Does breast feeding have nutritional advantages over bottle feeding?

The available evidence supports the view that it makes good biological sense to use human milk for the neonate and infant.

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Nutrient requirements

In order to address the question 'Does breast feeding have nutritional advantages over bottle feeding?' it is necessary first to discuss what is known about the nutritional requirements of infants.[1-3]

The information available is basically of two types. The major source of information is observations of the intake of infants described variously as thriving, growing normally or at a rate that meets accepted paediatric standards.[4,5] Such observations do not necessarily represent minimum requirements but they do demonstrate clearly that there is much variation both between babies and in the same baby from day to day. Another important source of information about the nutritional requirements of infants is situations in which infants have become deficient in one or more nutrients — which have provided data on inadequate levels of intake.

During the first six months of life human milk has been until very recently the sole source of energy and nutrients for most infants. It is thus not inappropriate to describe the requirements of infants in terms of the amount of human milk which on average provides for normal growth. *Table 1* shows recent data on the intake of human milk by infants of well nourished mothers in three countries including Australia.[6-8] The values obtained in each of the three countries are similar and indicate a twofold range of variation in the established intakes of normal infants of well nourished mothers from as little as 400 to 500 mL to as much as 1000 to 1100 mL daily.

Table 2 shows the amounts of energy and nutrients associated with 500 to 1000 mL of human milk[9] in comparison with the most recent recommendations of the Food and Nutrition Board of the US National Academy of Science[5] for infants during the first six months of life. With regard to energy the average intake in breast fed infants is clearly well below the recommended level. This recommended level of intake reflects essentially the intake of bottle fed infants although it includes infants fed on pasteurised human milk.

For most nutrients the recommended level of intake approximates the upper level of intake by breast fed infants; it reflects not only the principle of recommended

● A wide range of energy and nutrient intake is compatible with normal growth and development in infancy

Table 1
The volume of human milk consumed daily by healthy breast fed infants in the first six months of life

Month postpartum	Volume of milk (mL)		
	Sweden[6]	UK[7]	Australia[8]
1 - 2	724 ± 117	742 ± 104	704 ± 135
2 - 3	752 ± 177	787 ± 160	745 ± 124
3 - 4		805 ± 153	751 ± 169
4 - 5	756 ± 140	803 ± 113	—
5 - 6		—	—

levels to provide for the requirements of virtually all individuals, but also the need to meet the requirements of *formula* fed infants.

For a few nutrients however the recommended level of intake is considerably higher than the maximum amount available from human milk. It includes an additional margin of safety which reflects the fact that deficiencies of these nutrients can occur when the intake of milk is otherwise adequate. In the case of thiamine and pyridoxine the additional amount is recommended primarily to allow for possible losses during the prolonged heating of formulas, while in the case of iron it takes into account the much lower rate of absorption from formulas. In the case of vitamin B_{12} the additional amount takes into account the need to provide an adequate intake of this important vitamin for the breast fed infants of vegan mothers and for infants fed on soya based formulas. For electrolytes there are no recommended levels of intake as yet but the amounts found in human milk serve as a guide to safe and adequate daily intakes.

It is necessary to keep in mind the differences between the intakes of infants 'fed at the breast' and the levels of intake of energy and nutrients recommended for bottle fed infants when comparing the nutritional aspects of these different methods of feeding.

Advantages and disadvantages of breast feeding

The advantages, early in life, of breast feeding are easier to assess than those that may show later in life, and about which there is some uncertainty[10-12] *(Table 3).*

Susceptibility to infection

One of the most important advantages for the breast fed baby is the reduced susceptibility to respiratory and gastrointestinal infection in comparison with its bottle fed counterpart. There are several reasons for this:[10]

1. Breast feeding is more hygienic.
2. Breast fed infants have more acid stools which are more inhibitory to gram negative bacteria.
3. Lactobacillus growth factor stimulates a *Lactobacillus bifidus* flora which inhibits the development of potentially pathogenic organisms.
4. Macrophages present in human milk may reduce the risk of necrotising enterocolitis and are responsible for the synthesis of lysozyme, complement (C_3 and C_4), and lactoferrin which have antibacterial and antiviral properties.
5. Lactoferrin in human milk may reduce the availability of iron to bacteria.
6. T and B-cell lymphocytes are also present. B-cell lymphocytes produce immunoglobulins, primarily IgA which is thought to be active against viral and bacterial pathogens in the intestinal tract. T-cell lymphocytes may have a role in cellular immunity.

