LACTATION IN RURAL GUATEMALA: Nutritional Effects on the Mother and the Infant

Hernán L. Delgado, Víctor Valverde, and Elena Hurtado
Food and Nutrition Planning Division, Institute of Nutrition of Central America and Panama (INCAP), Guatemala City, Guatemala

INTRODUCTION

Considerable knowledge is available on the nutritional advantages (1-4) and immunological protection provided by breast milk (5-9), the psychological benefits of breast-feeding (10-11), the relationship of breast-feeding and suckling practices to reproductive endocrinology and the social and health consequences for the family and the community of close birth intervals (12-15).

Prolonged breast-feeding has been the only means of infant feeding until recently in poor socio-economic groups of developing countries, and it is still the most prevalent infant-feeding method in the world (16). Nevertheless, there is an obvious trend towards decreased breast-feeding throughout the underdeveloped countries of the world, especially in urbanizing areas. Socio-economic development, rapid urbanization, and participation of women in the work force have all been cited as possible causes for this trend. In addition, the promotion of infant foods and the absence of a firm stand in favour of breast-feeding by the health professionals may also be responsible for this trend (16).

This paper presents information on the related issues of lactation, breast-feeding, infant nutrition, and maternal nutritional status during lactation on the basis of data from a rural Guatemalan sample.

EXPERIMENTAL DESIGN AND SUBJECTS

The data presented here are drawn from a large longitudinal study of the effects of mild to moderate malnutrition on physical growth and mental development. This research was conducted in four poor rural Ladino* villages in eastern Guatemala (17). The total population in the four villages was 3,359 in 1975.

The residents in two of the villages received a high-protein high-calorie supplement called *atole* (6.4 g of protein and 91 calories per 100 ml), while the residents in the two other villages received a low-calorie supplement called *fresco* (no protein and 33 calories per 100 ml). In addition, all four villages received preventive and curative medical care services from auxiliary nurses under the supervision of a physician.

Longitudinal collection of nutritional, socio-economic, health, and demographic data on the population began in early 1969. The present paper uses a subset of the study sample comprising all mothers who gave birth between January 1969 and February 1977 and their children up to one year of age. During this period, 1,106 live births occurred in the four study villages. The following data were recorded as described:

The duration of lactation was determined prospectively by monitoring lactation every 14 days in all women in the study population. The length of lactation was defined as the interval (in months) between a birth date and weaning.

Maternal and infant body measurements were obtained at regular intervals (every three months during pregnancy and lactation and at birth, 15 days, and 3, 6, 9, and 12 months of the child's age) by personnel using carefully standardized procedures and calibrated scales. This report presents information on maternal and infant weight and height. In addition, standardization for skeletal size is calculated by multiplying an individual's weight by hp/h, where hp is the age-specific mean height in the population and h is the individual's height.

Supplement intake is expressed in terms of calories, because the usual dietary intake in these villages appeared to be more limited in calories than in proteins. Information on home diet was obtained through a 24-hour-recall survey

This study was supported by contracts 1-R01-HD 12631-01 and N01-HD-5-0640 from the National Institute of Child Health and Human Development, National Institutes of Health, Bethesda, Md., USA, and by contract AID 569-01-04-6-00-1037-03 (Amendment No. 3).

* "Ladinos" are members of the Guatemalan population who speak Spanish and engage in the general social customs of the national Guatemalan society. They contrast with Indian descendants of the Mayan cultural heritage who remain both linguistically and culturally distinct from Ladinos.

conducted once each trimester of pregnancy and was summarized as the mean home-caloric intake for the last two trimesters of pregnancy. After March 1974, dietary recall information was also collected monthly for lactating women and infants. The infants' dietary data did not include measurements of breast-milk intake. After March 1974, however, quarterly information on the frequency of suckling was collected.

Information was obtained on *maternal morbidity during pregnancy and lactation and child morbidity* through fortnightly surveys. The survey was symptom-oriented and utilized retrospective home interviews of mothers. For these analyses, a morbidity indicator combining the percentage of time ill with diarrhoea and other common illnesses is used as a proxy for maternal and child morbidity.

Finally, *other variables,* including obstetrical experience, family socio-economic status, and father's age and height, are also utilized in the analyses.

RESULTS AND DISCUSSION

Table 1 presents the mean daily total energy and protein intake, that is, the sum of home dietary intake and food supplementation for the mother during pregnancy and lactation and for the infant under one year of age, breast milk not included. The energy and protein requirements considered adequate for a moderately active person (18) are also shown in table 1. The data suggest that, for mothers during pregnancy and lactation, energy is more likely than protein to be limiting in the diet of this sample. On the other hand, the likelihood of the diet's becoming protein-deficient increases during the first months of lactation.

Energy and protein intakes and requirements for infants during the first year of life present a much more complicated issue, since there are no direct estimates of breast-milk ingestion for this sample. Nonetheless, it is useful to review the available information on breast-feeding and lactation in these communities because these data provide powerful inferential tools.

Patterns of Lactation and Factors Affecting Lactation Performance

Prolonged lactation is common among these women (17.6 ± 6.2 [S.D.] months; n = 885). There is a mean difference of 9 months between the length of lactation and the length of the entire birth interval to the subsequent delivery. This indicates that, on average, lactation is extended until or past the next conception in these women; in fact, in 50 per cent of the cases an overlapping period of pregnancy and lactation is observed. Retrospective information on all lactation periods in this population (n = 2,734 periods) indicates that, in addition to pregnancy as a reason for weaning, illness or death of the child is the cause of early termination of lactation in 11 per cent of the cases. All other reasons for weaning, such as absence of milk, advice from health personnel, illness of the mother, "bad" milk,

TABLE 1. Nutrient Intake and Recommended Intakes for Mothers and Infants

	Total Nutrient Intake				Protein Safe Levels and Energy Requirements	
	Protein		Energy			
	g/day	g/kg	kcal/day	kcal/kg	Protein, g/kg	Energy, cal/kg
Mothers						
– pregnancy (second half)	46.8 ± 13.3	0.93	1,562 ± 440	31.2	0.9	46
– lactation						
3 months	55.5 ± 21.5	1.15	1,766 ± 573	36.5	1.27	53
6 months	55.2 ± 21.8	1.16	1,764 ± 614	37.0	1.27	53
9 months	54.5 ± 21.4	1.16	1,795 ± 590	38.2	–	–
12 months	54.0 ± 22.4	1.16	1,708 ± 598	36.8	–	–
Infants						
3 months	2.3 ± 3.2	0.43	71 ± 101	13.1	2.25	120
6 months	4.0 ± 5.7	0.60	133 ± 167	20.0	1.82	115
9 months	7.1 ± 7.5	0.96	248 ± 220	33.5	1.62	110
12 months	10.9 ± 8.3	1.40	434 ± 252	55.6	1.44	105

employment of the mother, and child's refusal to breast-feed, account for less than 2 per cent each.

