

# Is breast best? Is early solid feeding harmful?

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## Abstract

The health benefits of breastfeeding for babies and mothers have long been recognised and it is now globally recommended that it be continued exclusively for six months. Although there are few controlled trials to support this recommendation, the most important advantage is less morbidity from gastrointestinal infection in developing countries. There is also evidence that respiratory tract infections and atopic dermatitis is reduced, and the maternal risk of breast cancer decreases, particularly with a longer duration of breastfeeding and a high parity. There is little to suggest that exclusive breastfeeding for six months adversely affects infant growth, nutritional status or infant feeding skills, but more studies are needed. Equally, there is no evidence that introduction of solids from 17 weeks is harmful in developed countries. However, in the UK breastfeeding prevalence is low and solids are introduced early for the majority of infants and much can be done to positively encourage and support all mothers to continue breastfeeding for a longer period.

## INTRODUCTION

Over 95% of the world's children are initially breastfed and the prevalence has increased throughout the 1990s in many developing countries.<sup>1</sup> The superiority of breastfeeding is indisputable, but opinions and recommendations are strongly divided on the optimal duration of exclusive breastfeeding and the timing of solid introduction. In developing countries, there is evidence and extensive experience to suggest that the risks of introducing food other than breast milk before six months outweigh potential benefits. It is now globally recommended that exclusive breastfeeding is continued for six months.<sup>2</sup> It is unclear whether such a rigid approach is necessary in the developed world. For some mothers it will involve a huge cultural change and may take many years to accept and establish.

## COMPOSITION OF BREAST MILK

The composition of breast milk varies and is influenced by lactation duration, maternal diet and the stage of an individual feed, i.e. the fat content increases as the breast empties. Colostrum is the milk produced during the first five days and transitional milk is that secreted between the fifth and tenth day of lactation. Mature milk is produced thereafter. Changes in nutrient composition between each stage are given in Table 1. The bioavailability of many breast milk nutrients is good.

Human milk contains less protein than other mammalian milks. A large proportion of the whey protein is made up of anti-infective properties of

immunoglobulins, lactoferrin, lysozymes, and active white cells. Cellular components, including specific T- and B-lymphocytes, and non-specific macrophages and neutrophils, are especially high in colostrum but persist in milk in lower concentrations but in activated forms for months. Lactoferrin binds iron in the breast milk, leaving it unavailable for iron-dependent bacteria, such as *Escherichia coli*. Breast milk contains many enzymes, hormones and growth factors including lipases, amylase, catalase, protease, insulin-like growth factors, prolactin, and thyroid stimulating hormone.<sup>3</sup>

Lactose contributes about 37% of the energy and levels are much higher than in cow's milk. Human milk lipids contain preformed long chain polyunsaturated fatty acids, which serve as precursors for the formation of prostaglandins, prostacyclins, and other lipid mediators, as well as essential components in membrane-rich tissues like the brain and the retina.

## INTERNATIONAL AND NATIONAL RECOMMENDATIONS ON FEEDING

The World Health Organization (WHO)<sup>2</sup> globally recommends that no solids or infant formula should be introduced for breastfed infants before six months. This recommendation is likely to be supported by individual countries and indeed is already supported by a UK ad hoc Expert Group on Child Nutrition (and further endorsed by the Scientific Advisory Committee on Nutrition 2001). However, the expert committee recognised that some mothers will be unable to, or may choose not

to, follow this recommendation for many valid personal, social and economic reasons. They therefore recommend that there should be some flexibility but that any complementary feeding should not be introduced before the end of four months (17 weeks).

### INFANT FEEDING PRACTICES IN THE UK

The National Statistics infant feeding survey indicated the initial prevalence of breastfeeding rates in 2000 were only 71% in England and Wales, 63% in Scotland and 54% in Northern Ireland. Highest incidences of breastfeeding were among mothers from higher occupation groups, with higher educational levels, aged 30 years or over, and mothers of first babies. Among the mothers who chose breastfeeding, one-fifth (21%) gave up within two weeks, by six weeks two-thirds were still breastfeeding and by four months the figures had reduced to less than half.

