

# We are IntechOpen, the world's leading publisher of Open Access books Built by scientists, for scientists

6,300

Open access books available

171,000

International authors and editors

190M

Downloads

Our authors are among the

154

Countries delivered to

TOP 1%

most cited scientists

12.2%

Contributors from top 500 universities



WEB OF SCIENCE™

Selection of our books indexed in the Book Citation Index  
in Web of Science™ Core Collection (BKCI)

Interested in publishing with us?  
Contact [book.department@intechopen.com](mailto:book.department@intechopen.com)

Numbers displayed above are based on latest data collected.  
For more information visit [www.intechopen.com](http://www.intechopen.com)



## Chapter

# Infant Nutrition and Feeding in the First 2 Years of Life

*Prince Kwabena Osei and Alex Kojo Anderson*

## Abstract

Infant feeding is the practice of feeding children who are below two years of age. The World Health Organization recommends that infants be exclusively breastfed for the first 6 months of life, followed by continued breastfeeding and gradual introduction of complementary foods. Breastfeeding is beneficial for both the mother and the infant. Breast milk is safe, sterile, and contains antibodies that protect infants against many childhood illnesses. In the US, infants who are not breastfed have a 21% higher risk of post-neonatal infant mortality. It is recommended that mothers who cannot breastfeed exclusively feed their infants with breast milk for at least four months before introducing complementary foods. Infant formula cannot be an absolute substitute for human breast milk, and the use of infant formula must be the last option to feed infants if mothers cannot breastfeed. Although breast milk continues to be an important source of nutrition for growing infants, at six months and beyond breast milk becomes insufficient to provide all the nutrient needs of infants. Therefore, infants must be introduced to complementary foods in addition to breast milk. Complementary foods should provide sufficient energy, protein, essential fats, oils, and particularly, micronutrients to meet the nutritional needs of infants.

**Keywords:** breast milk, infant-formula, complementary-foods, exclusive, breastfeeding

## 1. Introduction

Infant feeding (IF) is the practice of feeding infants who are below two years of age [1]. The food choices parents/caregivers make for feeding infants could have both short and long-term health consequences on them [1, 2]. What we feed infants, when, and how they are fed during the first two years of their lives are essential for the following reasons [3, 4]:

- Infants who are below two years of age are vulnerable to irreversible damage to brain formation that serves as a foundation for the development of cognitive, motor, and socio-emotional skills
- Infants are at risk of irreversible growth retardation

- The risk of developing chronic diseases like cardiovascular diseases, diabetes, and other chronic diseases later in the life span is linked to infant nutrition in the early stages of the life cycle
- Infants are at risk of mortality from common childhood illnesses

This chapter reviews and presents knowledge from several scientific research studies and evidence on policies, programs, recommendations, and the challenges of infant nutrition at different stages of the first two years of life. The chapter provides the reader with an overview of the current situation of infant food choices from birth through two years of age. The chapter is divided into four different sections. The first section discusses prelacteal feeds and the health benefits of human breast milk and exclusive breastfeeding [5–7]. In the second section, the benefits of breastfeeding and infant formula feeding are discussed and compared [8–11]. Under certain circumstances, women may not be able to breastfeed their newborns. Many myths are associated with the appropriate timelines to feed infants with breast milk and when to introduce complementary foods. The timelines and alternative food choices available to mothers for feeding their infants during complementary feeding are discussed in the third section [12–15]. Methods for the expression of breast milk are discussed in the fourth section [16].

### **1.1 Prelacteal feeds**

Prelacteal feeds are substances (mixtures and concoctions) such as honey, sugar water, dates, herbal tea and concoction, and fruit juice, among others that are given to newborns before the onset of breastfeeding within 1 to 3 days after birth [5]. The practice of giving prelacteal feeds to newborns is more common in developing countries than in developed countries [5–7, 17, 18]. The most usual reasons for giving prelacteal feeds are that newborns need them for their health and to fulfill traditional/cultural norms and practices [19]. In addition, some mothers give prelacteal feeds because of delayed lactation. However, this practice is inappropriate and unhealthy because it could be a potential source of infection in newborns, thereby affecting their health [5]. When babies are born, their intestines are sterile, and the introduction of prelacteal feeds may be a source of harmful microorganisms that may hurt their health [20]. Furthermore, the initiation of exclusive breastfeeding could be affected negatively by the introduction of prelacteal feeds to newborns after delivery, and therefore they may not benefit from the full immunological benefits of colostrum [5, 21]. More so, the early introduction of prelacteal feeds could lead to poor feeding of infants and increased risk of mortality [7]. For example, prelacteal feeding accounted for 45% of neonatal mortality, 30% of diarrheal mortality, and 18% of acute respiratory deaths globally [4]. Currently, the practice of prelacteal feeding is a predominant problem in low- and middle-income countries in Africa and Asia [19].

### **1.2 The human breast milk**

#### *1.2.1 Lactation*

During pregnancy, between weeks 16 and 22, the production of breast milk begins in the mammary gland in the breasts [22, 23]. The process of producing and releasing

Hormone	Stimulation	Function
Prolactin	Suckling, stress, & sleep	Promotes milk production
Oxytocin	Suckling or nipple stimulation	Promotes the ejection of milk from the milk gland

**Table 1.**  
*Hormonal control of lactation.*

milk from the breast is called lactation [24]. Lactation is controlled by two main hormones; prolactin and oxytocin [23]. The functions and sources of stimulation for the release of these hormones are listed in **Table 1** [23]:

