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Chapter

Infant and Young Child Feeding in the Developed and Developing Countries

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Abstract

Infant feeding challenges continue to manifest in developed and developing countries. Worldwide, more than 80% of babies are breastfed in the first few weeks of birth. However, about 37%, 25%, and less than 1% are exclusively breastfed at 6 months of age in Africa, the United States of America, and the United Kingdom, respectively. These statistics are far below the World Health Organization targets of 50% and 70% by 2025 and 2030, respectively. Complementary feeding practices are varied as well due to nonadherence to Infant and Young Child Feeding (IYCF) guidelines among parents. This accounts for the current trends in malnutrition in children under-5 years of age, adolescents, and the youth, and leads to intergenerational malnutrition. In this chapter we have included sections on appropriate infant feeding; including how to initiate breastfeeding in the first hour of birth, how to exclusively breastfeed infants until 6 months of age, how to complement breastfeeding after 6 months of infant's age as well as continuing to breastfeed until 24 months of age and even beyond. Furthermore, we have included a description of how mothers who are unable to breastfeed can feed their infants on expressed breastmilk or replace breastmilk with appropriate homemade or commercial formula. This chapter as well covers infant feeding in prematurity.

Keywords: breastfeeding, diet, feeding, infant, nutrition, young child

1. Introduction

Infant feeding challenges continue to manifest in both developed and developing countries across the world. For instance, in the United States, of the 84.1% who started breastfeeding in 2017, only 25% were exclusively breastfed at 6 months of age [1]. In the UK, the percentage is even less than 1% for infants exclusively breastfed at 6 months [2]. In Sub-Saharan Africa, only 37% of infants aged less than 6 months are exclusively breastfed [3]. This is even less in South Africa and Uganda with 32% and 36%, respectively [4, 5]. Most countries are still far away from the World Health Organization (WHO) set targets of ensuring that at least 50% and 70% of infants

are exclusively breastfed by 2025 and 2030, respectively [6, 7, 8]. Complementary feeding practices after 6 months of age have continued to vary due to nonadherence to Infant and Young Child Feeding (IYCF) guidelines. Only 40.1% and 32% of mothers are adherent to complementary feeding guidelines in Uganda and South Africa, respectively [4, 9]. This contributes to inappropriate infant feeding and high levels of malnutrition. For instance, the rates of stunting in South Africa and Uganda are 27% and 44.9%, respectively, for children below 5 years of age [4, 10, 11]. Infant feeding practices determine the nutrition, health, survival, growth, and development of children. It also determines the intellectual ability, quality of future citizens, social-economic transformation, and development of a country. Optimal infant feeding is recommended to achieve a healthy and economically able future generation. Optimal infant feeding includes initiation of breastfeeding within 1 h of birth, usually referred to as the golden hour, followed by active exclusive breastfeeding up to 6 months of age, unless advised otherwise by a qualified health worker. This is followed by another important age from 6 to 24 months and beyond in which breastfeeding is complemented with other foods. However, due to the risk of transmitting HIV to the infant through breastfeeding, HIV-positive mothers who have adhered to their Antiretroviral drugs (ARVs) are encouraged to breastfeed for 1 year [12]; this includes exclusive breastfeeding for the first 6 months, followed by complementary feeding up to 1 year of age. This is thought to reduce the risk of severe malnutrition among infants as well as minimize the risk of Mother to Child Transmission (MTCT). Mothers who do not wish to breastfeed can replace breastfeeding with an Affordable, Feasible, Accessible, Sustainable, and Safe (AFASS) breastfeeding substitute. Mixed feeding has been associated with a high risk for malnutrition and MTCT of HIV among HIV-exposed infants. In a study, Ogbo found that, despite this guide, infant feeding practices are varied across countries resulting in childhood illnesses, such as diarrhea [13]. This has led to poor nutritional outcomes, morbidity, and mortality among children under 5 years of age, as well as contributing to intergenerational malnutrition. Consequently, infant, childhood, and adolescent growth has been tremendously affected. The situation is more critical when it comes to the girl child; malnutrition in the girl child adversely affects the development of reproductive organs, thus increasing the risk of these young girls getting obstetric complications during labor and delivery at a later age. Poor nutritional status during early adolescent development has been cited as one of the indirect contributing factors to high maternal morbidity and mortality in developing countries. Additionally, poor nutrition contributes to poor intellectual ability. This has implications on the ability to perform in school and consequently impacts negatively on women's education and socio-economic empowerment.