Other factors associated with the duration of lactation were also explored. The basic statistical method used was a multiple regression analysis (19). This procedure is based on a general linear model in which the dependent variable, duration of lactation, is assumed to result from a linear (additive) combination of some independent variables, some of which are discrete and others continuous, and the effect of random error. The independent variables were: (a) nutritional status and dietary intake of mother and infant, anthropometric measurements of mother and infant, and home caloric intake and supplemental calories to mother during pregnancy and lactation and to the infant during lactation; (b) morbidity of the mother and infant; (c) maternal characteristics — parity, birth interval, and age; (d) age and height of the father; (e) socio-economic level; and (f) the type of nutritional supplement (atole or fresco). Only 17 per cent of the total variance in the duration of lactation was accounted for by this model.

In the same multiple regression analysis, caloric supplementation ingested by the mother during the first nine months of lactation is significantly and positively associated with the length of lactation (slope* = 0.2 months of lactation per 10,000 supplemental calories, $p < .01$) (19), and caloric supplementation ingested by the infant during the same period is significantly and negatively associated with the length of lactation (slope -0.6 months of lactation per 10,000 supplemental calories, $p < .001$), after controlling for all the other independent variables. Furthermore, parity, interval from previous birth, and age of the father are significantly and positively associated with the duration of lactation. The strong intercorrelations between age of the mother, parity, and age of the father explain the association found between age of the father and duration of lactation, while the association between birth interval and lactation reflect the well-known interrelationships between birth interval, length of postpartum amenorrhoea, and duration of lactation in natural fertility populations. In the study population, portpartum amenorrhoea, the more important determinant of the length of the birth interval, has a median value of 14 months and is positively correlated with the length of lactation ($r = .58$; $p < .001$). The length of lactation, limited by the next conception and pregnancy in most cases, is therefore strongly dependent upon the length of postpartum amenorrhoea.

Finally, there is a significantly negative association between the socio-economic indicator (a standardized scale summarizing construction materials and number of rooms of the family dwelling) and the length of lactation. This relation indicates that, in spite of the relatively restricted range in socio-economic status of this population, there is a significant trend toward shorter duration of lactation among women from economically better-off families.

Breast-feeding Pattern

Breast-feeding on demand is universally practised in this population. The infant is usually put to the breast very soon after delivery and remains and sleeps by the mother's side. During the first two to three months of life, the infant's only significant source of nutrients is breast milk. Extensive ethnographic and dietary data collected on this population indicate that by the time infants are three months of age the mother introduces supplementary feeding. The supplementary foods commonly utilized at three months are water sweetened with sugar and other low-calorie beverages. By six months of age, black bean soup, corn tortillas (flat cakes prepared by boiling corn in lime water, grinding it into a dough, and cooking it on a metal or clay plate), bread, and weak coffee are introduced. These foods are, in several respects, inappropriate for infant feeding and poor substitutes for breast milk. In addition to their low nutrient content, in most cases they are vehicles for potentially pathogenic agents.

The introduction of supplementary feeding does not result in an important reduction in the frequency of suckling.

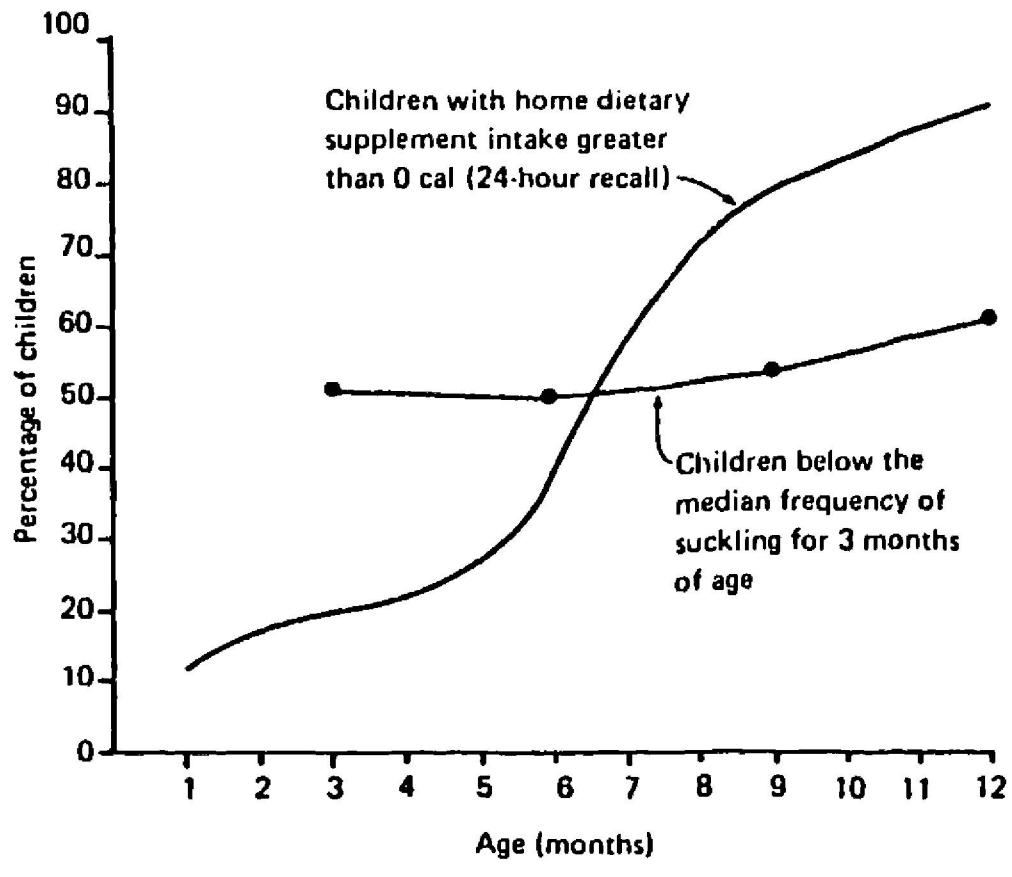

FIG. 1. Home Dietary Supplement Intake and Frequency of Suckling during the First Year of Life in Rural Guatemalan Children

* The slope of the regression line is the change in the dependent variable that corresponds to an increase of one unit in the independent variable.

As shown in figure 1, at the community level the frequency of suckling is not substantially diminished up to 12 months of age, in spite of a clear trend toward increased energy and protein intake from supplementary food at home. In addition, as presented in table 1, there is a significant increment with age in the amount of supplemental calories ingested by the infant.