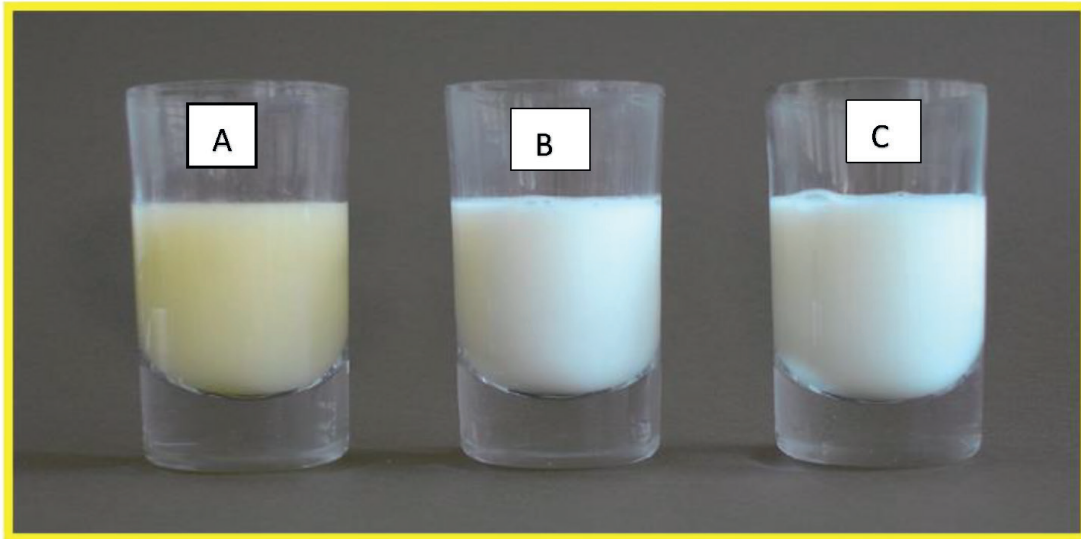
### 1.2.2 Colostrum

The first milk that is produced in the breast after birth is called colostrum and it typically lasts up to 5 days [23, 24]. Colostrum must be a newborn's first food after delivery [23]. It is thick and yellowish milk high in calories, essential nutrients, and antibodies [25]. Lactoferrin is a primary protein in colostrum and has antimicrobial activity [21]. In many societies, it is perceived that colostrum is dirty and contains germs or diseases because of its yellowish color [26]. This is untrue. Rather colostrum is rich in energy and several nutrients that are important for the health of newborn babies in their early days [26]. The health benefits of colostrum for newborn babies are listed below [22–24, 27]:

- The yellowish color of colostrum is due to the high carotene content. Carotene functions as an antioxidant to protect the newborn against inflammation
- Colostrum is rich in immunoglobulins that are involved in building the immune system of the newborn against infections
- It contains special protein compounds like  $\kappa$ -casein,  $\alpha$ -lactalbumin, lactoferrin, haptocorrin, and lysozyme that fight against infections
- Colostrum contains enzymes like Bile Salt Stimulated Lipase (BSSL), which allows for effective lipid digestibility, and better utilization of triglycerides, cholesterol, and fat-soluble vitamins
- It contains growth factors that promote growth and development
- Colostrum functions as a laxative to facilitate the defecation of a newborn's first stool, known as meconium, which aids the preparation of the newborn's gastrointestinal tract for mature breast milk
- Colostrum is high in energy and contains all the essential nutrients required for the growth of infants in the early days after birth

Following colostrum comes transitional milk which is much thinner and whiter than colostrum [1, 23]. It provides the baby with more calories and typically lasts for a few days after colostrum [21]. Mature breast milk is usually produced from the

10th day and is the type of milk that would be produced to feed infants until they are weaned from their mother's milk [24].



A = colostrum, B = transitional milk, C = mature milk  
Adapted from: <https://myaloo.com/blogs/news/colostrum-the-true-super-food>

### *1.2.3 Mature human breast milk*

The production of mature breast milk continues as long as the mother is comfortable with breastfeeding, nurses the infant or expresses her milk, and it is important to mention that infants do not need any other source of nutrition apart from breastmilk, from when they are born until they are six months old [28]. Breast milk is the ideal food for the growth and development of infants [1]. It is made up of approximately 87% water, 1% protein, 4% lipid, and 7% carbohydrate, in addition to many minerals like calcium, phosphorus, magnesium, potassium, sodium, and vitamins [24]. The nutritional composition of breast milk is dynamic and changes within a feed, time of the day, and as an infant grows [29]. Breast milk contains two types of proteins: whey and casein [22, 30]. Over time, the ratio of casein and whey proteins changes [29]. Whey is high in immunoglobulins and easier to digest, whereas casein helps babies feel full longer [30]. Human milk is more than food and cannot be substituted with any other infant foods because it contains immune factors that cannot be found in other foods like infant formula [10, 31]. The following are the main benefits of breast milk for infants:

- Breast milk is safe, and sterile and provides all the energy and nutrients required by infants for the first six months of their lives for optimal growth [1]. In addition, breast milk provides up to half or more of a child's nutritional needs during the second half of the first year, and up to one-third during the second year of life [29]
- Breast milk contains antibodies that protect infants against many childhood illnesses and breastfed infants are more likely to have fewer cases of colds and other infections than infants who are not breastfed [25]
- Research has shown that breastfed infants are less likely to become obese later in life because formula-fed infants usually have a higher calorie intake than infants who are fed breast milk [10, 32]

- Breast milk is easier for infants to digest and this helps to prevent diarrheal diseases as well as allergenic and autoimmune responses [21].
- Breastmilk helps reduce the incidence of infant mortality. Infants who are not breastfed have a 21% risk of post-neonatal infant mortality [4].
- Children who are not breastfed and fed with infant formula without docosahexaenoic acid/arachidonic acid supplementation are likely to develop autism [11].

### **1.3 Exclusive breastfeeding**

When babies are born, mothers must be supported by lactation support groups and professionals, Baby-Friendly Hospital, and breastfeeding education and resources to help initiate breastfeeding [3, 31]. Mothers must also be supported to have safe sleep practices [33]. Exclusive breastfeeding is the practice of giving only breast milk to infants as the sole source of nourishment until they are six months old, except for medications or vitamin and mineral supplements when there is a need [3, 34]. The World Health Organization (WHO) recommends that infants be exclusively breastfed until approximately six months of age, followed by continued breastfeeding and gradual introduction of complementary foods [4]. Breastfeeding is recommended to continue until a baby is at least 2 years old, and beyond, as long as it's mutually desired by the mother and infant [3]. Breastfeeding offers myriad of benefits for mothers including:

- Reducing the risk of cancers like breast cancer, ovarian cancer, and endometrial cancer [9].
- Improves cardiovascular health and prevents diseases like high blood pressure and high cholesterol [9].
- Mothers who breastfeed recover faster from childbirth [29].
- Breastfeeding produces the hormone oxytocin that aids the contraction of the uterus to return to its normal size [29].
- It increases both physical and emotional bonding between mother and baby [9].
- It helps to promote weight loss [35].