Nutrient bioavailability

The fat from human milk is somewhat better absorbed by infants (85 per cent to 95 per cent) than that from cow's milk (70 per cent); this appears to be due more

● Reduced susceptibility to infection in early infancy is a unique feature of breast feeding.

Table 2
The nutrients provided by 500-1000 mL of human milk compared with recommended levels of intake for infants of six months or less

Nutrient		Human milk[9] 500-1000 mL	Recommended[5] daily intake
Energy	kJ/kg	366 -420*	480 - 460
Protein	g/kg	1.7 - 1.9*#	2.2
Vitamin A	μg	300 - 600	420
Vitamin D	μg	4 - 8	10
Vitamin E	mg	1.75 - 3.5	3
Vitamin C	mg	19 - 38	35
Thiamin	mg	0.08 - 0.16	0.3
Riboflavin	mg	0.15 - 0.31	0.4
Niacin	mg equiv	3 - 6	6
Pyridoxine	mg	0.03 - 0.06	0.3
Folacin	μg	26 - 52	30
Vitamin B_{12}	μg	0.05 - 0.10	0.5
Calcium	mg	175 - 350	360
Phosphorus	mg	75 - 150	240
Magnesium	mg	14 - 28	50
Iron	mg	0.38 - 0.76	10
Zinc	mg	1.48 - 2.95	3
Iodine	μg	35 - 70	40
Sodium	mg	75 - 150	—
Potassium	mg	300 - 600	—
Chloride	mg	215 - 430	—

* Over the range 4-7 kg
\# Total nitrogen x 6.38

to the triglyceride arrangement of the fatty acids than to the actual amounts of individual fatty acids present.[13]

Although cow's milk contains a much higher proportion of casein to whey proteins than human milk, the protein of both milks is equally effective in promoting nitrogen retention in both premature and full term infants.[13] While the concentrations of vitamins in different milks and their degree of binding may vary *(Table 4)* [9,14] little is known about milk vitamin bioavailability. The bioavailability of several minerals is greater from breast milk.

Calcium is about 70 per cent absorbed from human milk and generally less than 30 per cent from cow's milk, primarily because of the lower phosphorous content and better fat absorption associated with human milk.

Iron in human milk is also well absorbed — 70 per cent or more compared with 10 per cent from cow's milk formulas.[15] The mechanism for this enhanced absorption is not clear however. Nevertheless the premature baby may need more iron than can be provided by human milk because of smaller hepatic iron reserves at birth.

Zinc bioavailability in human milk is enhanced by its association with citrate and possibly with picolinate.[16]

Food sensitivity

Breast feeding reduces the incidence of food sensitivity although it has been noted that, in infants with a family history of atopic disease, maternal cow's milk ingestion can lead to infantile colic.[17] (Adverse effects of cow's milk and

Table 3
Nutritional aspects of breast feeding

Advantages		Disadvantages[10]
Early[10, 11, 12]	**Late**[12]	
1. Nutrient content and availability — higher digestibility and absorption — lower renal solute load — avoidance of hypocalcaemia and hypomagnesaemia in the neonatal period — appropriate amino acid pattern for developing central nervous system 2. Reduced susceptibility to infection 3. Reduced food sensitivity and allergy 4. Reduced risk of — sudden infant death syndrome — gastrointestinal dysfunction — dental caries	? Reduced risk of — obesity — hypertension — coronary heart disease — ulcerative colitis	1. Maternal — anxiety about amount of feed — restriction of usual activities 2. Transfer of environmental pollutants and drugs by human milk 3. Breast milk jaundice (relatively uncommon) 4. Low vitamin B_{12} in vegan mothers 5. Dental caries from protracted feeding times