By three months of age, the average infant is breast-fed 6.5 ± 0.16 (SEM) times during the day and 3.8 ± 0.15 times during the night; at six months, the figures are 6.4 ± 0.13 during the day and 3.7 ± 0.13 at night; at nine months, 6.3 ± 0.15 during the day and 3.7 ± 0.13 at night; and by 12 months, 6.0 ± 0.12 during the day and 3.7 ± 0.14 at night.

There is a very high consistency in the pattern of breast-feeding within individuals. Frequency of suckling during the day correlates significantly with frequency of suckling at night for the same infant, at ages 6, 9, and 12 months ($r = .199$, $r = .273$, and $r = .319$, respectively; in all cases $p < .001$). About 20 per cent of the mothers report that infants three months old suckle too frequently at night to accurately determine the number of times they are breast-fed. Furthermore, the total number of breast-feedings reported by a mother at any one point is significantly correlated with frequency of breast-feeding reported during the following three months (between 3 and 6 months $r = .56$, between 6 and 9 months $r = .59$, and between 9 and 12 months $r = .54$). This clearly indicates that breast milk continues to be an important source of nutrients up to 12 months of age in this population.

For the analyses of the determinants and consequences of the frequency of breast-feeding, the number of feedings in 24 hours at three and six months of age were divided into terciles. The means of a series of bio-demographic and socio-economic variables were compared for each tercile. Table 2 presents these means, standard deviations, and numbers of cases for each tercile of frequency of breast-feeding. Infants in the lower tercile at three months of age, who were breast-fed less frequently in 24 hours, had higher birth weights and higher weights and lengths at three months than those in the upper tercile. Their mothers also had greater weights after three months of lactation. Total caloric intake was also higher in the mothers and infants in the lower tercile of frequency of breast-feeding than in those in the upper tercile.

The comparison of extreme terciles by way of t-tests indicates that the differences detected in birth weight and length at three months are statistically significant. As shown in table 2, the tendencies encountered at three months of age are also found at six months, but are statistically significant only for the infant's total energy intake at six months of age. It is interesting to note that the standardized measurement of housing characteristics, which appears significantly and negatively associated with the duration of lactation, is not associated with the frequency of breast-feeding.

TABLE 2. Maternal and Infant Characteristics by Tercile of Frequency of Suckling at Three and Six Months of Age

	3 Months			6 Months		
	<8	9-11	>12	<8	9-11	>12
Birth weight	3.2 ± 0.5 (84)	3.1 ± 0.4 (72)	2.9 ± 0.4 (76)	–	–	–
Infant's weight	5.6 ± 0.9 (86)	5.6 ± 0.8 (75)	5.4 ± 0.8 (75)	7.9 ± 1.1 (103)	7.0 ± 0.9 (95)	6.7 ± 1.0 (80)
Infant's length	58.1 ± 2.5 (86)	58.2 ± 1.9 (75)	57.3 ± 2.2 (75)	63.3 ± 2.5 (101)	63.2 ± 2.2 (94)	62.9 ± 2.2 (78)
Mother's weight	49.6 ± 7.2 (88)	49.1 ± 5.8 (67)	48.6 ± 7.9 (69)	47.9 ± 7.2 (83)	48.4 ± 5.8 (84)	47.8 ± 7.6 (71)
Energy intake in 24 hours, mother	1,802 ± 490 (64)	1,823 ± 701 (53)	1,763 ± 664 (66)	1,716 ± 644 (79)	1,843 ± 631 (82)	1,679 ± 586 (74)
Energy intake in 24 hours, infant (not including breast milk)	99 ± 143 (90)	60 ± 85 (71)	71 ± 90 (76)	176 ± 201 (115)	108 ± 130 (107)	109 ± 128 (87)

Values are mean ± standard deviation.
Figures in parentheses are number of cases.

TABLE 3. Probability of Remaining Amenorrhoeic at 15 Months Postpartum by Terciles of Frequency of Suckling at 3, 6, 9, and 12 Months Postpartum

Frequency of Suckling Terciles	Months Postpartum			
	3	6	9	12
Low	0.68 ± 0.07 (62)	0.53 ± 0.07 (72)	0.55 ± 0.08 (43)	0.65 ± 0.07 (46)
Middle	0.64 ± 0.08 (51)	0.62 ± 0.07 (75)	0.63 ± 0.06 (69)	0.86 ± 0.05 (44)
High	0.52 ± 0.08 (57)	0.68 ± 0.07 (63)	0.75 ± 0.06 (65)	0.76 ± 0.06 (46)

Values are mean probability of remaining amenorrhoeic ± standard error.
Figures in parentheses are number of cases.

In analysing and interpreting these findings, it appears that one of the factors associated with the greater or lesser number of breast-feedings is the nutritional status of the mother and infant. We have postulated the role of nutrition to be as follows: Those mothers who are relatively better nourished during pregnancy and lactation produce a greater quantity of milk, which satisfies the infant's needs more readily than the milk of the more malnourished mothers. Thus, infants of better-nourished mothers obtain the quantity of milk they need in fewer breast-feedings, and possibly in less time and with less effort, than infants of more malnourished mothers. Moreover, the supplementary feeding of infants of better-nourished mothers is greater than that of infants of more poorly nourished mothers, so that the former do not depend solely on breast-milk to satisfy nutritional needs. Thus, the infants of relatively more malnourished mothers nurse more frequently in an attempt to satisfy their nutritional needs. One may speculate that if nutritional needs are not adequately satisfied, the infant becomes irritable and cries, leading the mother to put him to the breast. It is common in rural areas to find that mothers put their infants to the breast when they cry in the same way that mothers in more developed or urban areas give their infants bottles and pacifiers to calm them.

If the above interpretation of the data is correct, prolactin levels should be higher in women who are relatively more malnourished than in the better nourished ones, given that the former receive greater nipple stimulation than the latter (14, 15). This is in general agreement with recently published findings. Therefore, malnourished mothers would have higher levels of prolactin and longer periods of postpartum amenorrhoea than the well-nourished mothers, with both groups having a similar pattern of lactation.

Table 3 presents results that partially support this interpretation. As shown in this table, the length of postpartum amenorrhoea in mothers of infants with greater numbers of breast-feedings per day at 3, 6, 9, and 12 months is longer than in mothers of infants in the lower tercile of frequency of breast-feeding.