#### *1.3.1 Factors affecting exclusive breastfeeding*

Many factors are associated with the discontinuation of exclusive breastfeeding by mothers before six months [9]. Studies have shown that mothers with early breastfeeding difficulties are more likely to discontinue exclusive breastfeeding, and the commonest reason for the inability of many mothers to exclusively breastfeed their infants is insufficient milk production [36, 37]. Some mothers also believe that breast milk is never sufficient to meet the nutritional needs of their infants [37]. Others discontinue breastfeeding due to busy work schedules, the illness of the infant, or the mother [37]. Hence, despite the enormous benefits of exclusive breastfeeding to both infants and their mothers, studies have shown that many mothers are unable to

feed their infants exclusively [9]. Globally, only 40% of infants aged 0–6 months are exclusively breastfed [9]. In the US, the breastfeeding initiation rate is approximately 84% [38]. However, the rate drops drastically by 6 months of age to 57% and by one year, only 35% of infants receive breast milk [38]. Despite these challenges, mothers could be supported to exclusively breastfeed their infants. Mothers must be educated about the importance of breast milk and exclusive breastfeeding. They must be supported by families, peers, and any other support groups that can empower them to feed their infants exclusively [4, 37, 38].

#### **1.4 Overcoming breastfeeding problems**

It is not uncommon for some mothers to experience some physiological challenges in their pursuit to feed their infants with breast milk [39]. For instance, after the delivery of a newborn, it is normal for a mother's breast to become heavy and tender [40]. However, this could lead to engorgement if the milk is not adequately removed, which is associated with severe pain and discomfort [40, 41]. Some infants may bite the nipples of their mother when they start teething and this could lead to sores on the nipples and in some cases, mastitis, which is the inflammation of breast tissues may occur [42]. Details of some of these physiological breastfeeding problems are discussed below:

##### *1.4.1 Nipple soreness*

For many mothers, there is no clear cause of nipple soreness. However, factors such as improper feeding techniques and lack of proper care of nipples [40]. Also, some infants often bite on the nipples of their mothers when they start teething [43]. For such infants, giving something cold and wet to chew on a few minutes before breastfeeding can help avoid this problem [43].

##### *1.4.2 Breast engorgement*

The gradual buildup of blood and milk in the breast a few days after birth without the milk being removed could lead to breast engorgement [41]. When a breast is engorged, it becomes swollen, hardened, and very painful [41]. The nipple may not stick out well to allow the infant to latch on it correctly [40]. To prevent engorgement, mothers must relax in a comfortable position when breastfeeding [43]. Mothers must also try to feed their infants more often or express their breast milk manually or with a breast pump [43]. Discomfort that comes with breast engorgement could be alleviated by taking warm showers and applying warm compresses on the breast [43].

##### *1.4.3 Clogged milk duct*

The milk duct can become plugged when breast milk is not completely drained from the breasts in successive breastfeeding sessions [40]. This could happen if the infant does not feed regularly or the mother skips feeding [40]. To remove the plug, the milk duct area can be massaged by putting gentle pressure [40].

##### *1.4.4 Mastitis*

This condition usually occurs within the first 12 weeks after birth [42]. It occurs when there is either the obstruction of the breast milk ducts, nipple cracks or there is

infection by microorganisms like *Escherichia coli*, streptococci, and staphylococci [42]. Breasts become reddish, and tender, and mothers could develop fever [43]. To prevent mastitis, the breasts must be emptied with the appropriate breastfeeding technique [43]. Also, if pain becomes unbearable, the mother will need to be evaluated by an International Board-Certified Lactation Consultant (IBCLC or a physician).

### **1.5 When should a baby or a mother not breastfeed**

Although breastfeeding is recommended as the optimal nutrition for the infant, it is a personal choice and if a mother is not comfortable with it or has medical contraindications, may choose not to breastfeed [9]. However, under the circumstances listed below, mothers and newborns may be advised not to breastfeed [3, 9, 42, 44]:

- Mother has HIV infection and AIDS
- Mother has active tuberculosis
- Mother has T-cell leukemia or any other cancer and is receiving chemotherapy
- Mother is a drug addict or heavy user of alcohol
- Mother is exposed to environmental pollutants
- Infant has galactosemia and cannot metabolize lactose

## **2. Infant formula feeding**

Although infant formula has an important role in infant feeding, it cannot be said to be an absolute substitute for breast milk, and the use of infant formula must be the last option to feed infants in early life if mothers cannot breastfeed [1, 10]. Extensive evidence has shown that human breast milk contains many bioactive compounds and substances that support the building of the immune system and brain development of infants which cannot be found in infant formula and other human milk substitutes [45]. Infant formula processing companies only try to mimic the composition of human breast milk hence, the health benefits of breast milk cannot be equated to infant formula [10, 25, 45]. It is recommended that mothers who cannot do exclusive breastfeeding feed their infants breast milk for at least four months before introducing infant formula [4, 9]. However, if mothers cannot breastfeed their infants, they are advised to use infant formula and other appropriate human milk substitutes, which are mainly intended to be an effective substitute for breast milk [45].

