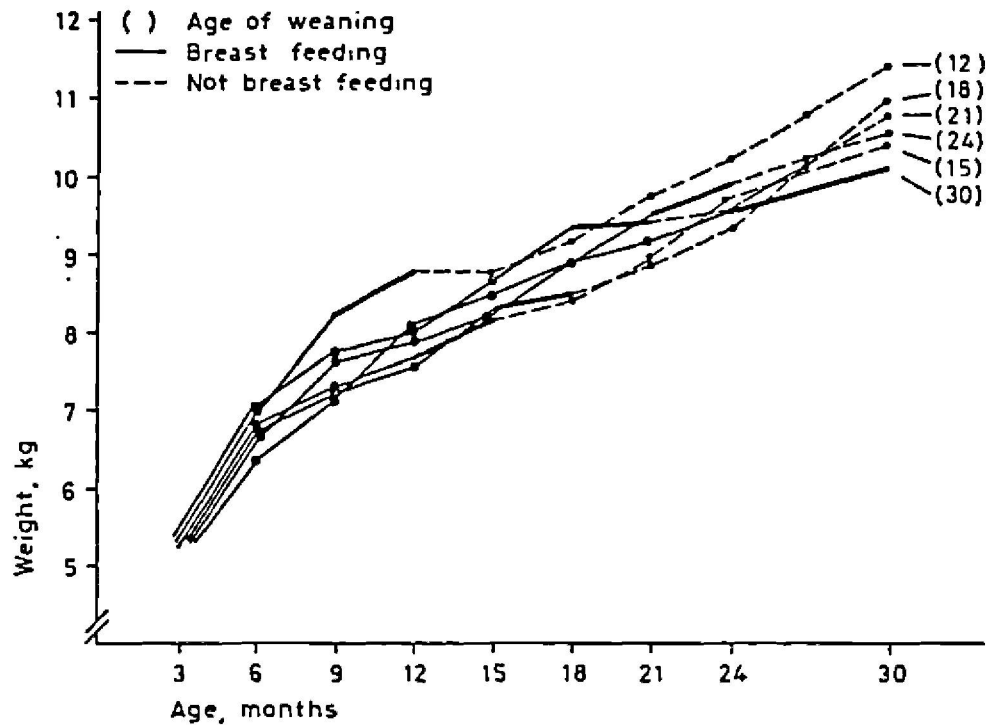


Fig. 2. Weight of children during and after breast-feeding.

opposite recommendations about prolonged breast-feeding, depending upon whether they can or cannot increase the family nutrient intake by entering the wage market.

What about our recommendation to mothers who are so well-off that taking a job would have no effect on the family nutrient intake? For such women, the marginal increase for their babies in psychological and physical health, as already mentioned, would counsel breast-feeding.

A further consideration in well-to-do families is that overfeeding during the first 6 months of life promotes fat-cell proliferation, which does not occur later [BROOK *et al.*, 1972] and which possibly increases the risk of being obese as an adult, a risk which is itself detrimental to adult health. Excessive caloric intake would appear more likely during artificial – than during breast-feeding. If studies reveal that breast-feeding during the first 6 months of life significantly reduces the risk of obesity during adulthood, this would militate strongly for breast-feeding among the well-to-do. A similar beneficial effect of breast-feeding on cholesterol metabolism and arteriosclerosis has been proposed, but not yet substantiated.

We have so far only considered the benefits of breast-feeding on the infant. Much less is known about the nutritional effects of lactation on the mother. It can be shown that most lactating mothers lose weight during