Pattern of Growth

Figures 2 and 3 present weight-by-age percentiles and length-by-age percentiles for boys and girls respectively. The National Center for Health Statistics (NCHS) standards are also included for purposes of comparison. The Guatemalan children are both lighter and shorter than NCHS children at comparable ages. There are no discernible sex differences in the pattern of growth of the Guatemalan children as compared to the NCHS children. Differences in length for both sexes between Guatemalan and NCHS samples are relatively stable from birth throughout the first year of life, while differences in weight increase gradually after three months of age. These results indicate that growth in weight is more seriously affected than growth in length in these children. The comparison of weight-for-length values of NCHS children confirms that notion. When compared to NCHS children, weight-for-length values in the Guatemalan children decrease steadily from 3 months (109.6 ± 3.8 [SEM] to 18 months of age (93.4 ± 3.6).

Although there is no information available on the amount of breast milk ingested by these infants, it is clear from table 1 that breast milk must be an important source of energy and nutrients up to 12 months of age, and maybe even longer. Based on the energy requirements per kilogram of weight and the average for different age groups in this population, it is possible to reach a gross estimate

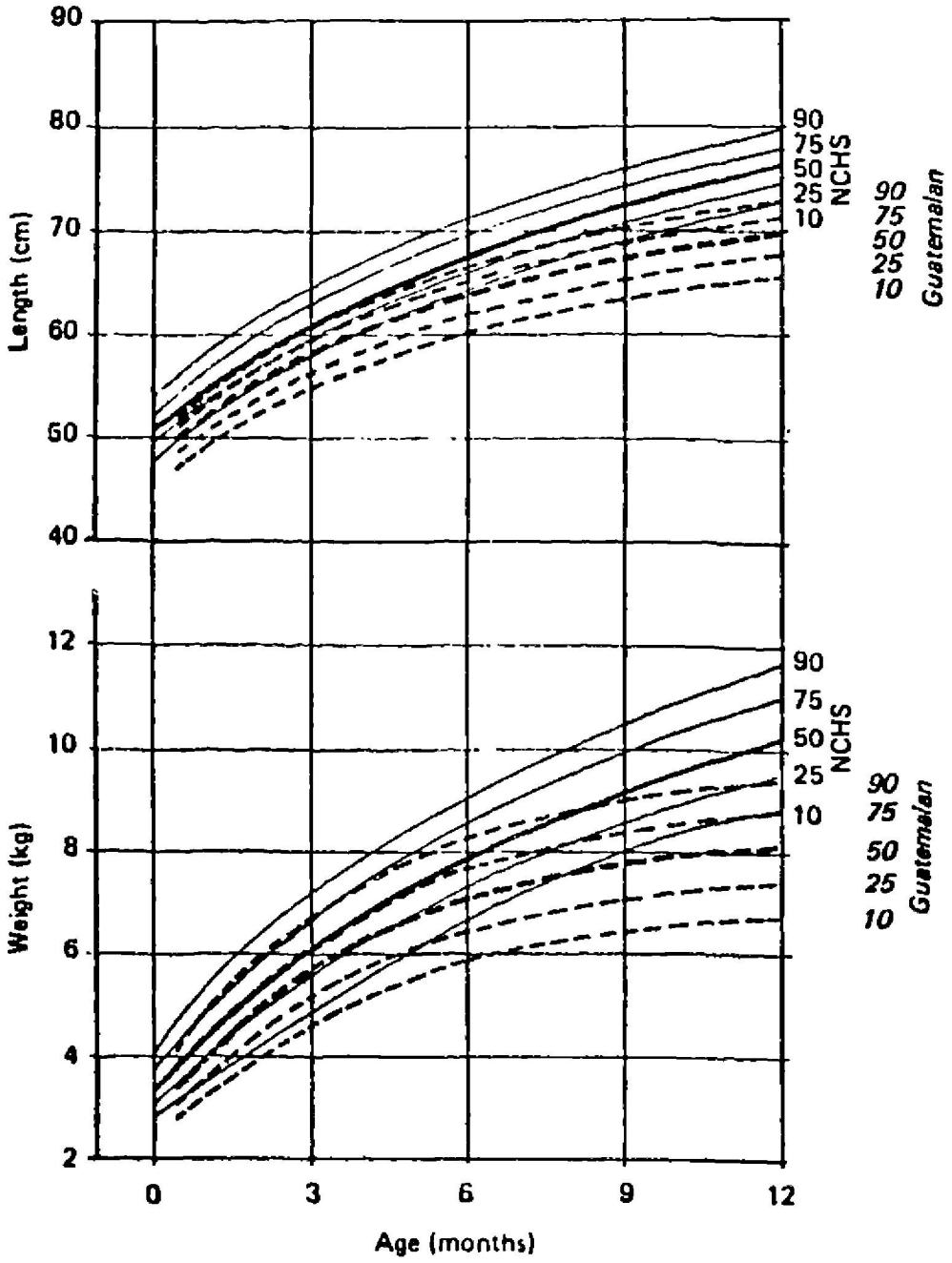

FIG. 2. Percentiles of Length and Weight for Guatemalan Boys Aged 15 Days to 12 Months Compared to NCHS Percentiles