### **2.1 Types of infant formula**

There are three main categories of infant formulas. These are cow milk-based formula, soy-based formula, and specialized formula [45]. The distinctions between these types of formulas are in terms of nutrition, energy content, taste, the bioavailability of nutrients, and cost [45]. The cow milk-based formula is the commonest type of formula for feeding most infants in many countries [46]. Raw cow's milk naturally contains high amounts of fats, minerals, and protein compared to human breast milk [47]. Hence, in



the processing of cow milk-based formulas, the nutrients in raw cow’s milk are diluted to levels similar to that of human breast milk [46]. Soy-based formulas are produced from soy milk and are usually intended to be given to infants with galactosemia or congenital lactase deficiency [45]. Due to soy allergies, it is recommended that mothers pay attention to signs of soy allergies like skin rashes and diarrhea during the introduction of soy-based formulas, especially to infants who are less than six months old [45]. Specialized formulas are mainly synthesized from protein hydrolysate and amino acids and are intended for infants who cannot tolerate cow’s milk or soy-based formulas [46]. Finally, there is no brand of infant formula that is best for all infants. Only infant formula specifically made for infants within a certain age category must be selected for feeding infants, and the infant formula selected must meet the FDA standards regarding the nutritional composition of the type of formula [27]. The health benefits of human breast milk over infant formulas are summarized in **Table 2** [4, 9, 22, 27, 29].

## 2.2 Complementary feeding and infant food choices

At six months of age, breastmilk continues to be an important source of nutrition but is insufficient to provide all the nutrient needs of infants [4]. Therefore, infants must be introduced to other foods in addition to breastmilk, to keep up with their growing needs for energy and nutrients. This process of introducing other foods is called complementary feeding [13]. Complementary feeding must begin after six months when breast milk alone is no longer enough to meet all the nutritional needs of infants, and therefore other sources of food are needed [3]. The American Academy of Pediatrics and the World Health Organization recommend introducing complementary foods at approximately 6 months of age [4, 48]. The introduction of complementary foods before 4 months of age may be too early for many health reasons [49]. Firstly, infants at this time are not developmentally ready for solid complementary foods [1, 48, 49]. The gut of an infant is more permeable at this stage and gastrointestinal

Nutrient factor	Breast milk	Infant formula
Carbohydrates	Rich in lactose and oligosaccharides	Some formulas do not have lactose and oligosaccharides
Fats & oils	Rich in omega 3 and cholesterol. All fats and oils are highly digestible and absorbed. Milk composition is adjusted to the infant’s needs.	No DHA. Digestion and absorption are usually not incomplete. Milk composition cannot be adjusted to the infant’s needs.
Proteins	Soft easily digestible whey protein. Contains growth factors. Lactoferrin for intestinal health, lysozyme	Casein proteins are hard to digest. No growth factors. No Lactoferrin and lysozyme
Minerals	Iron, zinc, and calcium are better absorbed	Iron, zinc, and calcium are not well absorbed
Immune boosters	Contains White Blood Cells	No live White Blood Cells
Enzymes and hormones	Rich in digestive enzymes and hormones	No digestive enzymes and hormones

**Table 2.**  
*Comparison of breast milk and infant formula.*

colonization of microflora is not fully established [50]. Also, infants may be infected and suffer from respiratory and diarrheal illnesses because their immune system is still developing [49]. More so, the early introduction of complementary foods could put undue stress on many of the developing internal organs of infants such as the immature renal and digestive systems [49]. Infants could also develop food allergies [13]. Lastly, infants who are introduced to complementary foods early are unlikely to be fed sufficient amounts of breastmilk which is the ideal food for infants until six months old [13]. Furthermore, many infants are at high risk of undernutrition after six months of age [3]. This is because feeding infants at this age with the right foods in the right amounts could be a challenge for many mothers [37]. Studies have shown that infants after six months are highly at risk of stunting, being underweight, and wasting, as well as food-borne illnesses [1, 3, 4, 51]. Hence, the World Health Organization recommends complementary feeding must be timely, adequate, safe, and properly fed [3, 4]. That is, complementary foods must provide sufficient energy, protein, and micronutrients to meet the nutritional needs of infants, they must be hygienically prepared and stored, and fed with kempt hands using clean feeding utensils including feeding bottles.

### **2.3 Complementary food consistency, frequency, and energy density**

Generally, the majority of infants after 6 months should be able to eat pureed, mashed, and semi-solid foods [4, 13]. The consistency and different varieties of complementary foods must be increased gradually for infants as they get older [13]. At eight months, most infants have to be able to eat snacks (including finger foods) alone and by 12 months, many infants can eat the same kinds of foods as the rest of the family [4]. Foods such as nuts, grapes, or raw carrots should not be fed to infants younger than 12 months because they could result in the choking of the trachea [14]. Moreover, the number of times infants are fed complementary foods must be gradually increased as they get older. The energy density and nutrient content of the complementary food must determine the frequency at which infants are fed, as well as the amounts infants, can consume at each feeding [14]. To begin complementary feeding, it is recommended to start feeding infants with semi-solid and solid foods at least 2–3 times per day between 6 and 8 months and moderately increase the frequency to 3–4 times daily after 8 months [4, 13]. It is important to feed infants with complementary foods that are nutrient dense like whole grains, meat, poultry, fish, eggs, and dairy products [12]. Frequent feeding may be required if the energy density and the nutrient content of complementary foods per meal are low to meet nutrient needs for growth and development [14].

### **2.4 Hygienic and safe practices during complementary feeding**

Complementary foods that are prepared under unhygienic conditions can make foods microbiologically unsafe to feed to the infant [15, 52]. Foods that are contaminated with microorganisms are harmful to feeding infants, especially when they are <2 years old because infants who are within these ages tend to have immature immune systems and are highly vulnerable to microbial infections [52, 53]. Poor food hygiene practice is one of the main causes of childhood diarrhea and studies have shown that about 88% of infant deaths are due to poor sanitation, poor personal hygiene, and unsafe water supplies in developing countries [52, 54]. More so, inadequate cleaning of eating utensils, improper storage of complementary foods after preparation, lack of knowledge about safe food handling, and poor environmental

sanitation are major contributory factors to foodborne illnesses among infants [2, 4, 52, 55, 56]. Nonetheless, honey and honey-related foods are potential sources of the pathogenic bacteria (*Clostridium botulinum*) that cause botulism [57]. Therefore, these foods must not be introduced to infants until they are over 2 years old because the immune system of infants may not be fully developed to fight pathogenic bacteria [57]. Lastly, the following food safety and sanitary guidelines must be followed about handling complementary foods to prevent the risk of foodborne illnesses [2, 4, 56]:

- Before feeding infants, mothers and caregivers must properly wash their hands and that of their infants with soap and water
- Eating utensils must thoroughly be cleaned with soap and water before use during the preparation of complementary foods for infants
- Bottles that are difficult to clean must not be used to feed infants because they could harbor dirt/microbes that might be a potential source of contamination
- Complementary foods to be fed to infants later must be stored in either a refrigerator or freezer immediately after preparation
- Refrigerated or frozen complementary foods should be thawed and properly warmed/cooked to the right temperature before feeding to infants
- Leftover meals from eating episodes should be discarded and must not be kept to feed infants at a later time

## **2.5 Food allergy and complementary feeding**

According to the American Academy of Pediatrics Committee on Nutrition guidelines for the introduction of complementary foods, mothers with a family history of food allergies from eggs, milk, peanuts, soy, and shellfish must delay the introduction of any of these foods to their infants [50, 58]. For infants at risk of milk allergy, dairy products must only be given after the first year of life [58]. For allergies to eggs, peanuts, soy, and shellfish, these foods must not be given to infants until they are two years of age [50]. In addition, to be able to identify potential food allergies, it is recommended that single-ingredient foods be given to infants first in the early stages of complementary feeding [13].

## **2.6 Expression of breast milk**

In the past few decades, breast milk expression was used mainly as a means to feed preterm and sick babies [59]. However, breast milk expression has become more of a norm in many societies for mothers because of convenience and the need for mothers to return to work after delivery [59]. Currently, breast milk expression forms an essential part of breastfeeding behavior among mothers, especially in developed countries [60]. In addition, the expression of breast milk has become a useful alternative for mothers to feed their babies with breast milk when direct breastfeeding is not possible, thereby allowing mothers to continue feeding their infants with breast milk [59]. Breast milk can be expressed in two main ways, either by hand expression or by the use of pumps [61]. In the first few days after birth, hand expression may be used to initiate milk production by the stimulation of the breast with the bare hand [61].

Studies have shown that breast milk expression by hand is more effective at enhancing milk production and increasing the duration of breastfeeding [61]. Breast pump plays an important role in breast milk expression and the continuation of breastfeeding among working mothers [62]. There are three main types of breast pumps and these are manual, battery, and electric pumps [63]. A manual breast pump requires the use of the hand to manually operate a pump to remove milk from the breast into a receptacle, but the battery and electric operated pumps respectively require battery and electricity as sources of power to extract breast milk from the breast. The selection of a particular type of pump for breast milk expression is dependent on factors such as time, cost, the volume of milk required and accessibility to power [63]. The battery and electric pumps work faster than the manual pump and are more suitable for mothers who have busy work schedules. A manual pump is also cheaper and easier to operate although it is not as efficient as an electric pump [63]. The following recommended guidelines for the expression of breast milk and storage are intended to maintain the safety and quality of breast milk after expression [60, 63, 64]:

- Properly wash hands with soap and water before expressing milk. Hand sanitizers may be used if soaps and water are unavailable
- Clean breast pumps thoroughly with soap and water before use for milk expression. If expressing by hand, the receptacle to collect the breast milk must be well cleaned
- Ensure that the contact surfaces of the areas where the milk expression is to be carried out are cleaned
- Clean all utensils and breast pumps with soap and water immediately after use
- Store breast milk at the appropriate refrigerator or freezer temperature as soon as milk expression is completed

## **2.7 Methods of breast milk expression**

### *2.7.1 Hand expression*

Hand expression of breast milk is a technique where the hands are used instead of infants or breast pumps to extract milk out of the breasts into a container. Expressing breast milk by hand is an essential skill that lactating mothers must learn because it has the following benefits [61, 65]:

- It can be used to get colostrum out of the breast quickly to feed newborns who may be unable to suckle the breast in the early days after delivery or those who are not able to have effective latch.
- Hand expression stimulates milk production and studies have shown that expression of breast milk by hand is more effective at helping to establish milk supply within the 24 hours after birth than expression by breast pumps.
- Expression of breast milk by hand facilitates easy emptying of the breasts and this aids the prevention of engorgement and mastitis.

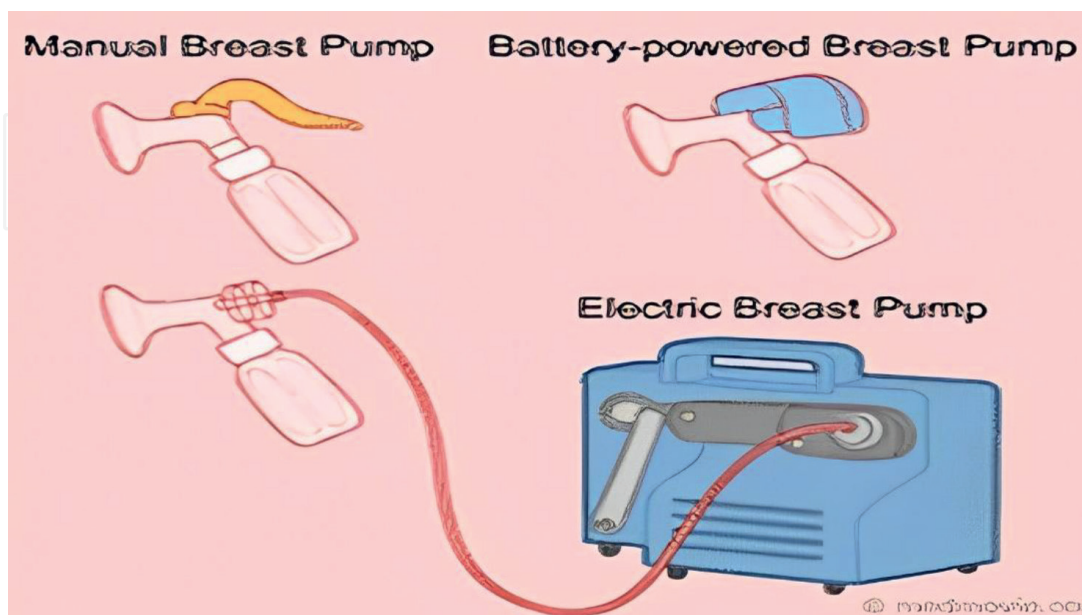
- Mothers who practice hand expression are more comfortable and confident about breastfeeding their infants.
- Hand expression requires no special device; it is cheaper, convenient, and easier to express breast milk by hand.