2. Initiation of breastfeeding after birth

Breast milk is the most nutritious food for a newborn and infants below 6 months of age. Initiation of breastfeeding within the first hour of birth ensures that the newborn receives colostrum or the first milk that is rich in nutrients and immunological factors [14]. Colostrum is richer in bioactive components with immune-enhancing properties. These include immunoglobulins, lactoferrin, leukocytes, lysozymes, alpha-lactalbumin, and beta-lactoglobulin compared to mature milk. Immunoglobulin A (IgA) is the most abundant and IgM and IgG antibodies are in lower concentrations in breast milk. These confer protection against infection before the infant's natural

immune system is built. IgA coats and seals a baby's respiratory and intestinal tract to prevent germs, such as bacteria, viruses, fungi, and parasites from entering the body and bloodstream. IgG is involved in the prevention of autoimmune and allergic diseases during childhood [15]. Despite the benefits of early initiation of breastfeeding, only 58.3% of mothers initiate breastfeeding within 1 h of birth in Sub-Saharan Africa with a huge variation between countries, ranging from 24 to 86% [16]. Immediately after the baby is born, the midwife places the baby on the mother's abdomen. The baby is dried, stimulated to breathe, and then is placed onto the mother's chest with the baby's mouth closer to the mother's breasts. Normally the baby shows signs that he or she wants to breastfeed called breastfeeding readiness cues, as they are commonly referred to, are then recognized by the mother or caregiver. These may include mouthing—frequently opening the mouth and leaking the lips, rooting—moving the mouth toward whatever touches the baby's cheeks, sucking—attempts to suckle whenever the baby's mouth or lips touches anything, and hand to mouth or hand to hand movements. If the baby's mouth is not wide open, the mother or other caretaker should bring the nipple to touch the baby's cheeks, the baby then moves the mouth toward the nipple and opens the mouth. The mother should then support the breast and put the nipple and areolar into the wide open mouth of the baby. The baby will then spontaneously start to suckle. Mothers with big breasts will need to support the breast for the baby, those with small breasts may only be required to position the baby in close proximity to the breast during the time when the mother is still lying on her back and the baby is lying skin to skin during the third stage of labor. When the baby becomes hungry and is not given the breast, she or he shows the breastfeeding readiness cues, and when giving the breast is further delayed, it will make the baby vigorously cry and will be irritable. All mothers should be supported to initiate and establish breastfeeding as soon as possible after birth and preferably within the first hour after childbirth. Breastfeeding within the first hour after birth has very profound benefits. It will result in an early and sustained breastmilk production by the mother as well as help in shortening the third stage of labor. After birth, the reduction in progesterone and estrogen following the expulsion of the placenta triggers the prolactin reflex and its increased production from the anterior pituitary gland. Further production of prolactin is stimulated when the baby continues to suckle the breast [17] (**Figure 1**). This ensures that the breast is full of breast milk and adequate for the infant.

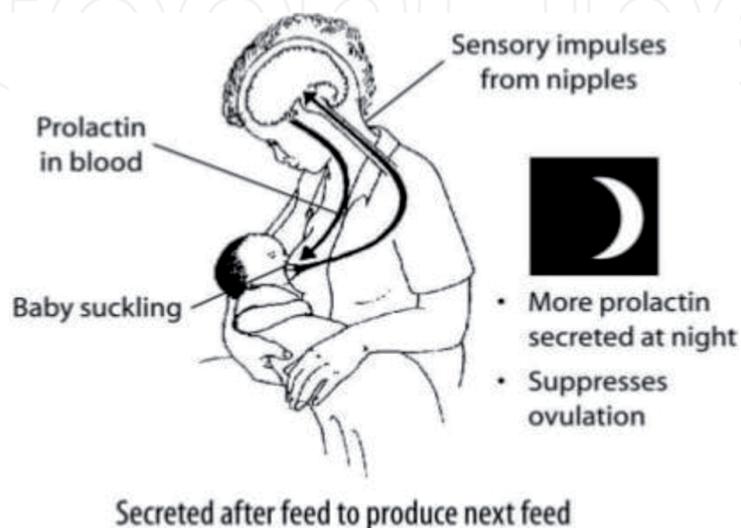


Figure 1.
Prolactin reflex.

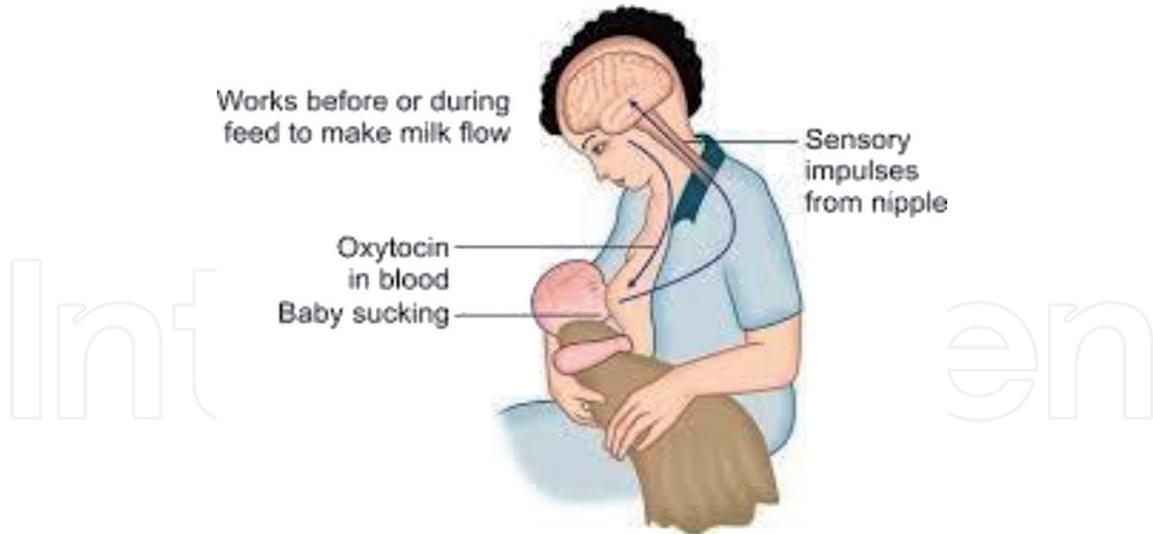


Figure 2.
Oxytocin reflex.