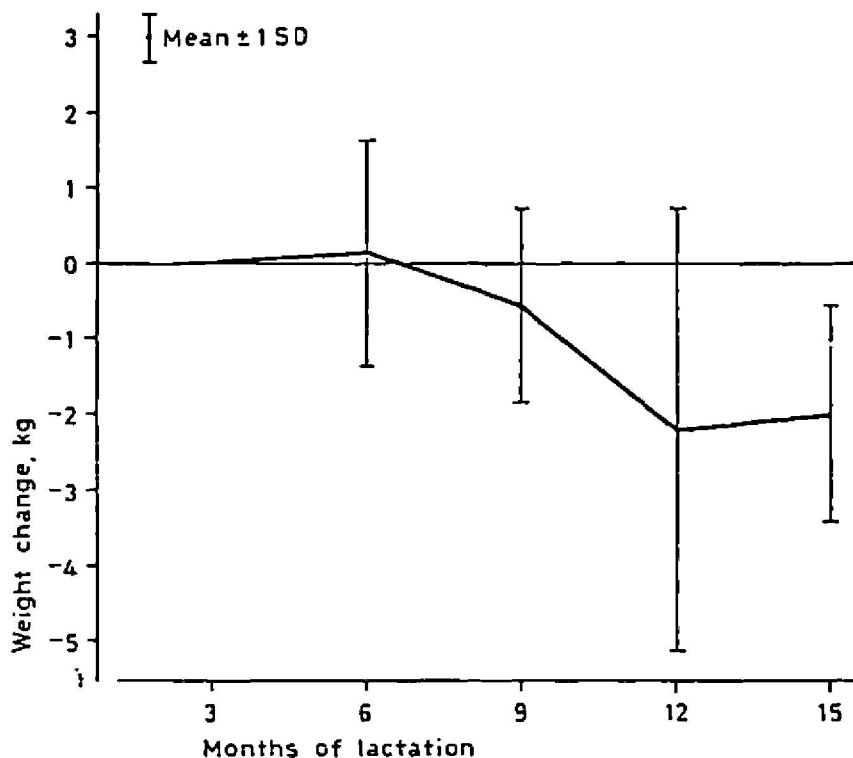


Fig. 3. Longitudinal weight changes of mothers during lactation.

lactation (fig. 3). The time span of observation in the mother should, however, extend from her conception with this child to the conception of the next child, for one to be able to make inferences about the beneficial or detrimental effects of lactation on the mother. It may well be that there is a physiological cycle in weight gain and loss (fig. 4), such that a substantial weight loss during lactation is normal, even to the extent that the mother's weight may be lower for a few months than it was at conception.

Thus, lactation may play a part in the weight homeostatic mechanism to be recommended to well-fed women who can afford the convenience.

For less well-fed mothers, the best indication that lactation has no serious long-term detrimental effect on the mother's nutritional status in these INCAP study populations is found in the fact that, unless the birth interval is shorter than 18 months, we see no relationship of birth interval with birthweight (LECHTIG *et al.*, 1972 b), even though the median length of lactation is 19 months:

One could, however, imagine that at inadequate nutrient intakes the mother is parasitized by her suckling child. Preliminary data on our population suggest that, at a certain weight deficit, breast-feeding ceases (fig. 5). If this finding replicates in longitudinal data, the infant would suffer more

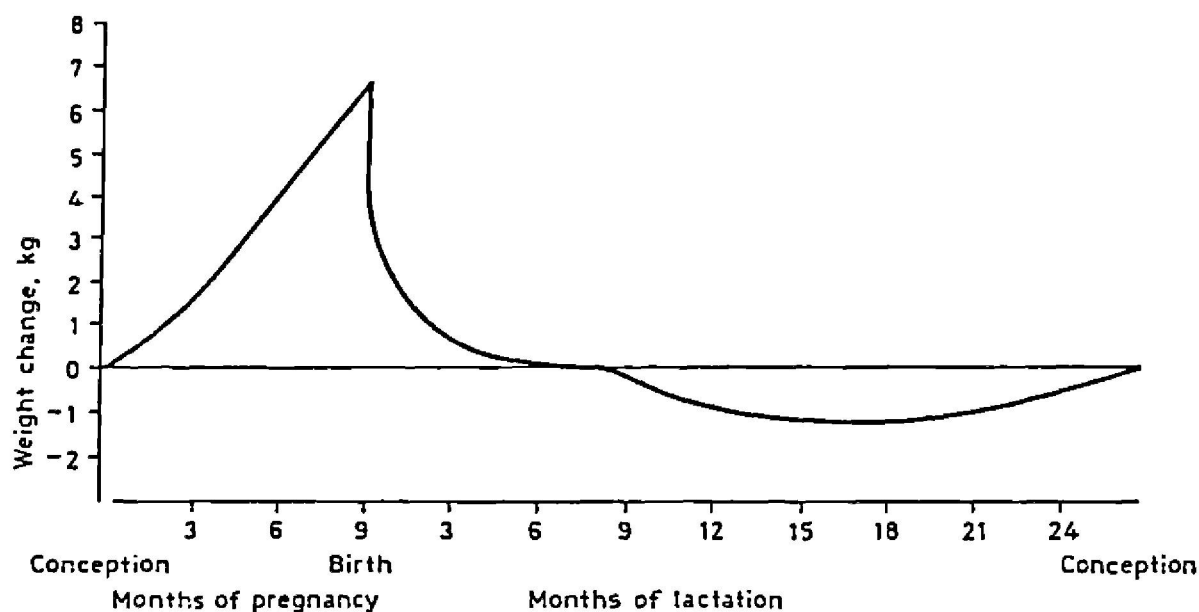


Fig. 4. Hypothetical cyclic weight changes of mothers between conceptions.