Weaning is generally started early in the UK. In 2000, 85% of infants were given solids by four months of age. Solid food tended to be introduced at a younger age by mothers in Northern Ireland, babies with a heavier birth weight and by mothers from a lower occupational group or educational level. Black (73%) and mothers of Asian origin (80%) were less likely to have given their babies solids before 17 weeks.<sup>4</sup>

### SHOULD EXCLUSIVE BREASTFEEDING BE CONTINUED UNTIL SIX MONTHS?

The scientific basis for the WHO recommendation has met with criticism. It was based on a systematic review of current evidence comparing exclusive breastfeeding for four or six months with exclusive breastfeeding for six months.<sup>5</sup>

Unfortunately, only 17 studies met their selection criteria and only two were controlled trials. Definitions of exclusive breastfeeding varied considerably across studies. All the studies had methodological failings. A further systematic review also considered the evidence and its conclusions are different. Lanigan and colleagues<sup>6</sup> searched over 400 published papers and 33 for meta-analysis. This review showed a lack of evidence to support or refute a change from the previous WHO recommendations to introduce solid food at four to six months of age. The authors also identified

population subgroups who may be at risk without the addition of appropriate complementary foods before six months.

### EFFECT OF EXCLUSIVE BREASTFEEDING FOR SIX MONTHS VS EARLIER INTRODUCTION OF SOLIDS

#### Energy intake and growth

After a certain age the volume of breast milk theoretically required to meet infants' energy and other nutrient requirements will eventually exceed the mother's lactation capacity, particularly if there is maternal malnutrition. In addition, it is unknown with certainty if complementary foods introduced before six months augment the infant's total energy intake or displace breast milk. If complementary foods displace breast milk in disadvantaged populations, the benefit/risk ratio of early introduction of foods would be low, given the high risk of contamination and typically low nutrient density of such foods when compared to breast milk.

However, there is some suggestion that complementary foods may displace breast milk. A number of studies have shown that there is no growth advantage in breastfed children being given complementary foods from four months of age, even with very high quality foods. In a randomised intervention study in Honduras, low income primiparous mothers who had exclusively breastfed for four months were randomly assigned to one of three groups: continued exclusive breastfeeding to six months; introduction of complementary foods at four months with *ad libitum* nursing from four to six months; and introduction of complementary foods at four months with maintenance of baseline nursing frequency from four to six months. Change in total energy intake (including solid foods) and infant weight and length gain did not differ significantly between groups. Weight and length gains from four to six months were comparable to those of breastfed infants in an affluent US population.<sup>7</sup> In a pooled sample of breastfed infants from industrialised countries, those given only breast milk (n=200) gained a similar amount of weight and length from four to six months as did infants given solid foods in addition to breast milk (n=122).<sup>8</sup> Other observational, cross-sectional studies in developing countries have revealed that complementary food introduced before six

months resulted in a lower nutritional status and lower linear growth,<sup>9</sup> possibly by avoiding infections and improved nutrient intake during infections.

#### Excess weight gain

There is limited contradictory evidence that early introduction of solid foods may be associated with excess weight gain in infancy. Forsyth *et al.*,<sup>10</sup> in an observational study, found infants given solid food at an early age were significantly heavier at four, eight, 13 and 26 weeks of age but not at 52 or 104 weeks. These differences in weight (about 200-300g) were evident at four weeks of age, before nearly all of those given solid food at an early age received their first solids. However, in a later follow-up study of 81% of the same cohort of children, early weaning before 15 weeks was associated with increased percentage body fat and weight at seven years.<sup>11</sup>

#### Nutritional adequacy

Many nutrients such as calcium, essential fatty acids, vitamins and minerals are often absent or less bioavailable in weaning foods, so the provision of a nutrient-enriched milk is essential in the first six months. The nutrient needs of a full-term infant typically can be met by human milk alone for the first six months of life providing the mother is well-nourished. However, some nutrients may become deficient, particularly when maternal nutritional status is poor.