Suckling the breast stimulates oxytocin from the posterior pituitary [17]. Oxytocin is responsible for milk ejection or let-down reflex (**Figure 2**). Oxytocin causes the myoepithelium of the breast to contract, this causes the temporarily stored breastmilk to be released from the lactiferous ducts and ampulla, out through the pores of the nipple, and into the baby's mouth.

Milk ejection or let-down reflex can be triggered by suckling, thoughts, sights, sounds, or odors that a mother associates with her baby (**Figure 3**). In each of these cases, neurohumoral reflex leads to a burst of prolactin secretion as well as stimulation of the oxytocin reflex. Breastfeeding mothers should ensure that the breast is emptied on each breastfeeding occasion and should breastfeed at least every 2–3 h. The more frequently and thoroughly the breasts are emptied, the faster they will refill with breastmilk.

Immediately after childbirth, breast milk may not be present except for a small amount of colostrum, this may be troublesome for mothers with babies demanding to breastfeed and may lead to the introduction of pre-lacteal feeds, a practice that reduces

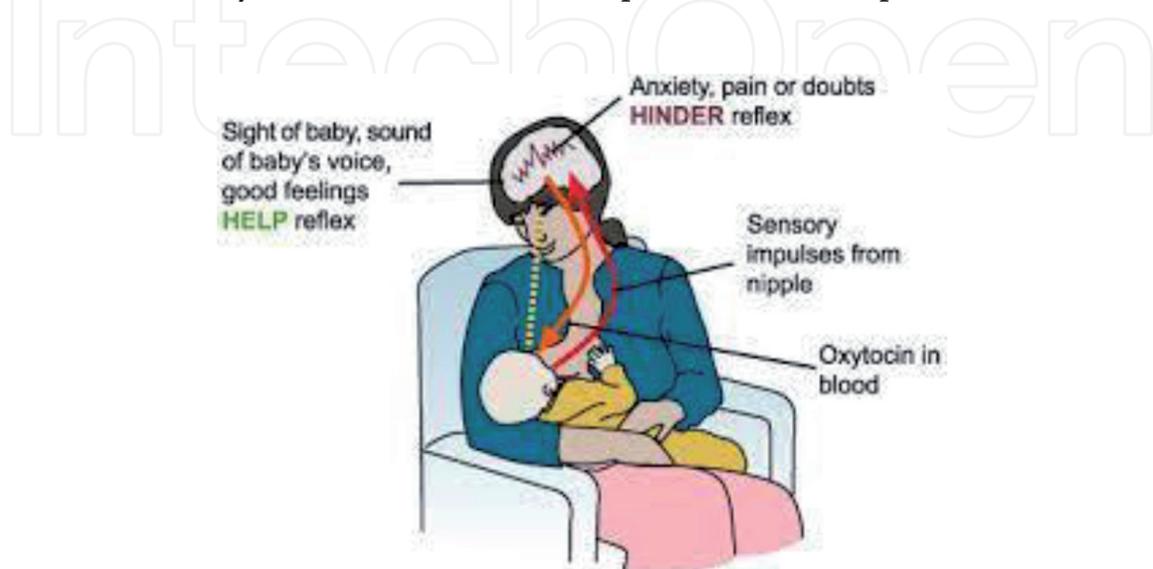


Figure 3.
Helping and hindering factors for the oxytocin reflex.

suckling frequency and reduces the amount of breastmilk. Mothers should be made aware that breast milk may fully appear in 1–7 days and average on the third day for most mothers depending on the frequency of breastfeeding, nutrition status, psychological status, especially anxiety and physical health of the mother. Mothers who deliver by caesarian section are less likely compared to their counterparts who deliver vaginally to initiate breastfeeding in the first 1 h of delivery [18]. This is due to the fact that mothers delivering by cesarean section will spend extra time (30 min to 1 h or more) in the theater as the operation is being concluded and during this time, the mother may not be in contact with the baby. In addition, mothers who are delivered by caesarian section usually have high anxiety levels and pain that hinder oxytocin reflex (**Figure 3**). Such mothers need extra support to ensure the early initiation of breastfeeding. Obstetric and medical complications associated with pregnancy, labor, and delivery that may delay breastfeeding should be anticipated, prevented, or managed early to reduce on the delay of breastfeeding [19, 20]. Mothers should be encouraged to breastfeed as early as when able for adequate breastmilk production. Each mother should receive instruction, assistance, and support in positioning and ensuring proper attachment on the breast until she is able to do so independently. Recommended techniques used to attach babies to breasts are discussed in this chapter later.

