INTRODUCTION

Human milk is species-specific, and all substitute feeding preparations differ markedly from it, making human milk uniquely superior for infant feeding. [1]

Exclusive breastfeeding is defined as an infant's consumption of human milk with no supplementation of any type (no water, no juice, no nonhuman milk, and no foods) except for vitamins, minerals, and medications. [2, 3]

Exclusive breastfeeding is the reference or normative model against which all alternative feeding methods must be measured with regard to growth, health, development, and all other short- and long-term outcomes. In addition, human milk-fed premature infants receive significant benefits with respect to host protection and improved developmental outcomes compared with formula-fed premature infants.[4] The AAP Section on Breastfeeding, American College of Obstetricians and Gynecologists, American Academy of Family Physicians, Academy of Breastfeeding Medicine, World Health Organization, United Nations Children's Fund, and many other health organizations support breastfeeding and recommend exclusive breastfeeding for the first 6 months of life. [5, 6]

BENEFITS OF BREASTFEEDING:

1- Benefits to the infant:

Infectious Diseases:

Research in developed and developing countries of the world, including middle-class populations in developed countries, provides strong evidence that human milk feeding decreases the incidence and/or severity of a wide range of infectious diseases [7] including:

bacterial meningitis, bacteremia,[1] diarrhea,[8] respiratory tract infection,[9] necrotizing enterocolitis, otitis media, urinary tract infection, and late-onset sepsis in preterm infants.[10] In addition, post neonatal infant mortality rates in the United States are reduced by 21% in breastfed infants. [11]

Other Health Outcomes:

WHO promotes breastfeeding as the best source of nourishment for infants and young children and one of the most effective ways to ensure child health and survival. Breast milk is safe and contains antibodies that help protect infants from common childhood illnesses. [12] Some studies suggest decreased rates of sudden infant death syndrome in the first year of life.[13] Reduction in incidence of insulin-dependent (type1) and non–insulin-dependent (type 2) diabetes mellitus,[14] lymphoma, leukemia, and Hodgkin disease,[15] overweight and obesity,[16] hypercholesterolemia[17] and asthma.[18]

Neurodevelopment:

- Breastfeeding has been associated with slightly enhanced performance on tests of cognitive development. [19, 20]

- Breastfeeding during a painful procedure such as a heel-stick for newborn screening provides analgesia to infants.[21, 22]

2- Maternal health benefits:

Important health benefits of breastfeeding and lactation are also described for mothers. These include:

- Decreased postpartum bleeding and more rapid uterine involution attributable to increased concentrations of oxytocin.[23]
- Decreased menstrual blood loss and increased child spacing attributable to lactational amenorrhea.[24]
- Earlier return to pre pregnancy weight.[25]
- Decreased risk of breast cancer,[26] decreased risk of ovarian cancer.
- Possibly decreased risk of hip fractures and osteoporosis in the postmenopausal period.[27]

3- Community benefits:

In addition to specific health advantages for infants and mothers, economic, family, and environmental benefits have been described. These include:

- The potential for decreased annual health care costs of $3.6 billion in the United States.[28]
- Decreased costs for public health programs such as the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC).[29]
- Decreased parental employee absenteeism and associated loss of family income; more time for attention to siblings and other family matters as a result of decreased infant illness.[30]
- Decreased environmental burden for disposal of formula cans and bottles; and decreased energy demands for production and transport of artificial feeding products.[30]

WHO recommendation:

- initiation of breastfeeding within half an hour of birth
- exclusive breastfeeding for the first six months of life
- introduction of solid foods at six months together with continued breastfeeding up to two years of age or beyond.[12]

Complementary feeding

When breast milk is no longer enough to meet the nutritional needs of the infant, complementary foods should be added to the diet of the child. The transition from

exclusive breastfeeding to family foods, referred to as complementary feeding, typically covers the period from 6 to 18-24 months of age, and is a very vulnerable period. It is the time when malnutrition starts in many infants, contributing significantly to the high prevalence of malnutrition in children under five years of age world-wide. WHO estimates that 2 out of 5 children are stunted in low-income countries.