Iron deficiency may occur when maternal iron status and infant endogenous stores of iron are sub-optimal. Significant iron deficiency has been reported in four month exclusively breastfed infants.<sup>12</sup> Low birthweight infants are particularly vulnerable. In Honduras, infants on breast milk with birth weights of less than 3,000g were at risk of developing anaemia even if given iron-fortified complementary foods.<sup>13</sup>

Zinc concentration of breast milk has been shown to be low, particularly from mothers with a poor zinc status<sup>14</sup> and preterm infants. Zinc concentrations in human milk decline sharply during the early months postpartum, regardless of maternal zinc intake, although its bioavailability is high. Breast milk zinc concentrations do not increase in response to increased maternal zinc intake if maternal zinc status is adequate. Several

case reports of infants with acrodermatitis enteropathica, which is a manifestation of zinc deficiency, have been described in breastfed infants.<sup>14-16</sup> Inadequate zinc in breast milk is thought to result from a defect in transfer of zinc from maternal serum to breast milk.

Breast milk contains small amounts of vitamin D and deficiency may occur in exclusively breastfed infants if maternal status is poor or there has been no exposure to sunlight. In Karachi, 65 infants who presented with hypocalcaemic seizures were subsequently found to have rickets. Forty-six infants less than six months were totally or predominantly breastfed. Very low plasma levels of 25(OH) vitamin D were identified in mothers and infants.<sup>17</sup> The retinol content of breast milk has also been shown to significantly decline from four to 12 months after delivery, which could increase the risk of vitamin A deficiency in children who were exclusively breastfed.<sup>18</sup> Vitamin B<sub>12</sub> deficiency may also occur in breastfed infants of vegan mothers. Indeed, there are case reports of neurological impairment in breastfed infants resulting from vitamin B<sub>12</sub> deficiency.<sup>19,20</sup>

### Infection

The most important advantage of exclusive breastfeeding for six months is less morbidity from gastrointestinal infection as breastfeeding reduces possible sources of food-borne infection from inadequate sanitation, and poor quality solid foods. Even in developed countries, among predominantly middle-class populations, there is strong evidence that human milk feeding decreases the incidence and/or severity of diarrhoea,<sup>21,22</sup> severity of respiratory infection,<sup>23</sup> croup,<sup>22</sup> otitis media,<sup>21,24</sup> sepsis,<sup>22</sup> bacterial meningitis,<sup>25</sup> urinary tract infections,<sup>26</sup> and necrotizing enterocolitis.<sup>27</sup> Dewey *et al*<sup>21</sup> demonstrated in a relatively affluent population that the incidence of diarrhoea was about 50% lower in breastfed than in formula-fed infants during the first year of life. Among other studies, Howie *et al*<sup>28</sup> found a similar or greater reduction in gastrointestinal illness associated with breastfeeding in a large prospective study in Scotland. In contrast, Rubin *et al*<sup>29</sup> found no significant relationship between type of feeding and the incidence of gastroenteritis in Denmark.

**Table 1**

### Composition of human milk

Nutrient		Colostrum	Transitional	Mature
Energy	Kcal	56	67	69
	kJ	236	281	289
Protein	g	2.0	1.5	1.3
Fat	g	2.6	3.7	4.1
Carbohydrate	g	6.6	6.9	7.2
Sodium	mg	47	30	15
Calcium	mg	28	25	34
Iron	mg	0.07	0.07	0.07
Retinol	µg	155	85	58
Vitamin C	mg	7	6	4

Holland *et al*<sup>53</sup>

**Table 2**

### Infant feeding definitions

#### Exclusive breastfeeding:

the infant receives only breast milk (from his or her mother or expressed breast milk) and no other liquids or complementary foods with the exception of undiluted drops or syrups consisting of vitamin and mineral supplements or medicines.