3. Exclusive breastfeeding

Exclusive breastfeeding is defined as giving only breast milk to the infant, without mixing it with water, other liquids, herbal preparations, or food in the first 6 months of life with the exception of vitamins, mineral supplements, or medicines. Exclusive breastfeeding during the first 6 months provides all the required nutrients to the baby. Offers protection against childhood illnesses, such as diarrhea and pneumonia. It leads to better physical growth, neuro-development, and increases intelligence [21]. In HIV-exposed infants, exclusive breastfeeding, in addition, offers protection against severe acute malnutrition, diarrhea, and even death [22]. Under normal circumstances, an infant should be exclusively breastfed for the first 6 months of life. Although this is associated with great benefits, the practice is still poor and in sub-Saharan Africa, only 36% of mothers exclusively breastfeed [23]. The mother should breastfeed every 2 h for a total of 8–12 times or more during day and night. However, mothers should learn to breastfeed every time the baby demands and may stimulate the baby to breastfeed if the baby does not demand the breast beyond 2 h. For successful exclusive breastfeeding, mothers should learn to position the baby and ensure appropriate attachment of the baby to the breast. Good baby positioning and attachment facilitate adequate breastfeeding. It ensures that both baby and mother are comfortable, the baby suckles optimally until the breast is emptied and he or she gets satisfied. There are some exceptional situations where the length of breastfeeding may be shortened. For instance, there are times when some babies at the age of 4 or 5 months may not be satisfied by breast milk alone. This may be due to unmodifiable factors, such as inadequate breastmilk production from the mother. A baby with a high body weight may also not be satisfied by breast milk alone at this age bracket despite all attempts to improve the quantity produced by the mother. In these special circumstances, other feeds may be introduced in the fourth or fifth months. Also, if the mother or baby has other illnesses other than HIV that makes the baby unable to exclusive breastfeeding for 6 months, other feeds may be introduced earlier. In such special circumstances, mothers are strongly advised to consult a qualified professional

health worker for advice before such other feeds are introduced. It is, therefore, imperative to also know how other feeds should be introduced to the baby's feeding practices. This topic is also elaborately discussed in this chapter later.

4. Attachment to the breast and baby positioning

Another important aspect of active and effective breastfeeding practice is how

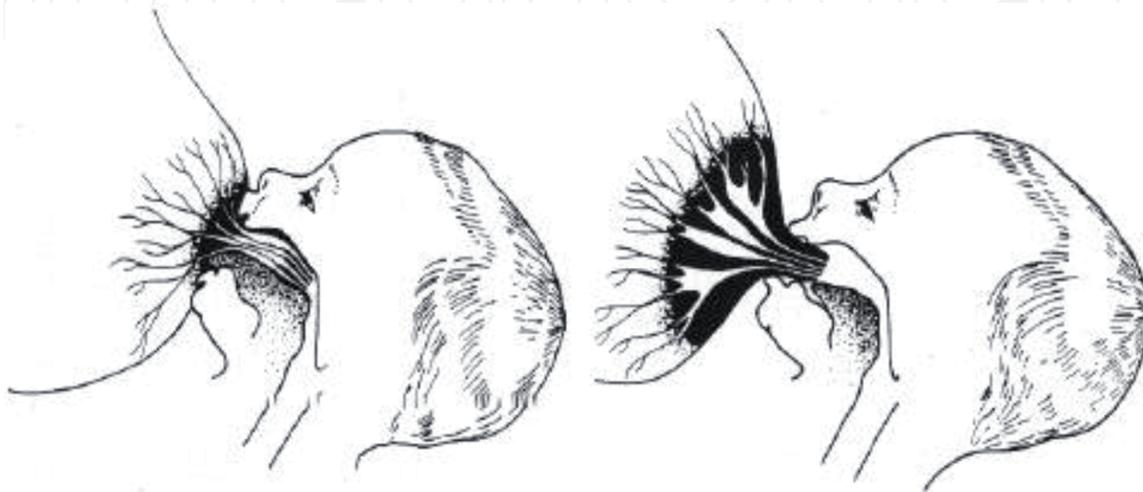


Figure 4.
Good and poor attachment to the breast.

to attach and position the baby onto the breast. Good attachment to the breast is



Figure 5.
Underarm position.



Figure 6.
Underarm position for twins.

necessary for effective suckling. The baby is well attached when he or she has taken much of the areola and the underlying tissues into his or her mouth, and the lower lip is turned outward (**Figure 4**). This attachment enables the baby to suckle adequately, fill the cheeks with breastmilk, and consequently swallow the milk well. Poor attachment may result in painful nipples, breast engorgement, less breastmilk production, unsatisfied baby, frustrated baby, and failure to thrive or gain weight.



Figure 7.
Cradle position.



Figure 8.
Cross cradle position.



Figure 9.
Side lying position.