#### 2.7.1.1 Procedure for hand expression

- The right thumb should be positioned above the left nipple with the four fingers below the nipple at about 1 to 2 inches behind the nipple. The thumb and the fingers must make a C – shape at this point.
- The thumb and fingers must be pressed and gently squeezed together back towards the chest.
- The procedure ought to be repeated in a rhythmic pattern by pressing, gently squeezing, and releasing the thumb and fingers until the milk flow stops.
- The same procedure should be repeated for the right breast by using the left thumb and fingers [66].

#### 2.7.2 Breast pumps

Breast pumps are considered as medical devices that are used to facilitate the suction of breast milk in order to maintain or increase milk supply [16]. A typical breast pump is made up of a breast shield, pump, and milk receptacle [16]. The **breast shield is the** cone-shaped cup that fits over the nipple and the area around the areola. The pump creates a vacuum that pulls milk out of the breast. The milk receptacle is a detachable container that fits beneath the breast shield and receives breast milk simultaneously as it is being pumped.



Adapted from: <https://www.fda.gov/medical-devices/breast-pumps/types-breast-pumps>

### *2.7.2.1 Manual breast pumps*

These pumps are operated by hand and require the user to manually squeeze a lever consistently to create a vacuum on the breast to express milk [16]. Manual breast pumps are cheaper and can be used without electricity or battery [16]. The choice to use a manual breast pump has the following downside to it [63]. First, the use of manual pump is time-consuming and requires a lot of manual work. Manual pump is not as efficient as an electric or battery-operated breast pump due to its limited suction capability. The creation of a regular pumping rhythm is difficult when using a manual pump [16, 61].

### *2.7.2.2 Battery breast pumps*

These pumps operate on battery for milk expression from the breast and there are two models of these pumps: single and double models [61]. The single model is used to express milk from one breast at a time and the double model is used to express milk from both breasts synchronously. Also, there are wireless breast pumps that allow for hands-free pumping [16]. Battery pumps are ideal for traveling mothers who may not have access to an electrical outlet [16]. The following downsides are associated with the use of battery-operated pumps. Battery pumps are relatively expensive compared to manual pumps. Although they are efficient at suction, their capacity may be limited depending on the amount of milk to be expressed. The intermittent charging of batteries may be inconvenient, and some batteries may not last for longer hours [16, 61].

### *2.7.2.3 Electric breast pumps*

Electric breast pumps are motorized pumps that create suction to draw milk from the breasts and they are the most efficient breast pumps with the most output of milk expression [67]. They also come in different models that can either express milk from one breast or both breasts at the same time [67]. The choice to use an electric breast pump has the following downsides to it. Electric pumps are comparatively more expensive than manual and battery-operated pumps. The use of electric pumps may be accompanied with discomfort, pain, and soreness if the suction intensity is not regulated properly [65, 67].

## **2.8 Conclusion**

The practice of giving prelacteal feeds such as honey, sugar water, dates, herbal tea, and fruit juice to newborn babies within 1 to 3 days after birth is more common among many cultures in developing countries than in developed countries. This practice is inappropriate because it could be a potential source of infection in newborns, and it could also lead to poor feeding of infants accompanied with many health consequences. The human breast milk is the best food for infants because it is safe, sterile, contains antibodies that protect babies against many childhood illnesses, and has all the nutrients infants need for their growth and development in the first six months of life. Breastfeeding is beneficial for both mothers and their infants. Also, breastfeeding helps to build strong emotional bond between mothers and their infants. Although breast milk continues to be an important source of nutrition for growing infants, at six months and beyond breast milk alone becomes inadequate to provide all the nutrient needs of infants. Therefore, infants must be introduced to complementary foods

in addition to breast milk. Complementary foods must provide sufficient energy, protein, essential fats, and particularly, micronutrients to meet the nutritional needs of infants. During the introduction of complementary foods, mothers with a family history of food allergies must delay the introduction of any potential allergenic food to their infants until they are two years of age. One of the reasons why some mothers discontinue breastfeeding is because of busy work schedules. Therefore, the expression of breast milk has become a useful alternative for mothers to feed their infants breast milk when direct breastfeeding is not possible. Breast milk can be expressed in two main ways, either by hand expression or by the use of breast pumps.


### **Author details**

Prince Kwabena Osei\* and Alex Kojo Anderson  
Department of Nutritional Sciences, College of Family and Consumer Sciences,  
University of Georgia, Athens, USA

\*Address all correspondence to: prince.osei@uga.edu

### **IntechOpen**

---

© 2023 The Author(s). Licensee IntechOpen. This chapter is distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/3.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. 

