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Clinical Health

BREASTFEEDING IN DEVELOPING COUNTRIES

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Summary The calculated protein and calorie requirements and nutritional status of intrauterine-growth-retarded infants of poor mothers in underdeveloped countries were compared with the estimated amounts of protein and calories supplied in the mother's milk and their nutritional status both before and during lactation. These mothers were only able to provide 69% of the infants' protein requirements at birth, falling to 51% at three months of age. 123% of calorie requirements were supplied at birth, falling to 55% at three months. Conversely, in terms of g protein per 100 kcal, 56% of requirements were met at birth, rising to 95% at three months—figures which reflect the decreasing protein requirement with age. Socioeconomic factors determine nutritional status in developing countries and it is the responsibility of governments to ensure the health and adequate nutrition of mothers and infants.

INTRODUCTION

Unsupplemented human milk from a well-nourished, well-motivated mother is all that a baby in optimal nutritional condition may require to sustain growth and good nutrition during the first 4 to 6 months of life.[1,2] To have a healthy, well-nourished, and well-developed infant, the mother must have laid down adequate nutritional reserves during pregnancy, including subcutaneous fat, and must remain well-fed throughout lactation. Unfortunately, in developing countries poorly nourished women give birth to infants of low birthweight (LBW) in bad environmental and sanitary conditions. The frequency of low birthweight (<2500 g) is, on average, three times greater in underdeveloped (17%) than in developed countries (6%). In some areas 30–40% of birthweights may be below 2500 g[3,4] with 75% of the infants intrauterine-growth-retarded (IUGR).[5] IUGR infants are the ones most at risk of perinatal death, illness, and subsequent handicap.

Can large numbers of high risk infants (IUGR) be fed exclusively on their undernourished mothers' milk and still achieve adequate growth and development? We consider three major factors in answering this question:

1. Nutritional requirements for growth in the IUGR infants.
2. Nutritional status of pregnant and lactating women in developing countries.
3. Characteristics of the milk produced by poorly nourished mothers.

NUTRITIONAL REQUIREMENTS FOR GROWTH IN IUGR INFANTS

To determine the nutritional intake required by IUGR infants to achieve adequate physical growth, we make some assumptions based on the experimental data of others. We use Cruise's[6] data (single birth and healthy) for IUGR infants up to the third month of life, plotted to outline growth patterns for newborn infants in a developed country, to calculate the expected weight gain.

In this population the mean birthweight was 2150 g and by the third month of life the average weight had reached 4850 g. We therefore estimate that the daily weight increase of IUGR infants during the first three months of life is 30 g, which is a figure identical with the velocity growth curve reported for IUGR infants in other series.[7] Using data from the Guatemalan longitudinal study on growth and development, we estimate the growth velocity of IUGR infants to be 27 g/day during the first three months of life, increasing to 30 g/day when low ponderal index IUGR infants are considered. The latter group had marked catch-up growth during the first trimester of life. Therefore, the proposed figure (30 g/day of weight gain) appears to be constant for these full-term babies in different populations. From a "reference fetus at term"[8] we calculate that 14·2% of the weight gained will be protein.

We estimate from the data of Fomon et al.[9,10] that the inevitable protein losses in IUGR infants who weigh an average of 2150 g at birth will be 0·75 g/kg/day. Furthermore, the infants will absorb about 83% of the protein from breast milk. Taken together, the values of 30 g/day weight increase (14·2% as protein), 0·75 g/kg/day inevitable protein loss, and 83% protein absorption, mean that an IUGR infant at birth needs a minimum daily intake of 3·2 g protein/kg body weight/day.[11]

Table I shows the protein requirements for IUGR infants of different weights and ages up to 3 months expressed as total daily requirement in g/day and g per 100 kcal (1kcal = 4·2 kJ). The estimated weight gain of 30 g/day is important since it allows these babies the possible benefit of a period of "relative catch up," although they will still be smaller than their normal counterparts at the age of three.[6]

NUTRITIONAL STATUS OF PREGNANT AND LACTATING WOMEN IN DEVELOPING COUNTRIES

A healthy, well-nourished woman must be prepared for successful lactation in two ways:

a) By the physiological changes of pregnancy, especially the accumulation of fat reserves (an average of 4 kg during a normal gestation period).[14] This represents an additional 36 000 kcal.
b) By an increased dietary intake during lactation (600–800 additional kcal/day) to give a total daily intake of 2800–3000 kcal.[15] Greater consumption of all essential nutrients, including an additional 20 g of protein/day,[16] is also necessary for adequate lactation.