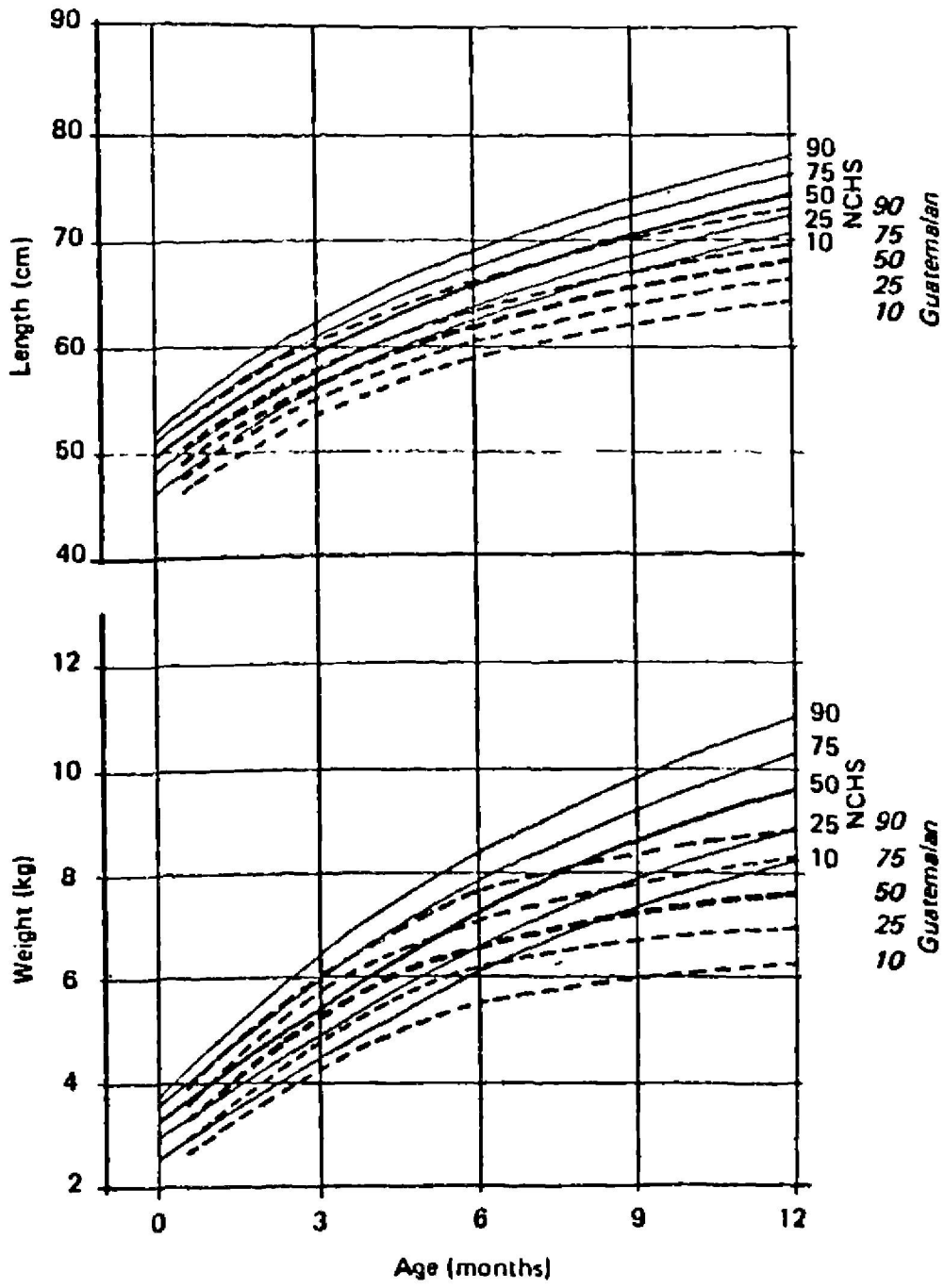

FIG. 3. Percentiles of Length and Weight for Guatemalan Girls Aged 15 Days to 12 Months Compared to NCHS Percentiles

of breast milk needed to sustain adequate growth. This estimation was made for this sample and, as also found by others (16, 20), there is an apparent discrepancy between infant growth, infant requirements, and the volume of breast milk produced by the mothers: the actual growth would demand incredibly high breast-milk outputs. We will discuss explanations for this discrepancy below.

As previously mentioned, although no information is available on breast-milk quantity in this sample, data were collected on the home dietary intake and caloric supplementation ingested by mothers during pregnancy and lactation and by the infants. In order to assess the statistical significance of each of these variables in relation to their effect on infant growth, multiple regression analyses were performed (19). In these analyses, the dependent variable was changed in either trimestral infant weight or length (0-3, 3-6, 6-9, and 9-12 months of age), and the independent variables, specific to the trimester being analysed, were caloric supplementation to the mother and to the infant and all potentially confounding factors for which data were available in this study. Furthermore, in order to control for a particular pattern of growth or nutrient intake, information on incremental weight and length and maternal and infant caloric intake for the previous trimester were also entered in the regression model. The data indicate that infant calorie supplementation before three months of age is significantly negatively associated with infant weight gain; after three months of age, supplemental calories consumed by the infant are significantly and positively associated with infant weight and length gains. In addition, a small positive association was found betwen maternal caloric supplementation during lactation and infant weight gain during the first two trimesters of life. The negative association between infant supplementation and infant growth could be due to mothers whose infants were not growing adequately beginning to give supplements to the infants earlier than mothers whose infants were growing well. On the other hand, the minimal association found between maternal

food supplementation and infant weight gain could be because the amount of caloric supplementation ingested by the mother was relatively low (about 100 calories per day) and not all this extra energy was necessarily converted to breast milk.

In spite of the diminishing contribution of breast milk to the infant's nutrient intake, lactation continues to be an important determinant of infant growth in this population up to 18 months of age. Figure 4 presents the weight-for-age adequacy of a cohort of children who were followed from birth to 24 months of age. For each semester, data on children who were still breast-feeding, who were being weaned, and who were already weaned are presented. These data show that up to 18 months of age weaned children weigh consistently less than those who are in the process of weaning, and the latter significantly less than those who continue to breast-feed. These figures also show that growth failure begins before weaning takes place, suggesting the presence of maternal and child factors that may precipitate weaning.

LACTATION AND MATERNAL NUTRITIONAL STATUS

The average daily milk production of women living in conditions similar to those of the women in the Guatemalan sample has been estimated to be approximately 600 ml (21). To produce this amount of milk, the mother would need about 530 extra kcal from food, assuming an 80 per cent efficiency of milk production (18). When the estimated extra energy needs of these women are compared with actual intake, it is clear that the estimate is incorrect, unless women utilize stored fat to subsidize their increased demands. We have previously estimated that, during pregnancy, mothers store 1.7 kg of body fat that can be mobilized later to supply a portion of the additional energy required for lactation (22). Furthermore, the anthropometric data collected during lactation indicate that mothers are losing weight, specifically fat, during the first year postpartum. As shown in figure 5, weight and anterior thigh skinfold measurements increase during pregnancy and decline to initial levels by nine months postpartum. In addition, greater fat reserves are observed in non-lactating than in lactating women (23–24).

Table 4 shows the standardized weight changes of mothers during lactation. These women lose about 2 kg of weight between three and 12 months postpartum. Between three and six months of lactation, mothers lose an average of 240 g of weight per month; after six months, the trend in weight loss is linear (207 g per month).