## References

- [1] McAndrew F et al. *Infant Feeding Survey*. Leeds: Health and Social Care Information Centre; 2010, 2012
- [2] Stuebe A, Schwarz E. The risks and benefits of infant feeding practices for women and their children. *Journal of Perinatology*. 2010;**30**(3):155-162
- [3] World Health Organization. *Global Nutrition Policy Review 2016-2017: Country Progress in Creating Enabling Policy Environments for Promoting Healthy Diets and Nutrition*. WHO IRIS, Geneva, ID: who-275990; 2018. pp. 111-114
- [4] World Health Organization. *Infant and Young Child Feeding: Model Chapter for Textbooks for Medical Students and Allied Health Professionals*. Geneva: WHO Press; 2009. pp. 10-26
- [5] Nguyen P et al. Prolactal and early formula feeding increase risk of infant hospitalisation: A prospective cohort study. *Archives of Disease in Childhood*. 2020;**105**(2):122-126
- [6] Temesgen H et al. Prolactal feeding and associated factors in Ethiopia: Systematic review and meta-analysis. *International Breastfeeding Journal*. 2018;**13**(1):1-12
- [7] Berde AS et al. Determinants of pre-lacteal feeding practices in urban and rural Nigeria; a population-based cross-sectional study using the 2013 Nigeria demographic and health survey data. *African Health Sciences*. 2017;**17**(3):690-699
- [8] Camps G et al. Gastric emptying and Intra-gastric behavior of breast Milk and infant formula in lactating mothers. *The Journal of Nutrition*. 2021;**151**(12):3718-3724
- [9] Victora CG et al. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. *The Lancet*. 2016;**387**(10017):475-490
- [10] Packard V. *Human Milk and Infant Formula*. New York: Elsevier, Academic Press INC.; 2012. pp. 140-198
- [11] Schultz ST et al. Breastfeeding, infant formula supplementation, and autistic disorder: The results of a parent survey. *International Breastfeeding Journal*. 2006;**1**(1):1-7
- [12] Agostoni C, Przyrembel H. The timing of introduction of complementary foods and later health. *Evidence-Based Research in Pediatric Nutrition*. 2013;**108**:63-70
- [13] West C. Introduction of complementary foods to infants. *Annals of Nutrition and Metabolism*. 2017;**70**(Suppl. 2):47-54
- [14] Chiang KV et al. Timing of introduction of complementary foods—United States, 2016-2018. *Morbidity and Mortality Weekly Report*. 2020;**69**(47):1787
- [15] Samady W et al. Recommendations on complementary food introduction among pediatric practitioners. *JAMA Network Open*. 2020;**3**(8):e2013070-e2013070
- [16] Eglash A, Malloy ML. Breastmilk expression and breast pump technology. *Clinical Obstetrics and Gynecology*. 2015;**58**(4):855-867
- [17] Tariku A et al. Factors associated with prolactal feeding in the rural population of Northwest Ethiopia: A community cross-sectional study.



International Breastfeeding Journal. 2016;**11**(1):1-7

[18] Pirzada S et al. Use of PRELACTEAL feeds-study IN tradition. Pakistan Armed Forces Medical Journal (PAFMJ). 2021;**71**(5):1718-1721

[19] Ogundele T, Ogundele OA, Adegoke AI. Determinants of prelacteal feeding practices among mothers of children aged less than 24 months in Ile-Ife Southwest Nigeria: A community cross-sectional study. The Pan African Medical Journal. 2019;**34**:1-6. DOI: 10.11604%2Fpamj.2019.34.172.17642

[20] Sako S. Prelacteal feeding practice and associated factors among mothers of children less than two years of age in Ethiopia: A multilevel analysis. Heliyon. 2022;**8**(4):e09339

[21] Кисельова М et al. Breastfeeding is the-"Gold Standard" old experience and new scientifically proven benefits. Неонатологія, хірургія та перинатальна медицина. 2022;**12**(2):53

[22] Shamir R. The benefits of breast feeding. Protein in Neonatal and Infant Nutrition: Recent Updates. 2016;**86**:67-76

[23] Lawrence RA. 3-Physiology of lactation. In: Breastfeeding 9th edition, A Guide for the Medical Profession. Elsevier INC; 2022. pp. 58-92

[24] Boquien C-Y. Human milk: An ideal food for nutrition of preterm newborn. Frontiers in Pediatrics. 2018;**6**:295

[25] Ríos J, Valero-Jara V, Thomas-Valdés S. Phytochemicals in breast milk and their benefits for infants. Critical Reviews in Food Science and Nutrition. 2022;**62**(25):6821-6836

[26] Nembongwe G et al. Beliefs, attitudes and practices of mothers

towards breastfeeding colostrum and factors associated: Case of the Yaounde Gynaeco-obstetric and Pediatric hospital. Journal of Food Science Nutrition. 2022;**8**(130):2

[27] Andreas NJ, Kampmann B, Le-Doare KM. Human breast milk: A review on its composition and bioactivity. Early Human Development. 2015;**91**(11):629-635

[28] Breastfeeding, S.o et al. Breastfeeding and the use of human milk. Pediatrics. 2012;**129**(3):e827-e841

[29] Kordus A. The Benefits of Breastfeeding. 2014

[30] Riordan J, Wambach K. Breastfeeding and Human Lactation. 4th ed. Massachusetts: Jones & Bartlett Publishers; 2010. pp. 215-296

[31] Robbins ST, Beker LT. Infant Feedings: Guidelines for Preparation of Formula and Breastmilk in Health Care Facilities. American Dietetic Association. Pediatrics Nutrition Practice group Publishers; 2004. pp. 37-42

[32] Hester SN et al. Is the macronutrient intake of formula-fed infants greater than breast-fed infants in early infancy? Journal of Nutrition and Metabolism. 2012;**2012**:1-13. Article ID 891201. DOI: 10.1155/2012/891201

[33] Salm Ward TC, Kanu FA, Anderson AK. Trends and factors associated with breastfeeding and infant sleep practices in Georgia. Journal of Community Health. 2018;**43**(3):496-507

[34] Busch DW, Logan K, Wilkinson A. Clinical practice breastfeeding recommendations for primary care: Applying a tri-core breastfeeding conceptual model. Journal of Pediatric Health Care. 2014;**28**(6):486-496