Baby positioning entails steps the mother should follow to hold the baby and ensure that the baby reaches the breast without strain and the mother breastfeeds comfortably while relaxed. The baby position adopted by the mother may vary depending on whether the mother is seated, lying, has a small versus big baby, or is nursing twins. The different positions include; cradle baby position or hold, underarm position,

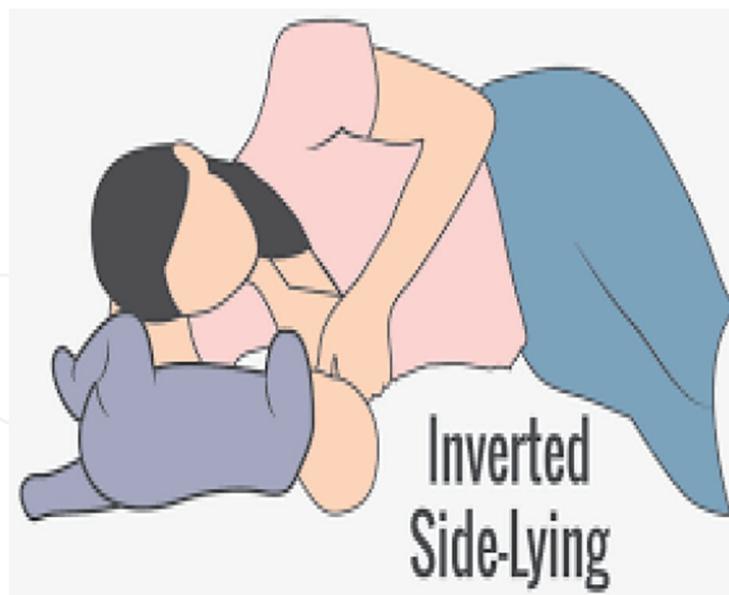


Figure 10.
Inverted side lying position.



Figure 11.
Cross position for twins.

cross-cradle, lying down, underarm position for twins, and cross position for twins (Figures 5–11). In each of these, mothers should note the four key points, which are as follows:

- a. The baby's body should be inline: A baby cannot suckle or swallow easily if his head is twisted or bent.

- b. The baby is held close to the mother's body: A baby cannot attach well to the breast if he or she is far away from it. The baby's whole body should almost face his or her mother's body.
- c. The baby is well supported: The baby's whole body is supported with the mother's arm along the baby's back. This is particularly important for newborns and young babies. For older babies, support from the upper part of the body is usually enough.
- d. Placing the *baby on the breast* with the *nose* at the level of *nipple* will encourage him or her to open the mouth wide and attach to the *breast* well.

Many mothers in developing countries know and commonly use cradle and side-lying breastfeeding positions. This leaves some mothers with no other options yet there are other positions that can be used for the comfort of the mother and the satisfaction of the baby. It is advisable to use various breastfeeding positions depending on the mother's comfort.

5. Complementary feeding and weaning practices

Complementary feeding is the feeding of the baby with other foods in addition to breastfeeding at 6 months of age when breastmilk alone is no longer adequate to meet the nutritional needs of the infant. In Sub-Saharan Africa, infant feeding is characterized by either early or late introduction of complementary feeds. In a study, 59% of mothers introduced other feeds early and 30.7% did not receive other foods between 6 and 8 months of infant's age [24]. Additional foods should be introduced into the infant's diet at 6 months of age and continued until breastfeeding is entirely stopped at 24 months of age or beyond if the mother so wishes to extend breastfeeding. Weaning is the process of stopping the infant from breastfeeding. Weaning should be done gradually; however, it may be done abruptly in HIV-positive mothers at 1 year of infant's age to reduce the risk of transmitting HIV to the infant. HIV-positive mothers who are well retained in HIV care and are adhering well to Highly Active Antiretroviral Therapy (HAART) are encouraged to breastfeed at least for the first 1 year of age [25, 26]. In 1 year, the mother exclusively breastfeeds for 6 months and introduces complementary feeds after 6 months of infant's age. The period from 6 to 24 months is critical and includes rapid growth and development. Due to this, the energy requirement doubles and other nutrient deficiencies are common if complementary feeds are not appropriately introduced as recommended (**Figures 12–15**).

Infants require adequate caloric intake to provide energy for growth and physical activity. The energy requirement increases with age. For example, at age < 3 months (3.5–5 kg), the energy requirement is 110 Kcal/kg/day (450–550 kcal); at age 3–5 months (5.5–7 kg), the energy requirement is 100 Kcal/kg/day (550–700 kcal); at age 6–8 months (8–9 kg), the energy requirement is 95 Kcal/kg/day (700–800 kcal) and age 9 months–1 year (9–10 kg), the energy requirement is 100 Kcal/kg/day (900–1000 kcal) (**Figure 12**). To fill the gap, the infant should be fed on energy rich and thick foods, such as porridge, banana (matooke), cassava, and Irish potato, from 6 to 24 months of age. This may be supplemented with cooking oil, ghee, and other sources of energy.