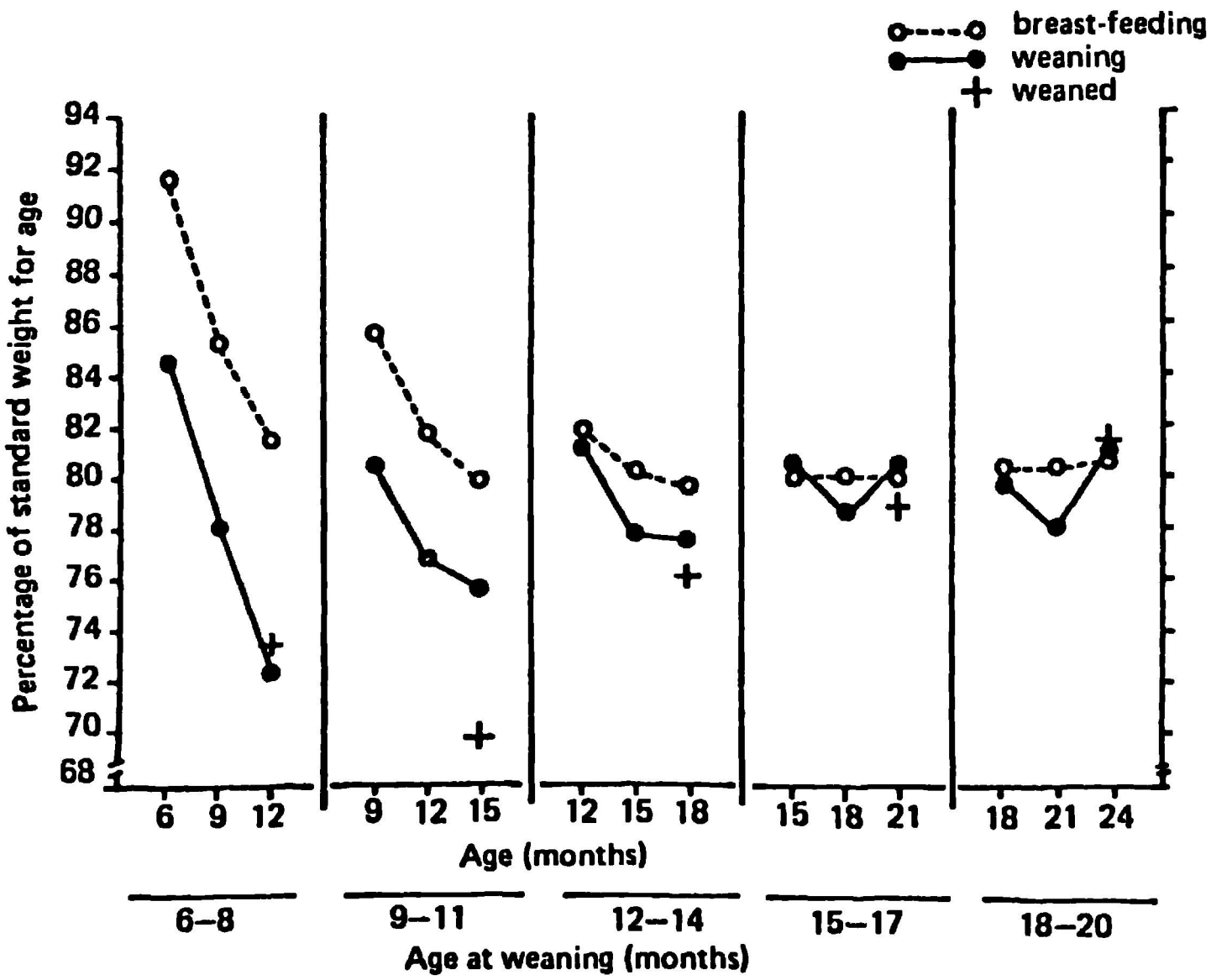

FIG. 4. Weight of Children before, during, and after Weaning Compared to NCHS References Standards

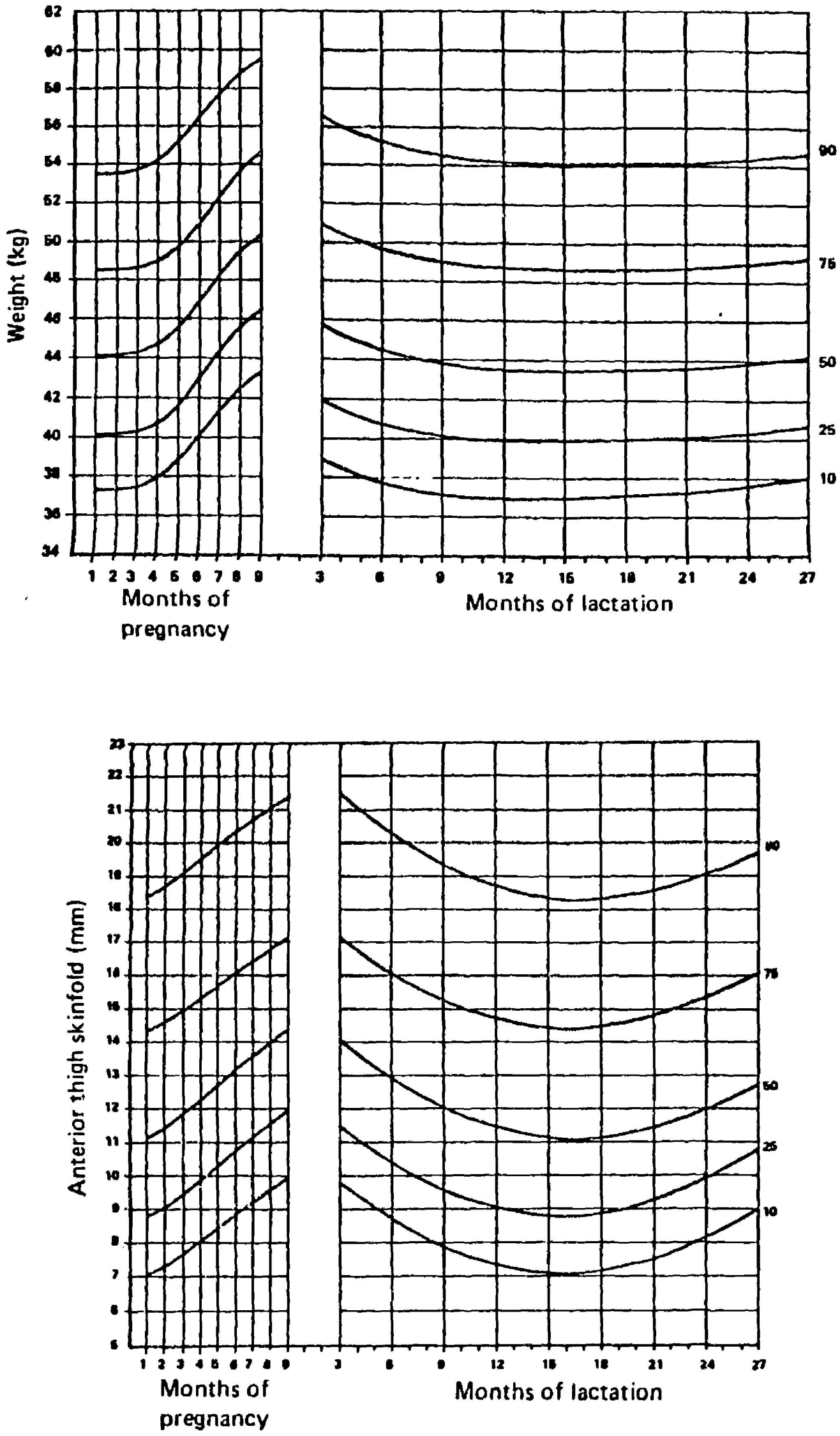

FIG. 5. Changes in Weight and in Anterior Thigh Skinfold in Guatemalan Women during Pregnancy and Lactation