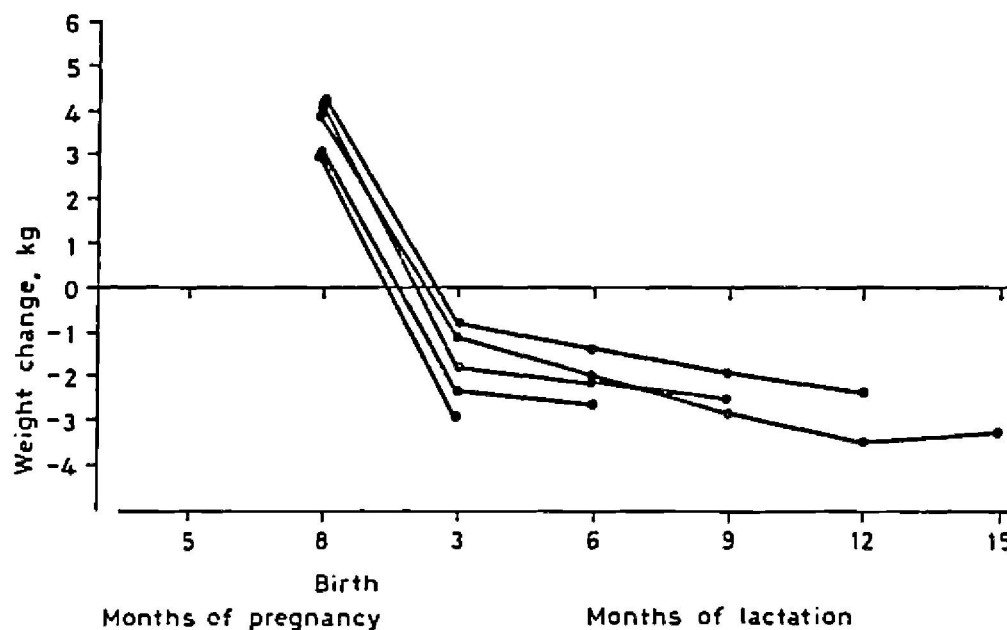


Fig. 5. Semi-longitudinal weight changes in pregnant and lactating women from fifth month of pregnancy.

from inadequate maternal nutrition than the mother. At any rate, in such circumstances, one can hardly counsel weaning when the family nutrient intake is so low that it is unlikely that the family could afford an adequate substitute for breast milk. There remains in such cases no adequate recourse except supplementary feeding to the mother, or the prevention of that child-birth to begin with.

This brings us to a most important benefit of lactation in underdeveloped areas, where modern family planning methods are lacking. In practice, one finds in both developed [GIOISA, 1955; SALBER *et al.*, 1965] and underdeveloped countries [BONTE and VAN BALEN, 1969; PÉREZ *et al.*, 1971; WYON and GORDON, 1971; HINSHAW *et al.*, 1972] that the average onset of ovulation or menstruation is delayed about 1 month for each 2 months of lactation after a first 6-weeks' sterile post-partum period. While this is not an effective birth prevention method, especially on an individual basis, it does promote longer birth-spacing intervals in those populations which practice extended breast-feeding. This is particularly important, because short birth-spacing intervals appear to be nutritionally detrimental [ST. GEORGE *et al.*, 1970; LECHTIG *et al.*, 1972 a] to the mother, as judged by diminished birth weight of her infant whether she lactates or not.

To conclude, we would advise prolonged breast-feeding whenever it is economically feasible; for the well-to-do mother for 6 months, and for the less well-to-do for as long as possible. Emphasis on the introduction of supplementary foods as of 3 months is also of vital importance.

References

- ARROYAVE, G.: Nutritive values of dietary proteins, for whom? IX Congreso Internacional de Nutrición, México, September 3-9, 1972.
- BONTE, M. and VAN BALEN, H.: Prolonged lactation and family spacing in Rwanda. — *J. biosoc. Sci.* 1: 97-100 (1969).
- BROOK, C.G.D.; LLOYD, J. K., and WOLF, O. H.: Relation between age of onset of obesity and size and number of adipose cells. *Brit. med. J.* 2: 25-27 (1972).
- BULLEN, J. J.; ROGERS, H. J., and LEIGH, L.: Iron-binding proteins in milk and resistance of *Escherichia coli* infection in infants. *Brit. med. J.* 1: 69-75 (1972).
- CRISTIANINI, G. and DE GRESS, E.: Nutrition and growth of children in a province of Gorizia. *Minerva pediat.* 22: 359-361 (1970).
- DUGDALE, A. E.: Breast feeding in a South East Asian city. *Far East med. J.* 6: 230-234 (1970).
- FLORES, M.: MENCHÚ, M. T., y LARA, M. Y.: Valor nutritivo de los alimentos para Centro America y Panamá. INCAP, Guatemala: 18 p. (1971).
- GIOISA, R.: Incidence of pregnancy during lactation in 500 cases. *Amer. J. Obstet. Gynec.* 70: 162-174 (1955).
- GRANTHAM-MCGREGOR, S. M. and BACK, E. H.: Breast feeding in Kingston, Jamaica. *Arch. Dis. Child.* 45: 404-409 (1970).
- HABICHT, J-P.; LECHTIG, A.; YARBROUGH, C., and KLEIN, R. E.: The timing of the effect of supplementation feeding on the growth of rural preschool children. IX Congreso Internacional de Nutrición, México, September 3-9, 1972a.