- [35] Hatsu IE, McDougald DM, Anderson AK. Effect of infant feeding on maternal body composition. *International Breastfeeding Journal*. 2008;**3**(1):1-8
- [36] Tengku Alina TI, Wan Manan WM, Mohd Isa B. Factors predicting early discontinuation of exclusive breastfeeding among women in Kelantan, Malaysia. *Health and the Environment Journal*. 2013;**4**(1):42-54
- [37] Yaqub A, Gul S. Reasons for failure of exclusive breastfeeding in children less than six months of age. *Journal of Ayub Medical College Abbottabad*. 2013;**25**(1-2):165-167
- [38] Tomori C. Overcoming barriers to breastfeeding. *Best Practice & Research Clinical Obstetrics & Gynaecology*. 2022;**83**:60-71. DOI: 10.1016/j.bpobgyn.2022.01.010
- [39] Powell R, Davis M, Anderson AK. A qualitative look into mother's breastfeeding experiences. *Journal of Neonatal Nursing*. 2014;**20**(6):259-265
- [40] Scadden J. Breastfeeding and Lactation Consulting. Fay W. Whitney School of Nursing, University of Wyoming, Honors Capstone Project. 2022. pp. 9-15
- [41] Çaka SY, Topal S, Altınkaynak S. Anne sütü ile beslenmede karşılaşılan sorunlar. *Journal of Pediatric Nursing-Special Topics*. 2017;**3**(2):120-128
- [42] Özhüner Y, Özerdoğan N. Breast problems related to breastfeeding and alternative approaches to the solutions. 1st ed. No: 47083. *Current Research in Health Sciences*, Gece Publishing; 2022. pp. 220-226
- [43] Berens PD. Breast pain: Engorgement, nipple pain, and mastitis. *Clinical Obstetrics and Gynecology*. 2015;**58**(4):902-914
- [44] Kuhn L, Reitz C, Abrams EJ. Breastfeeding and AIDS in the developing world. *Current Opinion in Pediatrics*. 2009;**21**(1):83-93
- [45] Martin CR, Ling P-R, Blackburn GL. Review of infant feeding: Key features of breast milk and infant formula. *Nutrients*. 2016;**8**(5):279
- [46] Koletzko B et al. Global standard for the composition of infant formula: Recommendations of an ESPGHAN coordinated international expert group. *Journal of Pediatric Gastroenterology and Nutrition*. 2005;**41**(5):584-599
- [47] Hochwallner H et al. Cow's milk allergy: From allergens to new forms of diagnosis, therapy and prevention. *Methods*. 2014;**66**(1):22-33
- [48] Grummer-Strawn LM, Scanlon KS, Fein SB. Infant feeding and feeding transitions during the first year of life. *Pediatrics*. 2008;**122**(Supplement\_2):S36-S42
- [49] Krebs NF. Food choices to meet nutritional needs of breast-fed infants and toddlers on mixed diets. *The Journal of Nutrition*. 2007;**137**(2):511S-517S
- [50] Kemp AS et al. Guidelines for the use of infant formulas to treat cows milk protein allergy: An Australian consensus panel opinion. *Medical Journal of Australia*. 2008;**188**(2):109-112
- [51] Yalew BM. Prevalence of malnutrition and associated factors among children age 6-59 months at lalibela town administration, north WolloZone, Anrs, Northern Ethiopia. *Journal of Nutrition Disorders Therapy*. 2014;**4**(132):2161-0509

- [52] Demmelash AA et al. Hygienic practice during complementary feeding and associated factors among mothers of children aged 6-24 months in Bahir Dar Zuria District, Northwest Ethiopia, 2019. *Journal of Environmental and Public Health*. 2020;**2020**:1-7. Article ID 2075351. DOI: 10.1155/2020/2075351
- [53] Parvez SM et al. Escherichia coli contamination of child complementary foods and association with domestic hygiene in rural Bangladesh. *Tropical Medicine & International Health*. 2017;**22**(5):547-557
- [54] Usfar AA et al. Food and personal hygiene perceptions and practices among caregivers whose children have diarrhea: A qualitative study of urban mothers in Tangerang, Indonesia. *Journal of Nutrition Education and Behavior*. 2010;**42**(1):33-40
- [55] Redmond EC, Griffith CJ. The importance of hygiene in the domestic kitchen: Implications for preparation and storage of food and infant formula. *Perspectives in Public Health*. 2009;**129**(2):69-76
- [56] Msuya J. Food Safety of Homemade Complementary Foods in Morogoro Municipality-Tanzania. The Ohio State University and OhioLINK Publishers; 2016. pp. 32-69
- [57] Borriello PS. Infant botulism. In: *Clostridia in Gastrointestinal Disease*. CRC Press Publishers; 2018. pp. 39-54
- [58] Briefel RR et al. Feeding infants and toddlers study: Improvements needed in meeting infant feeding recommendations. *Journal of the American Dietetic Association*. 2004;**104**:31-37
- [59] Daniels S et al. Donor human milk for the high-risk infant: Preparation, safety, and usage options in the United States. *Pediatrics*. 2017;**139**(1):1-3
- [60] Jiang B et al. Evaluation of the impact of breast milk expression in early postpartum period on breastfeeding duration: A prospective cohort study. *BMC Pregnancy and Childbirth*. 2015;**15**(1):1-13
- [61] Becker GE, Smith HA, Cooney F. Methods of milk expression for lactating women. *Cochrane Database of Systematic Reviews*. 2016;**9**
- [62] Bass JL, Gartley T, Kleinman R. Outcomes from the Centers for Disease Control and Prevention 2018 breastfeeding report card: Public policy implications. *The Journal of Pediatrics*. 2020;**218**:16-21
- [63] Lawrence RA. Storage of human milk and the influence of procedures on immunological components of human milk. *Acta Paediatrica*. 1999;**88**:14-18
- [64] Peters MDJ, McArthur A, Munn Z. Safe management of expressed breast milk: A systematic review. *Women and Birth*. 2016;**29**(6):473-481
- [65] Meier PP et al. Which breast pump for which mother: An evidence-based approach to individualizing breast pump technology. *Journal of Perinatology*. 2016;**36**(7):493-499
- [66] Meek JY, Noble L. Breastfeeding and the use of human milk. *Pediatrics*. 2022
- [67] Leiter V et al. Pay at the pump?: Problems with electric breast pumps. *Social Science & Medicine*. 2022;**292**:114625