TABLE 4. Standardized Weight Gain during Pregnancy and Weight Loss during Lactation

	Pregnancy			Lactation (Months)			
	First trimester	Second trimester	Third trimester	3	6	9	12
Mean weight (kg) standardized for height	47.33	49.98	53.57	48.39	47.67	47.05	46.43
± Standard deviation	±6.56	±6.24	±6.58	±6.16	±6.23	±6.27	±5.87
Change from initial weight standardized for height (kg)		+2.65	+6.24	+1.06	+0.34	-0.28	-0.90
Number of cases	265	274	400	480	496	533	552

Because non-lactating mothers do not lose significant amounts of weight and have higher fat stores than lactating women, it can be assumed that weight loss in lactating women is the result of breast-milk production. On this basis, it is calculated that weight loss (8 g per day) provides about 70 kcal/day (25), which represent about 85 ml of breast milk per day at six months of lactation. This is only about 14 per cent of the daily amount of breast milk estimated for this population. Energy for the remaining portion of breast milk, about 515 ml, must be provided by the mother's diet. However, as shown in table 1, the diet of these women is poor, in spite of an observed increase in energy and protein consumption for the period of lactation as compared with the period of gestation. Based on current knowledge, an increase of 200 calories in the mother's diet during lactation represents about 230 ml of breast milk, leaving a shortfall of 285 ml below the 600 ml breast-milk estimate.

As previously indicated, this apparent discrepancy between infant growth requirements and breast-milk output has been reported elsewhere (16, 20). In the Guatemalan sample, in addition to the quality of the data, which has proved to be highly valid and reliable, other factors need to be taken into account.

First, the possibility has been suggested that the calorie requirements for these infants may be lower than those estimated by FAO/WHO and adopted by the National Research Council (26). Fomon and May's studies of infants who were bottle-fed with breast milk estimated actual consumption to be 94 kcal/kg of weight per day between three and six months of age (27). Thus, it is possible that our estimated requirements are even higher than the actual intake of well-nourished infants. Second, and more important, only a small fraction of the energy consumed by the infant is utilized for growth after the first trimester of age (28). When caloric intake is inadequate to meet normal requirements, adaptation could be made by maintaining growth and reducing physical activity (29). Thus, it would be possible for infants consuming 80 per cent of their requirements to maintain adequate growth rates, in relation to the reference, by markedly reducing their physical activity (30). This is probably the case in most areas where malnutrition and morbidity are prevalent. Even though breast-milk consumption could be fairly adequate to meet the infant's demands for growth up to three months, and in some cases up to six months of age, there is probably a reduction in physical activity that, in itself, could affect other aspects of infant development. In fact, it is common in rural areas in Guatemala to find children developmentally retarded as manifested by delayed sitting and walking and restricted playing and social interaction patterns.

On the other hand, it is also possible that successful lactation is attainable with energy intakes less than current recommendations (31) or that mothers reduce physical activity during lactation, particularly during the first months after delivery, as a means of increasing energy for breast-milk production.

CONCLUSIONS

Infant growth is frequently used as an indicator of nutritional status of the mother, the family, and the community as a whole. This is particularly useful in rural areas of economically and technically less developed countries, where most growth retardation in children can be attributed to environmental factors (32) and where the prevalence of malnutrition in early childhood is a major health concern. In fact, several growth studies in rural areas of developing countries have shown that there is a clear tendency for children to be smaller at birth and to experience smaller gains in weight and length during the first two years of life than their well-nourished counterparts. In rural areas, breast-feeding is generally on demand and breast milk is the principal or unique source of nutrients for at least the first six months of life. The data presented here indicate that breast milk, as the only food

available to the infant, is insufficient to support adequate growth beyond three months of age. The data also suggest that insufficient energy and nutrient intake could impair normal activity even before it affects growth. This is a potentially serious problem that requires further investigation.

On the other hand, the data also show that in the poor study communities, breast-fed infants are heavier and longer than weaned infants up to 18 months of age, indicating that breast milk continues to be an important source of nutrition for these infants. In fact, it has been observed that weaning in Guatemalan children is almost always accompanied by a reduction in weight, irrespective of the age at weaning. In addition, the observation of growth failure before the beginning of weaning at younger ages is very important, as it indicates the presence of maternal and infant factors that precipitate weaning.

The Guatemalan data also show a significant positive association between infant's supplement ingestion and infant's weight and length gains after three months of age. This finding supports the hypothesis that, in this population, some form of supplementation is needed to maintain adequate infant growth.

Finally, the data indicate that maternal nutritional status is significantly positively correlated with the length of pregnancy and with birth weight (33, 34) and that improved maternal nutrition favourably affects infant growth (35). This suggests that infant growth is dependent not only on breast milk quantity and quality but also on maternal nutritional status before, during, and after pregnancy.

To recommend that maternal nutrition be improved before and during pregnancy and during lactation, that appropriate weaning foods be introduced at appropriate times, and that lactation be prolonged from three to six months is almost equivalent to recommending socio-economic development as a short-term solution for the health problems of developing countries. More realistically, public health professionals should recommend prolonged lactation on demand in rural areas because, under present circumstances, there is almost no adequate alternative for infant feeding. In this context, the exact role of nutrition education in solving the food problems of the world has recently come under the examination of nutrition and development planners everywhere. However, research on nutrition education in developing countries is extremely limited, and its efficacy in changing the nutritional status of people with limited food resources is still questionable.