#### Complementary feeding:

is the provision of any nutrient containing foods or liquids other than breast milk. It includes solids, water and infant formula.

#### Weaning:

is the process of introducing semi-solid food into the infant's diet in addition to milk.

### Allergy

There have always been concerns about early weaning because the gastrointestinal tract is immature, and the gut is more permeable to some of the foreign proteins introduced with food, thus increasing the risk of allergic reactions.

However, the influence of breastfeeding on the induction of allergic diseases in children appears contradictory.

### Respiratory disease

Recent investigations show that respiratory tract infections and asthma are reduced in breastfed infants. In a prospective cohort study of 2,602 live born children, predominant breastfeeding for less than six months was associated with an increased risk for two or more hospital, doctor, or clinic visits or hospital admissions for wheezing or lower respiratory illness.<sup>30</sup> Wilson *et al*<sup>11</sup> in a seven-year follow-up study of Dundee children from infancy found exclusive breastfeeding for 15 weeks or

more to be associated with less respiratory illness and cough. In addition, they found early weaning before 15 weeks was associated with an increased probability of wheeze during childhood.

In contrast, Wright *et al*<sup>31</sup> also found a significantly lower prevalence of wheeze up to two years of age in children who were exclusively breastfed for four months or more, but at follow-up at the age of six years they found that breastfeeding was associated with an increased risk of asthma and wheeze for atopic children with asthmatic mothers. In a further study of 3,316 breastfed infants for an average of 157 days, breastfeeding did not appear to prevent asthma, delay its onset, or reduce its severity.<sup>32</sup>

### Atopic dermatitis

In a cohort of 1,121 infants, exclusive breastfeeding for at least four months was associated with less atopic dermatitis in the first year of life. Age at first

introduction of solid food and diversity of solid food showed no effect on atopic dermatitis.<sup>33</sup>

### Neurodevelopment

There is considerable controversy over whether nutrition in early life has a long-term influence on neurodevelopment. Lucas *et al*<sup>34</sup> has shown in preterm infants that breast milk was associated with higher developmental scores at 18 months and intelligence quotient (IQ) at seven to eight years of age. In contrast, in full term infants Jacobson *et al*<sup>35</sup> assessed IQ at four and 11 years of age in 280 children who were breastfed in infancy and found they had significantly higher IQ scores at both ages, even after adjusting for social class and education, confirming the earlier findings. However, the effect of breastfeeding was no longer significant after adjusting for maternal IQ and for parenting skills, suggesting that the observed advantage of breastfeeding on IQ is related to genetic and socio-environmental factors rather than to the nutritional benefits of breastfeeding on neurodevelopment.

### Protection against other diseases

A growing body of research suggests that infant feeding practices influence the risk for several chronic diseases of childhood and adolescence. There are a number of studies that indicate a possible protective effect of human milk feeding against sudden infant death syndrome,<sup>36</sup> childhood type 1 diabetes mellitus,<sup>37</sup> Crohn's disease,<sup>38</sup> and lymphoma.<sup>39</sup> However, results of studies are so far inconsistent. There is also emerging evidence of longer term benefits. For example, children who were breastfed show reduced systolic blood pressure at school age,<sup>11</sup> reduced adult serum cholesterol concentrations,<sup>40</sup> and ischaemic heart disease mortality in males.<sup>41</sup> In contrast<sup>42</sup> Leeson found that in 331 young adults a history of breastfeeding for four months or more was associated with significantly reduced arterial function than those breastfed for less than four months or exclusively formula fed.

### Feeding development

There are important developmental reasons for introducing solid food. The neuromuscular coordination needed to eat

solid foods develops during the early months of life. At four months, most infants can put objects to their mouths, take soft foods from a spoon, form a bolus and swallow. From about five months, teeth begin to erupt and infants are able to chew. Feeding behaviour therefore proceeds from sucking to biting and chewing. Chewing improves the mouth and tongue coordination, which is important for speech development. Introduction of different tastes and textures promotes biting and chewing skills. However, if introduction of solids is delayed beyond six months the weaning process may become more difficult. Infants may be less receptive to new tastes and it is more difficult to teach older infants to chew.