- HABICHT, J.-P.; SCHWEDES, J. A.; ARROYAVE, G., and KLEIN, R. E.: Biochemical indices of nutrition reflecting ingestion of a high protein supplement in rural Guatemalan children. *Amer. J. clin. Nutr.* (in press, 1973).
- HARFOUCHE, J. K.: The importance of breast-feeding. *J. trop. Pediat.* 16: 133-175 (1970).
- HINSHAW, R.; PYEATT, P., and HABICHT, J.-P.: Environmental effects on child-spacing and population increase in Highland Guatemala. *Curr. Anthropol.* 13: 216-230 (1972).
- JELLIFFE, D. B. and JELLIFFE, E. P. F.: The uniqueness of human milk (Symposium). *Amer. J. clin. Nutr.* 24: 967-1024 (1971).
- KUBÁT, K.; KOURCIN, J., and SYROVÁTKA, A.: Relation of breast feeding to body growth and to acute disorders in children 6 years old studied for a long period. *Ces. Pediat.* 25: 547-550 (1970).
- LECHTIG, A.; HABICHT, J.-P.; GUZMÁN, G., GIRÓN, E. M.: Influencia de las características maternas sobre el crecimiento fetal en poblaciones rurales de Guatemala. *Arch. latino-amer. Nutr.* 22 (1972)a.
- LECHTIG, A.; HABICHT, J.-P.; YARBROUGH, C.; DELGADO, H.; GUZMÁN, G., and KLEIN, R. E.: Influence of food supplementation during pregnancy on birth weight in rural populations of Guatemala. IX International Congress of Nutrition, Mexico, September 3-9, 1972b.
- LEVIN, B., MACKAY, H. M. M.; NEILL, C. A.; OBERHOLZER, V. G., and WHITEHEAD, T. P.: Weight gains, serum protein levels, and health of breast fed and artificially fed infants. Med. Res. Council, Special Report Series No. 296. (Her Majesty's Stationery Office, London 1959).
- MATA, L. J. and WYATT, R. G.: Host resistance to infection. *Amer. J. clin. Nutr.* 24: 976-986 (1971).
- MAYNARD, J. E. and HAMMES, L. M.: A study of growth, morbidity and mortality among Eskimo infants of Western Alaska. *Bull. wld Hlth Org.* 42: 613-622 (1970).
- NEWTON, N.: Psychologic differences between breast and bottle feeding. *Amer. J. clin. Nutr.* 24: 993-1004 (1971).
- PÉREZ, A.; VELA, P.; POTTER, R., and MASNICK, G. S.: Timing and sequence of resuming ovulation and menstruation after childbirth. *Population Studies* 25: 491-503 (1971).
- SALBER, E. J.; FEINLEIB, M., and MACMAHON, B.: The duration of postpartum amenorrhea. *Amer. J. Epidem.* 82: 347-358 (1965).
- ST. GEORGE, J.; ST. JOHN, E. H., and JOSA, D.: Factors influencing birth weight in normal pregnancy. *J. trop. Pediat.* 16: 93-102 (1970).
- THOMSON, A. M.; HYTTEN, F. E., and BILLEWICZ, W. Z.: The energy cost of human lactation. *Brit. J. Nutr.* 24: 565-572 (1970).
- WHITEHEAD, R. G.: Rapid determination of some plasma amino acids in subclinical kwashiorkor. *Lancet* i: 250-260 (1964).
- WYON, J. B. and GORDON, J. E.: The Khana study. Population adaptation in rural Punjab, India. (Harvard University Press, Cambridge, Mass. 1971).

Author's address: Dr. JEAN-PIERRE HABICHT, Head, Biomedical and Epidemiological Section, Division of Human Development, Institute of Nutrition of Central America and Panama, P.O. Box. 1188, Guatemala (Guatemala)