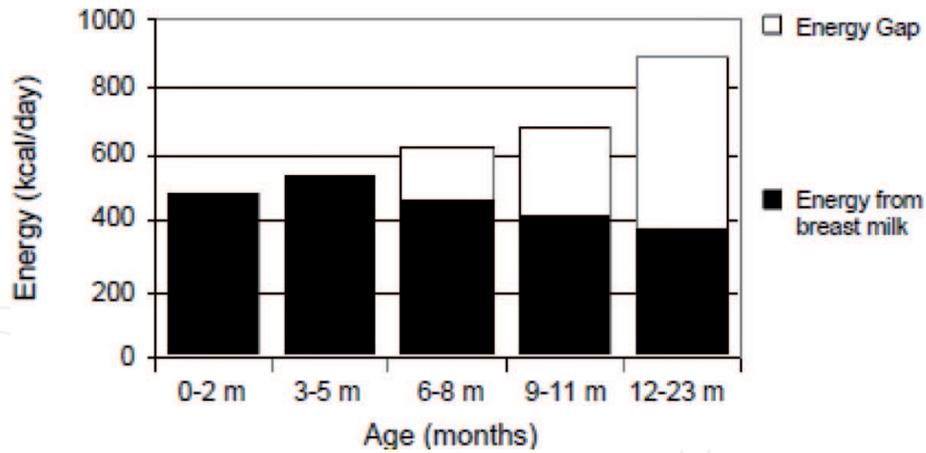


Figure 12.
 Energy requirement by age and amount supplied by breastmilk.

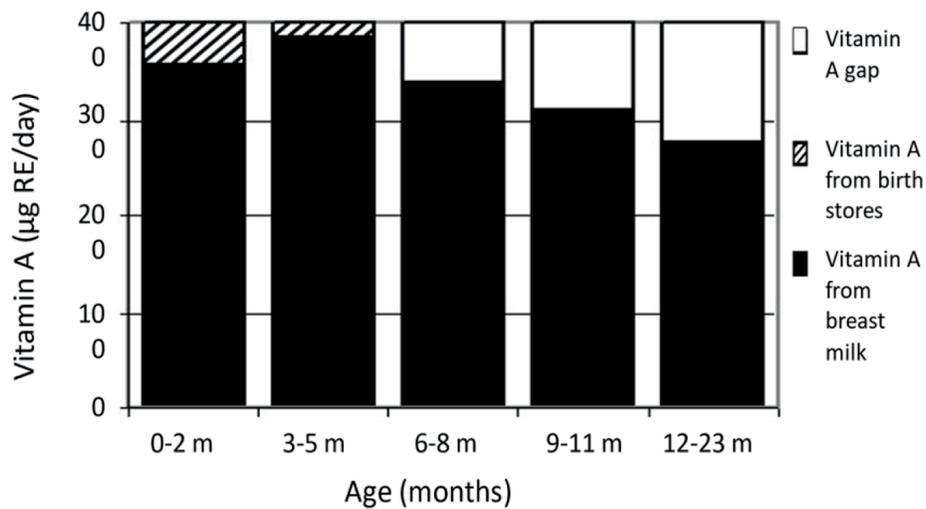


Figure 13.
 Vitamin A requirement by age and amount supplied by breastmilk.

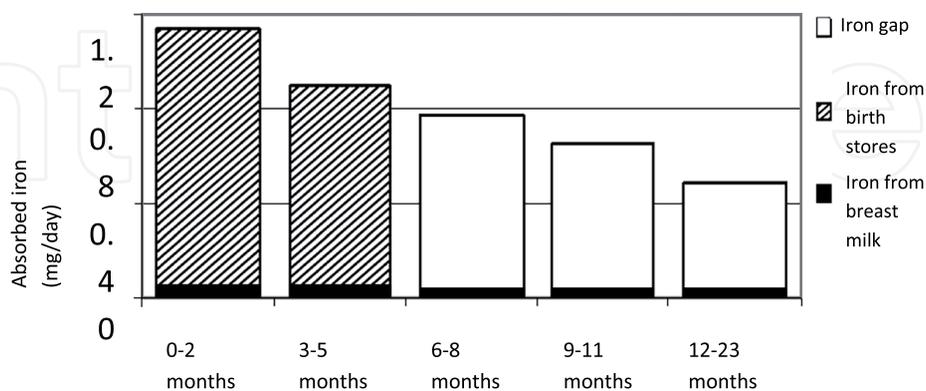


Figure 14.
 Iron requirement by age and amount supplied by breastmilk.

To fill the vitamin-A gap at 6 months of age, as shown in **Figure 13**, the infant's diet should be supplemented with dark-green leaves and yellow-colored fruits and vegetables, such as dodo, pumpkin, carrot, papaya, spinach, and mangoes.