REFERENCES

1. A.M. Thompson and A.E. Black, "Nutritional Aspects of Human Lactation," *Bull. Wld. Hlth. Org.*, 52: 163-177 (1975).
2. J.C. Waterlow and A.M. Thomson, "Observations on the Adequacy of Breastfeeding," *Lancet*, 1979 ii: 238-243.
3. D.B. Jelliffe and E.F.P. Jelliffe, "Adequacy of Breastfeeding," *Lancet*, 1979 ii: 691-692.
4. J.C. Waterlow, A. Ashworth, and M. Griffiths, "Faltering Human Growth in Less-Developed Countries, *Lancet*, 1980 ii: 1176-1178.
5. A.S. Cunningham, "Morbidity in Breast-fed and Artificially Fed Infants," *J. Pediat.*, 90: 726-729 (1977).
6. A.S. Cunningham, "Morbidity in Breast-fed and Artificially Fed Infants, II," *J. Pediat.*, 95: 685-689 (1979).
7. L. Hanson and J. Winberg, "Breast Milk and Defense against Infection in the Newborn," *Arch. Dis. Child*, 47: 845-849 (1972).
8. J.K. Welch and J.T. May, "Anti-infective Properties of Breast-milk," *J. Pediat.*, 94: 1-9 (1979).
9. L.J. Mata and J.J. Urrutia, "Infections and Infectious Diseases in a Malnourished Population: A Long-Term Prospective Field Study," in L. Hambraeus, L.A. Hanson, and H. McFarlane, eds., *Food and Immunity*, Swedish Nutrition Symposium XIII (Almqvist and Wiksell, Stockholm, 1977), pp. 42-57.
10. M. Klaus and J.H. Kennell. *Maternal-Infant Bonding* (Mosby, St. Louis, Mo., USA, 1976).
11. T.B. Brazelton, E. Tronick, L. Adamson, H. Als, and S. Wise, *Parent-Infant Interaction*, CIBA Foundation Symposium 33 (Elsevier, Amsterdam, 1975).
12. S.L. Huffman, "Maternal and Child Nutritional Status: Its Association with the Risk of Pregnancy," presented at a WHO/NAS workshop on Breastfeeding and Fertility Regulation: Current Knowledge and Policy Implications, Geneva, February 1982.
13. H.L. Delgado, R. Martorell, and R.E. Klein, "Nutrition, Lactation and Birth Interval Components in Rural Guatemala," *Amer. J. Clin. Nutr.*, 35: 1468-1476 (1982).
14. P.W. Howie, A.S. McNeilly, M.H. Houston, A. Cook, and M. Boyle, "Effect of Supplementary Food in Suckling Patterns and Ovarian Activity during Lactation," *Br. Med. J.*, 283: 757-759 (1981).
15. P.G. Lunn, S. Austin, A.M. Prentice, and R.G. Whitehead, "The Effect of Improved Nutrition in Plasma Prolactin Concentrations and Postpartum Infertility in Lactating Gambian Women," *Amer. J. Clin. Nutr.*, 39: 227-235 (1984).
16. D.B. Jelliffe and E.F.P. Jelliffe, *Human Milk in the Modern World* (Oxford University Press, Oxford, UK, 1978).
17. V. Mejía Pivaral, "Características económicas y socioculturales de cuatro aldeas ladinas de Guatemala," *Serie Guatemala Indígena*, vol. 7, no. 3 (Instituto Indigenista Nacional, Guatemala, 1972).
18. *Energy and Protein Requirements*, report of a joint FAO/WHO ad-hoc expert committee, World Health Organization Technical Report Series, no. 522 (WHO, Geneva, 1973).
19. N.R. Draper and S. Smith, *Applied Regression Analysis* (John Wiley and Sons, New York, 1966).
20. R.G. Whitehead, "Infant Feeding Practices and the Development of Malnutrition in Rural Gambia," *Food Nutr. Bull.*, 1 (4): 36-41 (1979).
21. A. Chávez and C. Martínez, "Effects of Maternal Undernutrition and Dietary Supplementation on Milk Production," in H. Aeby and R. Whitehead, eds., *Maternal Nutrition during Pregnancy and Lactation*, Nestlé Foundation Publication Series (1980).
22. A. Lechtig, C. Yarbrough, H. Delgado, J-P. Habicht, R. Martorell, and R.E. Klein, "Influence of Maternal Nutrition on Birth Weight," *Amer. J. Clin. Nutr.*, 28: 1223-1233 (1975).
23. J-P. Habicht, H. Delgado, C. Yarbrough, and R.E. Klein, "Repercussions of Lactation on Nutritional Status of Mother and Infant," in *Proceedings of the IX International Nutrition Congress* (Mexico City, 1972), vol. 2, p. 106.
24. B. Newman, H. Delgado, R. Martorell, and R.E. Klein, "Maternal Anthropometric Changes during Pregnancy and

Lactation in Rural Guatemala," *Amer. J. Phys. Anthropol.*, 52: 261-262 (1980).
25. F.E. Hytten and I. Leitch, *The Physiology of Human Pregnancy*, 2nd ed. (Blackwell Scientific Publications, Oxford, UK, 1972).
26. National Academy of Sciences–National Research Council, *Recommended Dietary Allowances*, 8th ed. (National Academy Press, Washington, D.C., 1980).
27. S.J. Fomon L.J. Filler, T.A. Anderson, and E.E. Ziegler, "Pediatrics for the Clinician: Recommendation for Feeding Normal Infants," *Pediatrics*, 63: 52-59 (1979).
28. R.L. Bergman K.E. Bergman, "Nutrition and Growth in Infancy," in F. Falkner and J.M. Tanner, eds., *Human Growth*, vol. 3 (Plenum Press, New York, 1979), pp. 331-360.
29. C. Gopalan B. Belavady, "Nutrition and Lactation," *Fed. Proc.*, 20: 177-184 (1961).
30. I.H.E. Rutishauser and R.G. Whitehead, "Energy Intake and Expenditure in 1-3-Year-Old Ugandan Children Living in a Rural Environment," *Br. J. Nutr.*, 28: 145-152 (1972).
31. N.F. Butte, C. Garza, J.E. Stuff, E.O. Smith, and B.O. Nichols, "Effect of Maternal Diet and Body Composition on Lactational Performance," *Amer. J. Clin. Nutr.*, 39: 296-306 (1984).
32. J-P. Habicht, R. Martorell, C. Yarbrough, R. Malina, and R.E. Klein, "Height and Weight Standards for Preschool Children," *Lancet*, 1974 i: 611-615.
33. A. Lechtig, J-P. Habicht, H. Delgado, R.E. Klein, C. Yarbrough, and R. Martorell, "Effect of Food Supplementation during Pregnancy on Birthweight," *Pediatrics*, 56: 508-520 (1975).
34. H.L. Delgado, R. Martorell, E. Brineman, and R.E. Klein, "Nutrition and Length of Gestation." *Nutr. Res.*, 2: 117-126 (1982).
35. H. Delgado, A. Lechtig, C. Yarbrough, R. Martorell, R.E. Klein, and M. Irwin, "Maternal Nutrition: Its Effects on Infant Growth and Development and Birth Spacing," in K.S. Moghisi and T.N. Evans, eds., *Nutritional Impacts on Women* (Harper and Row, Hagerstown, Md., USA, 1977).