Complementary feeding should be ***timely***, meaning that all infants should start receiving foods in addition to breast milk from 6 months onwards. It should be ***adequate***, meaning that the complementary foods should be given in amounts, frequency, consistency and using a variety of foods to cover the nutritional needs of the growing child while maintaining breastfeeding. Foods should be prepared and given in a ***safe*** manner, meaning that measures are taken to minimize the risk of contamination with pathogens. And they should be given in a way that is ***appropriate***, meaning that foods are of appropriate texture for the age of the child and applying responsive feeding following the principles of psycho-social care.[31]
Complementary foods are often of inadequate nutritional quality, or they are given too early or too late, in too small amounts, or not frequently enough. Premature cessation or low frequency of breastfeeding also contributes to insufficient nutrient and energy intake in infants beyond 6 months of age.

Guiding principles for complementary feeding of the breastfed child.[32]

1. Practise exclusive breastfeeding from birth to 6 months of age, and introduce complementary foods at 6 months of age (180 days) while continuing to breastfeed
2. Continue frequent, on-demand breastfeeding until 2 years of age or beyond.
3. Practise responsive feeding, applying the principles of psychosocial care.
4. Practise good hygiene and proper food handling.
5. Start at 6 months of age with small amounts of food and increase the quantity as the child gets older, while maintaining frequent breastfeeding.
6. Gradually increase food consistency and variety as the infant grows older, adapting to the infant's requirements and abilities.
7. Increase the number of times that the child is fed complementary foods as the child gets older.
8. Feed a variety of nutrient-rich foods to ensure that all nutrient needs are met.
9. Use fortified complementary foods or vitamin-mineral supplements for the infant, as needed
10. Increase fluid intake during illness, including more frequent breastfeeding, and encourage the child to eat soft, favorite foods. After illness, give food more often than usual and encourage the child to eat more. [32]

Breastfeeding should continue with complementary feeding up to 2 years of age or beyond, and it should be on demand, as often as the child wants.
Breast milk can provide one half or more of a child's energy needs between 6 and 12 months of age, and one third of energy needs and other high quality nutrients between 12 and 24 months. [33]

The overall quantity of food is usually measured for convenience according to the amount of energy – that is, the number of kilocalories (kcal) – that a child needs. Other nutrients are equally important, and are either part of, or must be added to, the staple food. The following Figure shows the energy needs of infants and young children up to 2 years of age, and how much can be provided by breast milk. It shows that breast milk covers all needs up to 6 months, but after 6 months there is an energy gap that needs to be covered by complementary foods. The energy needed in addition to breast milk is about 200 kcal per day in infants 6–8 months, 300 kcal per day in infants 9–11 months, and550 kcal per day in children 12–23 months of age. The amount of food required to cover the gap increases as the child gets older, and as the intake of breast milk decreases. [34]

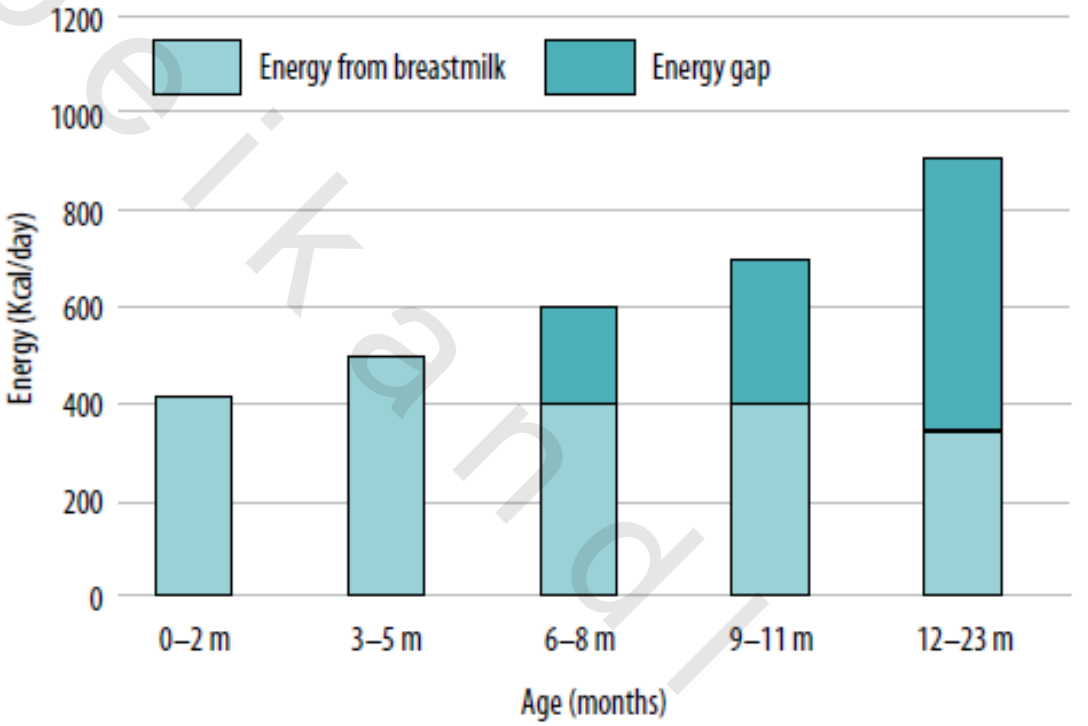


Figure (1): Energy required by age and the amount from breast milk.[34]