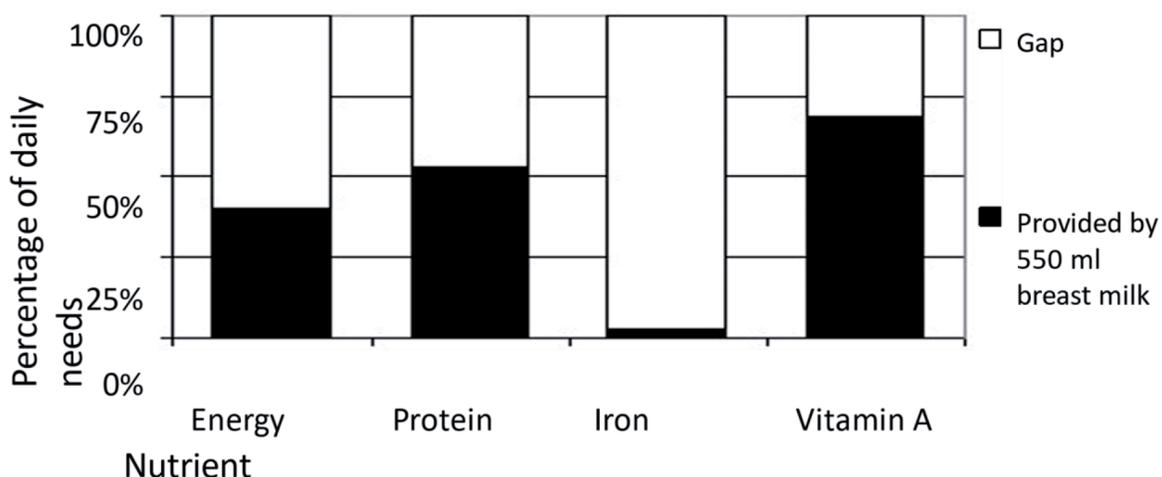


Figure 15. Summary of gaps to be filled by complementary foods for a 12–23-month-old child.

To fill the iron gap at 6 months of age, as shown in **Figure 14**, the infant’s diet should be supplemented with millet, dark leafy green vegetables, liver, poultry, and eggs.

To fill the protein gap, at 6 months of age, as shown in **Figure 15**, the infant’s diet should be supplemented with both animal and plant sources of proteins. Animal sources include; chicken, eggs, fish, meet, and milk. Plant sources include; beans, groundnuts, and peas.

To meet all the nutritional requirements, infants should receive nutritionally adequate and safe complementary foods while continuing to breastfeed for up to 24 months or beyond. Starting other foods in addition to breastmilk at 6 completed months of age can help the infant to grow well. After 6 months of age, infants should be fed on thick porridge and mashed foods. Mashed foods should include major nutrient ingredients, such as carbohydrates, proteins, fats, and vitamins in right-ful proportions. Mineral requirements are met by giving water and micronutrient supplements to the infant during feeding. It is important for parents to understand that complementary feeds should be timely, meaning that they should be introduced at appropriate infant age; they should be adequate both in nutrient variability and quantity; they should be safe. Foods should be well prepared, hygienic, well stored, and fed using clean hands and utensils. Additionally, parents should desist from using bottles and teats to feed their infants and instead use a cup and a spoon. This is because bottles and teats are difficult to clean and keep hygienic by many parents. Parents should feed infants in consistence with a child’s signals of appetite and satiety and the meal frequency and feeding should be suitable for age. Parents should take care in the feeding of infants by being responsive to the infant’s clues for hunger and also encourage the infant to eat, especially those that have reached the age for feeding themselves. There is variability in the zeal or enthusiasm to feed self across infants; those that are poor at feeding themselves will need additional support and encouragement from parents or caregiver. Feeding the child should take an active form. Children should be actively supported during feeding. They should be actively fed by adults and not by their fellow young ones. Each child should have his or her food on a separate serving plate. Parents or caregivers should not feed many children of varying age groups on the same plate. Feeding many children on the same plate, some children will be out-competed and will not be satisfied. In addition, in case the food served on the plate is eaten to completion, more food should be added and the child

encouraged to continue feeding until the child is satisfied and some food is left on the serving plate. World Health Organization (WHO) and the Ministry of Health (MoH) recommend that infants should initially receive complementary foods 2–3 times a day between 6 and 8 months, increase to 3–4 times daily between 9 and 11 months, and 12–24 months of age [27]. Additional nutritious snacks should also be offered 1–2 times per day for ages 12–24 months of age. Parents should gradually increase food thickness and variety as the infant gets older, adapting to the infant's requirements and abilities. Infants can eat soft mashed and semi-solid foods beginning at 6 months, by 8 months most infants can eat more solid foods. By 12 months, most infants can eat the same types of foods as consumed by the rest of the family while keeping in mind the need for nutrient-dense foods including animal-sourced foods like meat, poultry, fish, eggs, and dairy products. Parents should avoid foods in a form that may cause chokings, such as whole grapes, or raw carrots. Avoid giving drinks with low nutrient value, such as tea, coffee, and sugary soft drinks. Parents should limit the amount of juice offered to avoid displacing more nutrient-rich foods.