Table 4
Nutrient content of various infant feedings per 1000 kJ

Nutrient		Human milk[9]	Cow's milk	Modified* cow's milk[14]	New Lactogen	Nan	Prosobee
Protein	g	3.7	12.1	7.3	7.3	6.1	8.3
Fat	g	14.3	17.3	10.4	11.9	12.5	11.3
Carbohydrate	g	25.3	13.9	31.9	27.3	27.1	22.6
Vitamin A	mg	0.20	0.12	0.07	0.22	0.21	0.21
Vitamin C	mg	13.0	5.5	3.3	19.2	17.8	18.3
Vitamin D	μg	2.73	0.11	0.07	5.00	4.64	3.50
Thiamine	mg	0.06	0.15	0.09	0.15	0.18	0.21
Vitamin B_{12}	μg	0.03	1.11	0.67	0.05	0.46	0.87
Sodium	mg	51	184	110	115	57	171
Potassium	mg	205	552	331	308	214	300
Calcium	mg	120	443	266	269	179	316
Phosphorus	mg	52	350	210	211	125	300
Iron	mg	0.26	0.18	0.11	2.96	2.86	4.16
Magnesium	mg	10	44	27	27	20	26
Zinc	mg	1.01	1.29	0.77	1.50	1.43	1.73

* Modification for infants up to 2 months of age (60 mL milk + 40 mL water + 6.6 g carbohydrate = 279 kJ per 100 mL

Recommendations for infants are usually expressed in terms of energy rather than volume and hence nutrient content is presented here per 1000 kJ and not per litre.

● The timimg of the introduction of solids somewhere between the third and sixth month depends on many factors and is best individualised.

infant formulas may have different mechanisms only one of which may be allergy. Hence the term 'food sensitivity' is preferred.)[18] Effects described include eczema, urticaria, reversible airways obstruction, abdominal pain, vomiting, diarrhoea, protein-losing enteropathy, hypoproteinaemia and failure to thrive.[16] Over diagnosis of food sensitivity can be avoided by formal evaluation of a double blind elimination diet.

Introduction of solids

Adequate intakes of infant formulas or of human milk from well nourished mothers are considered to meet all the known nutritional requirements of infants for the first six months of life.[19] There is generally no need to introduce other foods for nutritional reasons before the second six months of life. In breast fed infants the mother's nutritional status may influence the time of weaning. Some foods other than milk are frequently introduced from three to four months of age onwards when infants develop the ability to move semisolids from the front to the back of the mouth. Breast feeding compared with formula feeding during this transitional period (three to nine months of age) has been found to result in a lower incidence of severe or obvious atopic disease particularly in babies with a family history of atopy.[21]

Infants whose intake of human milk is at the lower end of the normal range may require additional sources of energy to maintain a normal rate of growth at a weight of around 5 kg because their energy intake is then less than 300 kJ/kg. Their intake of other nutrients will also be relatively low and in this situation nutritional needs may be met most readily by complementary formula feeds. Alternatively they may be met initially by an appropriate combination of infant cereal and suitably prepared fruits and vegetables, in addition to breast feeding.

At around six months of age human milk and infant formulas are frequently replaced with whole cow's milk. The major associated changes in nutrient intake are a reduction in ascorbic acid and vitamin D intake in both breast fed and formula fed infants and a marked reduction in iron intake by formula fed infants. In infants exposed normally to sunlight, dietary vitamin D supplementation is unnecessary but additional sources of vitamin C and the introduction of some foods containing haem iron are recommended at this time.

Conclusion

The available evidence supports the view that it makes good biological sense to use human milk for the neonate and infant in preference to substitutes. The timing of weaning depends however on many factors including maternal preference, adequacy of lactation and milk composition. These in turn depend on maternal nutrition, community attitudes to breast feeding and most importantly, adequate maternal preparation and support for breast feeding from the health care team.

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