AMOUNT OF COMPLEMENTARY FOOD NEEDED. [35]

A. Guideline: Start at six months of age with small amounts of food and increase the quantity as the child gets older, while maintaining frequent breastfeeding.

B. Scientific rationale: The total energy requirements of healthy, breastfed infants are approximately615 kcal/d at 6-8 months, 686 kcal/d at 9-11 months, and 894 kcal/d at12-23 months of age. Energy needs from complementary foods are estimated by subtracting average breast milk energy intake from total energy requirements at each age. Among breastfed children in developing countries, average breast milk energy intake is 413, 379 and 346 kcal/d at 6-8, 9-11 and 12-23 months, respectively. The equivalent values for industrialized countries (for breastfed children only) are 486, 375 and 313 kcal/d, respectively.

The above guideline is based on children receiving average amounts of breast milk at each age. If an infant is consuming more or less breast milk than the average, the amount needed from complementary foods will differ accordingly. In practice, caregivers will not know the precise amount of breast milk consumed, nor will they be measuring the energy content of complementary foods to be offered. Thus, the amount of food to be offered should be based on the principles of responsive feeding, while assuring that energy density and meal frequency are adequate to meet the child's needs. With the sample diets shown in the document Complementary feeding: family foods for breastfed children (WHO, 2000), which have a composite energy density ranging from 1.07 to 1.46 kcal/g, the approximate quantity of complementary foods that would meet the energy needs described above is 137-187 g/d at6-8 months, 206-281 g/d at 9-11 months, and 378-515 g/d at 12-23 months. [It should be noted, however, that these diets will not always satisfy micronutrient requirements. Recommended intakes of iron, and to a lesser extent zinc, are unlikely to be provided by these diets.] It is important not to be overly prescriptive about the amount of complementary foods to be consumed, recognizing that each child's needs will vary due to differences in breast milk intake and variability in growth rate. Furthermore, children recovering from illness or living in environments where energy expenditure is high may require more energy than the average quantities. [35]

FOOD CONSISTENCY. [35]

A. Guideline: Gradually increase food consistency and variety as the infant gets older, adapting to the infant's requirements and abilities. Infants can eat pureed, mashed and semi-solid foods beginning at six months. By 8 months most infants can also eat "finger foods" (snacks that can be eaten by children alone). By 12 months, most children can eat the same types of foods as consumed by the rest of the family (keeping in mind the need for nutrient-dense foods). Avoid foods that may cause choking (i.e., items that have a shape and/or consistency that may cause them to become lodged in the trachea, such as nuts, grapes, raw carrots).

B. Scientific rationale: The neuromuscular development of infants dictates the minimum age at which they can ingest particular types of foods. Semi-solid or pureed foods are needed at first, until the ability for "munching" (up and down mandibular movements) or chewing (use of teeth) appears. The ages listed above represent the

usual capabilities of normal, healthy infants. When foods of inappropriate consistency are offered, the child may be unable to consume more than a trivial amount, or may take so long to eat that food intake is compromised. Evidence from several sources indicates that by 12 months, most infants are able to consume "family foods" of a solid consistency, although many are still offered semi-solid foods (presumably because they can ingest them more efficiently, and thus less time for feeding is required of the caregiver). There is suggestive evidence of a "critical window" for introducing "lumpy" solid foods: if these are delayed beyond 10 months of age, it may increase the risk of feeding difficulties later on. Thus, although it may save time to continue feeding semi-solid foods, for optimal child development. [35]

Factors affecting linear growth during the period of complementary feeding.