Indeed, it was observed in the Avon Longitudinal Study of Pregnancy and Childhood on 9,360 infants<sup>43</sup> that those infants who had been introduced to lumps at the earliest age consumed a greater variety of foods at the age of six months, while those introduced at ten months or later had been given fewer solids of all types by six months of age and at 15 months were significantly less likely to eat family foods when compared to those between six and nine months. At each age, those introduced late (ten months or older) to lumps were more difficult to feed and had more food dislikes.

In contrast, Cohen *et al*<sup>44</sup> demonstrated that delaying the introduction of complementary foods until six months did not adversely affect appetite or food acceptance among breastfed infants. More randomised studies should be conducted on the effect of feeding development and speech on late and early weaning.

### HIV transmission through breastfeeding

Transmission of the HIV virus type 1 via breastfeeding can occur throughout lactation and breastfeeding is associated with a significant additional risk of HIV transmission from mother to child as compared to non-breastfeeding. The rate of HIV transmission via breastfeeding ranges from 14% to 26%. Maternal and infant factors contributing to the risk of mother-to-child transmission are still poorly understood but include: advanced clinical stages of infection in the mother; high maternal plasma HIV-1 load which is highest early after delivery,<sup>45</sup> presence of mastitis; and infant oral thrush.<sup>46</sup>

Where breast milk substitutes are affordable, sustainable and safe, avoidance of all breastfeeding by HIV-infected mothers is recommended but if this is impossible, exclusive breastfeeding is recommended during the first months of life.<sup>47</sup> Unfortunately in developing countries poor socio-economic and living conditions place infants on breast milk substitutes at higher risk of non-HIV infectious diseases with high mortality and morbidity rates as compared with breastfed infants. Mothers in these settings need information about the relative risks and benefits of breastfeeding, early weaning, wet-nursing and formula feeding. In many developing countries, international agencies are providing support and recommendations for preventing mother-to-child transmission of HIV-1 by breastfeeding.

### Possible breastfeeding health benefits for mothers

Advantages to the mother of breastfeeding include greater postpartum weight loss and a prolonged period of lactational amenorrhoea (and so infertility) in mothers who breastfeed frequently, i.e. ten to 14 feedings per day for six months.<sup>48</sup> Although inconclusive, there is some evidence that breastfeeding reduces the risk of breast cancer in women diagnosed under the age of 40, and it may offer some protection for older women also.<sup>49</sup> High parity and longer duration of breastfeeding reduce breast cancer risk significantly. In the reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50,302 women with breast cancer and 96,973 women without the disease, the relative risk of breast cancer decreased by 4.3% for every 12 months of breastfeeding in addition to a decrease of 7.0% for each birth.<sup>50</sup> These results were corroborated in a further population-based case-control-family study performed in Germany.<sup>51</sup> Women with familial risks could potentially benefit most from breastfeeding.<sup>52</sup>

### CONCLUSIONS

In developed countries, although the limited data indicate there are few apparent risks in recommending exclusive breastfeeding for the first six months of life, there is little convincing evidence to suggest introduction of solids from 17 weeks is harmful. More studies are needed

on infant growth, displacement of breast milk by solids, infant biochemical and haematological nutritional status and infant feeding skills, particularly their acceptance of tastes and textures if weaning is delayed. In addition, in a modern society the demands on a young mother to maintain the number and

frequency of breastfeeds in order to provide an older infant with their full nutritional requirements may be too demanding and is a further consideration. On balance, exclusive breastfeeding to six months should be encouraged, but mothers wishing to introduce solids earlier should not be chastised. Furthermore, it is

important all health professionals closely monitor breastfeeding infants particularly if maternal diet is inadequate and complementary nutrition should be advised if appropriate.

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