TABLE I—DAILY PROTEIN REQUIREMENTS OF IUGR INFANTS AND PROTEIN CONTENT OF MILK FROM POORLY NOURISHED MOTHERS

	Estimated protein requirements IUGR Infants			Protein in milk from poorly nourished mothers*	
Age (mo)	g protein/kg bodyweight	g protein/day	g/100kcal	g protein/day	g/100kcal†
Birth	3·20	6·90‡	2·47	4·80 (*69*)§	1·40 (*56*)§
1	2·53	7·71	1·95	4·80 (*62*)	1·40 (*71*)
2	2·16	8·50	1·66	4·80 (*56*)	1·40 (*86*)
3	1·92	9·33	1·47	4·80 (*51*)	1·40 (*95*)

*Assuming a daily volume of 600ml.
†0·8 g protein/dl[12] and 57 kcal/dl.[13]
‡Average birthweight 2150 g.
§ % of infant requirement supplied by mother's milk.

Satisfaction of these two requirements will allow a mother to breastfeed her baby for six months (an energy expenditure of about 135 000 kcal) without depleting her own energy stores. However, these conditions are rarely satisfied in poorly nourished mothers in developing countries.

How well the first condition is met can be assessed by examining weight gain during gestation. An accepted increase that allows for fat accumulation is 10–12 kg[14] but the average weight gain during pregnancy by poor women in developing countries has consistently been between 5 and 7 kg.[17–20] This level of weight gain can lead to weight losses of between 2 and 4 kg, dependent upon pregestational weight, in mothers who breastfeed for nine months.[21] Other workers have calculated that in underfed mothers this loss can be as high as 7 kg after a year of lactation.[22] Data on the nutrient intake of lactating mothers are scarce and table II compares the W.H.O./F.A.O. with recommended daily intake of certain nutrients with the dietary patterns of lactating women in three culturally different developing countries, revealing that the daily intake in these populations falls below the recommended level for most nutrients. Furthermore, seasonal variation in food production can affect maternal nutrient intake and temporarily decrease breast milk production. Unfortunately, families in the Third World cannot store food for the dry season as farmers do in the developed world in order to feed cows and improve milk output.

Neither of the two physiological processes required for successful lactation is found in poorly nourished mothers from developing countries and these women are, from their first pregnancy, in a state of general "maternal depletion," characterised by progressive weight loss and/or specific nutritional deficiencies.

CHARACTERISTICS OF MILK FROM POORLY NOURISHED MOTHERS

From the review of Jelliffe and Jelliffe[26] we can draw some conclusions about the volume and the protein, calorie, and fat content of the milk.

Volume.—The milk volume of poorly nourished women may be between 500 and 700 ml a day in the first six months after delivery, but is often nearer 500 ml during the dry season.

The volume of milk produced by the mothers of IUGR infants during the second to sixth month, correlates significantly with the birthweights of non-premature infants.[27] It is uncertain whether this results from the incapacity of the smaller growth-retarded infants to suck more milk or if the same factors that reduced fetal growth are responsible. In the above series[27] the breast milk supplied to the growth-retarded infants never allowed for catch-up growth, and the growth retardation present at birth lasted throughout the first year.

TABLE II—COMPARISON OF DAILY INTAKE OF NUTRIENTS BY LACTATING WOMEN IN THREE UNDERDEVELOPED COUNTRIES AND THE F.A.O./W.H.O. RECOMMENDED LEVELS

	W.H.O./F.A.O. recommendation	Guatemala[23]	Iran[24]	India[25]
Energy (kcal)	2750	1599	1840	1702
Protein (g)	65	58	61	35
Vitamin A (IU)	4000	..	2910	241
Vitamin B_1 (mg)	1·10	1·03	1·40	1·01
Vitamin B_2 (mg)	1·7	0·6	1·0	0·8
Vitamin B_6 (mg)	2·5[16]	0·6	1·0	..
Vitamin C (mg)	30	13	32	7
Calcium (mg)	1200[24]	887	506	221
Iron (mg)	28	21	15	20

Human milk production is greatly reduced under conditions of famine and severe physiological stress, and sometimes by oestrogens in contraceptive pills. Such conditions cannot be dismissed as being extraordinary or infrequent in developing countries, especially among the poor. In fact, in a survey of oestrogen/progestagen oral contraceptive prescribing during lactation, most clinicians (Africa 88%, Asia 71%, and Latin America 63%) prescribed them to lactating women who wanted contraception. However, 32–46% of the doctors in the developing countries received complaints of reduced milk production from mothers taking this type of oral contraceptive.[28]

Protein and aminoacids.—The protein content of the milk does not vary greatly between well-nourished and under-nourished mothers (about 0·8±0·1 g/100 ml).[2] However, decreased concentrations of free aminoacids have been reported in the milk of undernourished mothers. In a study[29] in rural Guatemala of a population similar to that in table II, the concentrations of tryptophan and lysine in milk were 23% and 29%, respectively, of those found in well-nourished American controls, regardless of period of lactation. Furthermore, total protein and lipid concentrations were significantly lower among the Guatemalan mothers who had nursed for up to six months. In the study, milk was collected from both groups by the same technique and tested in the same laboratory. In a similar study of Pakistani women, the lysine and methionine contents of their milk were decreased but the total protein content was normal.[12]