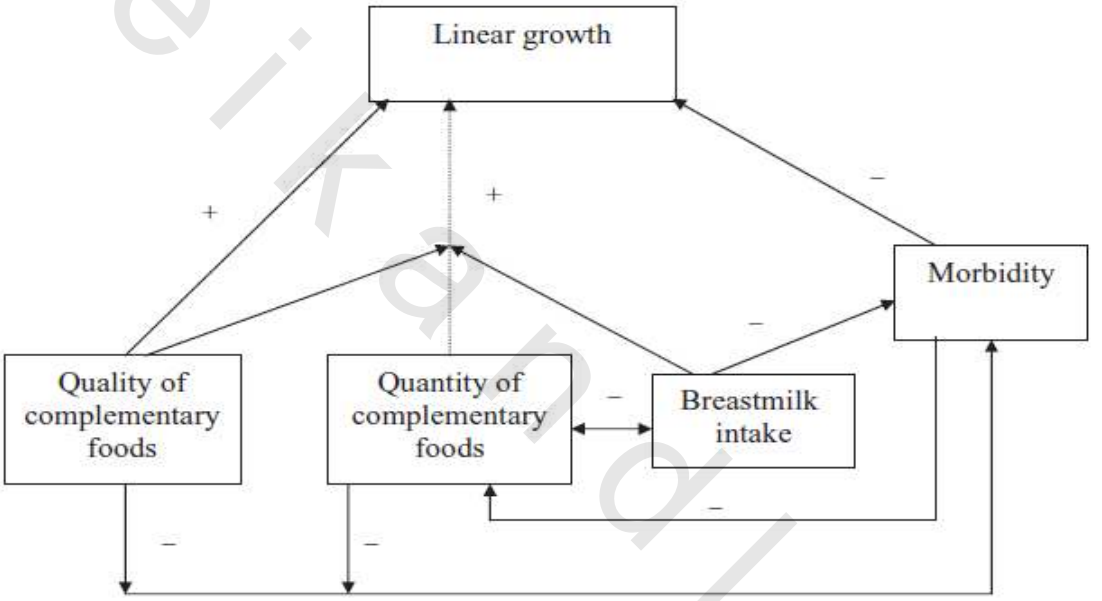


Figure (2): Factors affecting linear growth during the period of complementary feeding. [36]

Both the quality and the quantity of complementary foods can positively influence linear growth, but simply increasing the quantity of food will not be effective if dietary quality is poor. Thus, dietary quality modifies the relationship between food quantity and linear growth. In addition, changes in breast milk intake may modify the relationship between food quantity and linear growth, as breast milk intake usually decreases when consumption of complementary foods increases. The other key proximal factor is morbidity, which has a negative effect on linear growth, as well as on intake of complementary foods. Morbidity rates can be reduced by sustaining breast milk intake and by optimizing the quality (including good hygiene during preparation, storage and feeding) and quantity of complementary foods. Thus, complementary feeding interventions should ideally address all of these proximal factors. [36]

The benefits of optimal introduction of complementary food.

Although some mothers succeed in exclusively breastfeeding their infants until six months of age or beyond, many others report introducing other foods before six months. The reason most frequently given for the "early" introduction of solids is that the mother considers the infant to be hungry and not satisfied by breast milk alone. [37]

Opinions and recommendations about the optimal duration of exclusive breastfeeding have been strongly divided, but few published studies have provided direct evidence on the relative risks and benefits of different breastfeeding durations in recipient infants. [38]

Growth

The age of introduction of complementary feeding seems not to have a strong impact on growth velocity (both weight and length). However, some data suggest that late introduction, after 6 months, could result in a decline in rate of length and weight gain and early introduction, at <4 months, could result in an increased rate of weight gain which could have long term negative consequences with regard to an increased risk for obesity, type 2 diabetes and cardiovascular disease in adult life.

Developmental aspects

Neuromuscular coordination

The available data do not permit to define precisely an age when the introduction of complementary food is needed for further neuromuscular development. However, many infants will have matured their neuromuscular coordination enough at about 5 months to be spoon fed.

Digestion and absorption

If complementary food is introduced after 4 months of age, the digestive system will be mature enough to digest and absorb starches, proteins and fats provided by a non-milk diet.

Health aspects

The risk of developing celiac disease and type 1 diabetes mellitus (T1DM) has been related to the timing of gluten introduction into the infant's diet. Based on the available data, the early (< 4 months) introduction of gluten might increase the risk of celiac disease and T1DM, whilst the introduction of gluten between 4 and 6 months while still breast-feeding might decrease the risk of celiac disease and T1DM. The available data suggest that gluten containing complementary food could be introduced after 4 months in small amounts preferably while the infant is still breast-fed.[39]
There is a reduction in leukemia that is correlated with the duration of breastfeeding.[40,41] A reduction of 20% in the risk of acute lymphocytic leukemia and 15% in the risk of acute myeloid leukemia in infants breastfed for 6 months or longer.[42,43]

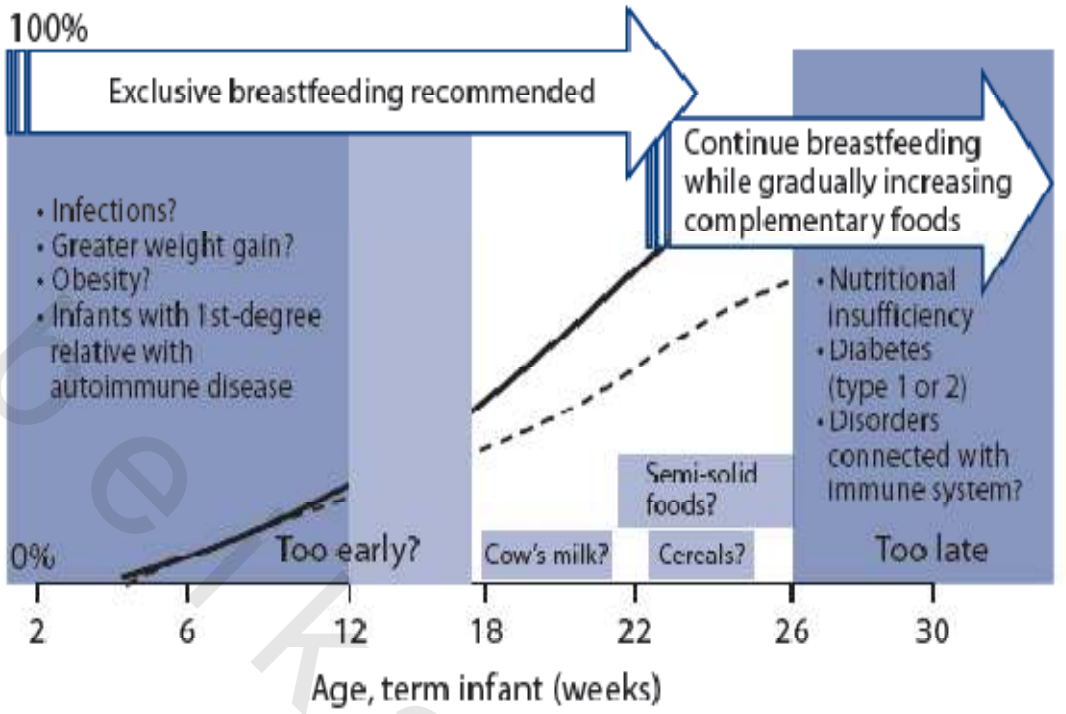
The risk of hospitalization for lower respiratory tract infections in the first year is reduced 72% if infants breastfed exclusively for more than four months. [40, 44] Infants who exclusively breastfed for four to six months had a fourfold increase in the risk of pneumonia compared with infants who exclusively breastfed for more than six months. [45]

Breast-feeding protects against infectious morbidity. This effect is proportional to the length of breast-feeding. The available evidence suggests that early introduction (< 3 months) of complementary feeding may increase the risk of infectious morbidity. There seem to be no effect of introduction of complementary feeding after 4 months on the risk of infectious morbidity.

Overall, on the basis of present knowledge the introduction of complementary food into the diet of healthy term infants between the age of 4 and 6 months is safe and does not pose a risk for adverse health effects (both in the short-term, including infections and retarded and excessive weight gain, and possible long-term effects such as allergy and obesity).

Consistent with these conclusions, presently available data on the risk of celiac disease and T1DM support also the timing of the introduction of gluten containing food (preferably while still breast-feeding) not later than 6 months of age.

Exclusive breast-feeding provides adequate nutrition up to 6 months of age for the majority of infants, while some infants may need complementary foods before 6 months (but not before the age of 4 months) in addition to breast-feeding to support optimal growth and development.[39]



Theoretical 'window' (unshaded area) and current feeding practices (curves; shape and percentages are approximate). Dotted curve = Formula feeding (may be fortified/supplemented); solid curve = liquids other than breast milk or formula [46]

Figure (3): Timing of Introduction of Complementary Food, short- and Long-Term Health Consequences. [46]

Complexity and challenges in understanding the strength of relationship / causality between timing and outcomes. Too early or too late introduction can have adverse health consequences/bear an increased risk of disease.