The Guatemalan diet contains only small amounts of tryptophan and lysine since maize is the principal source of dietary protein in many areas. The Pakistani diet consists mainly of rice or wheat—both deficient in lysine—and a non-supplemented diet of cereals and pulses often deficient in methionine. Both these examples suggest a direct effect of maternal diet on free aminoacid composition, while total protein content may be stable. The significance of a reduction in the concentration of a given aminoacid is unclear. However, reduced tissue tryptophan can limit polysome aggregation and protein synthesis in the liver,[30] and free tryptophan levels are low in the brains of rats fed on a maize-based diet, with a concomitant reduction in the synthesis of serotonin.[31]

Calorie value.—Reports on groups of well-fed mothers give a mean milk calorie content of about 70 kcal/dl (range: 45 to 119)[13] but in poorly nourished women both milk volume and fat content may be less than in well-fed mothers.[26] After the second month of life (table III) the IUGR infant does not get enough calories from its mother's milk. Similar figures have previously been reported.[32] Lower levels of vitamin A, thiamine, riboflavine, and vitamin B_{12} have also been found in the milk of mothers from developing countries.[26]

CONCLUSIONS

Tables I and III compare the requirements of IUGR infants with the calorie and protein contents of milk from malnourished mothers. The milk from these women does not cover the protein requirements of IUGR infants during the first three months of life. When rapid growth starts to slow down at the end of three months, the protein content of breast milk per 100 kcal is almost at the required level, but these mothers must produce more than a litre of milk a day in order to provide enough protein.

Growth patterns during the first three months of life have been studied in a population where the frequency of

TABLE III—DAILY CALORIE REQUIREMENTS OF IUGR INFANTS AND CALORIE CONTENT OF MILK FROM POORLY NOURISHED MOTHERS

Age (mo)	IUGR infants (kcal)*	Poorly nourished mothers (600 ml/day)†	% of infant requirement
Birth	280	345	123
1	395	345	87
2	511	345	68
3	631	345	55

*Average birthweight 2150 g

†Assuming uniform volume and 57 kcal/dl, i.e., the average of the mean and the lowest value for well-nourished mothers.

IUGR/LBW babies is about 15%, and around 40% of all births are below the 10th percentile of weight for gestational age.[33] The mothers breastfeed these babies for over 18 months. During the first month of life there was a period of "catch-up" growth, but a greater than expected growth deceleration occurred later. We calculate that IUGR infants receive between 90 and 123% of their first month's calorie requirements from human milk, which may account for the accelerated growth seen during this period, and it is the interaction between infection and insufficient nutrient intake which causes the subsequent growth retardation.

Insufficient intake may explain the high early mortality in breastfed populations. Recently, data from 730 infants were studied in the Guatemalan Longitudinal Study on Growth and Development (Villar J, Klein R—paper in preparation). The infant mortality was 52/1000 live births and 80% of the deaths occurred during the first six months of life.

Breastfeeding alone neither corrects malnutrition nor modifies its basic causes. When the infant is already malnourished at birth, as are about 40% in developing countries, breastfeeding alone during the first four months of life is unlikely to provide adequate nutrition.

Socioeconomic factors determine the nutritional status of infants and their mothers in developing countries and scientists and international organisations should be aware that there is no simple and effective solution.

We do not suggest that women should not breastfeed—breastmilk is best for the healthy infants of healthy well-nourished women. In underdeveloped countries governments must act to ensure the health and adequate nutrition of mothers and babies. It is wrong and unfair to put this responsibility on the women.

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Hospital Practice

EFFECT OF EARLY RETURN TO WORK AFTER ELECTIVE REPAIR OF INGUINAL HERNIA: CLINICAL AND FINANCIAL CONSEQUENCES AT ONE YEAR AND THREE YEARS

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Summary Since January, 1976, male patients undergoing elective unilateral inguinal herniorrhaphy have been included in a trial to see whether early return to normal activity is associated with an increased recurrence rate and to investigate economic consequences. By June, 1981, 500 patients had been reviewed at one year. 2 patients had defaulted. The first 200 patients had been examined at one year and three years. Recurrence was assessed independently, and recurrences were found of which the patient was unaware. The acceptable definition of recurrence was need for reoperation or a truss. The overall recurrence rate at one year was 3·9%. At three years no further recurrences were detected in the first 200 patients. There was no difference in the recurrence rate for those in the "early" group with 8 recurrences in a total of 246 patients and

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