6. Replacement feeding practice

This refers to feeding an infant who is not breastfeeding with a diet that provides all the nutrients that the infant needs. This may be applicable in mothers who may not wish to breastfeed as in HIV-positive mothers or if a mother dies immediately after childbirth and the baby survives. Other circumstances in which breastfeeding may be contraindicated, the mother may not express breastmilk and should replace breastfeeding include; metabolic disease, such as galactosemia of the infant, the mother is taking chemotherapeutic agents, the mother is infected with human T-cell lymphotropic virus type I or type II, the mother is using an illicit street drug, such as cocaine, the mother has suspected or confirmed Ebola virus disease. Conditions in which the mother may temporarily replace breastfeeding and may not express breastmilk include; the mother is infected with untreated brucellosis, the mother is taking certain medications, vaccinations, drugs, tobacco, and alcohol, the mother is undergoing diagnostic imaging, the mother has an active herpes simplex virus (HSV) infection with lesions present on the breast and other bilateral breast diseases. Conditions in which the mother should temporarily not breastfeed, but can express breastmilk include; the mother has untreated active tuberculosis (the mother may resume breastfeeding once she has been treated appropriately for 2 weeks and is documented to be no longer contagious), the mother has active varicella (chickenpox) infection that developed within the 5 days prior to delivery to the 2 days following delivery [28–30]. The breastmilk substitute should be a suitable substitute for breastmilk, such as a commercial or homemade formula. However, parents should be aware that available substitutes may not wholly replace the benefits of breastfeeding and breastfeeding remains the most appropriate mode of feeding infants 0–6 months of age. Selected replacement feeds should meet the AFASS criteria; that is to say, they should be Acceptable—the mother perceives no significant cultural or social barriers to replacement feeding. Feasible—the mother has adequate knowledge, skills, resources, and support to correctly mix, formula or milk, and feed the infant up to 12 times in 24 h. Affordable—the mother and family can pay the costs of, replacement feeding associated with fuel, clean water, and all ingredients without compromising the health

and nutrition, of the family. Sustainable—the mother has access to a continuous and uninterrupted supply of all ingredients needed for safe replacement feeding as long as the infant needs it. Safe—replacement feeds are correctly and hygienically stored, prepared, and fed in nutritionally adequate amounts. The infant is fed with clean hands and preferably by the cup.

6.1 Homemade formula

Homemade formulas are made from local foods available at home. While preparing a local formula, mothers should include at least one type of food from each of the following classes. (a) Sources of proteins, such as beans, peas, groundnuts, milk, meat, chicken, fish, and eggs; (b) sources of carbohydrates, such as millet flour, sorghum flour, maize flour, potatoes, and matooke or banana; (c) sources of vitamins, such as dodo, nakatti, buga, tomato, eggplant and carrot, and sources of fats, such as ghee, shea butter, margarine, and palm oil in their rightful proportions.

6.1.1 Home-modified formula for infants 0–6 months of age

Infants who are not breastfed from birth can be given a homemade milk-based formula prepared from cow's, goat's, camel's, sheep's, or buffalo's milk. Such formula can be prepared as follows;

1. Fresh cow's, goat's, or camel milk

a. 40 ml milk +20 ml water +4 g sugar = 60 ml

b. 60 ml milk +30 ml water +6 g sugar = 90 ml

c. 80 ml milk +40 ml water +8 g sugar = 120 ml

d. 100 ml milk +50 ml water +10 g sugar = 150 ml

2. Sheep and Buffalo milk

a. 30 ml milk +30 ml water +3 g sugar = 60 ml

b. 45 ml milk +45 ml water +5 g sugar = 90 ml

c. 60 ml milk +60 ml water +6 g sugar = 120 ml

d. 75 ml milk +75 ml water +8 g sugar = 150 ml

Micronutrient supplements should be given with all the above home-prepared infant formulas; this includes minerals, such as manganese—7.5 µg, Iron—1.5 mg, copper—100 µg, zinc—205 µg and iodine, and vitamins, such as vitamin A—300 IU, vitamin D—50 IU, vitamin E—1 IU, vitamin C—10 mg, vitamin B1—50 µg, vitamin B2—80 µg, Niacin—300 µg, vitamin B6—40 µg, folic acid—5 µg, Pantothenic acid—400 µg, vitamin B12—0.2 µg, vitamin K—5 µg, and biotin—2 µg.

6.1.2 Home-modified complementary formula for infants 6 months of age and above

Home-modified complementary formula can be made of porridge as a major source of energy, mixed with pounded roasted groundnuts or ground nuts paste as a major source of protein, mixed with pounded dodo as a major source of vitamin, mixed with margarine as a supplementary source of energy. The thickness of the preparation should be regulated based on the age of the infant and the ability of the infant to eat. Other sources of energy, proteins, vitamins, and fats can as well be used depending on availability.

6.2 Commercial formulas

Commercial infant formulas are designed to resemble human milk as closely as possible, although none has ever duplicated it. The exact composition of infant formula varies with the manufacturer but all must meet specific standards. Four main categories of commercially prepared formulas; cow's milk-based formula such as NAN (milk-based with iron), soy-based formulas—commonly used for children who are lactose or cow's milk intolerant, such as Soy Isomil infant formula and Enfamil ProSobee *Infant Formula*, casein or whey-hydrolysate formulas—used primarily for children who cannot tolerate the other two formulas, and amino acid formulas—used for infants with multiple food protein intolerances.

It is important for parents to note that commercially available infant feeding formulas occur in two categories. That is to say; those prepared for infants 0–6 months of age, for example, NAN for 0–6 months infants and those prepared for infants 6–12 months of age for example NAN for infants 6–12 months of age. This is because nutrient requirements vary at different ages of infants.

Commercial formulas are available in three forms: 1. Ready-to-feed formula- is the most expensive but easiest to use. 2. Concentrated formula- is less expensive than ready to feed, it is diluted with equal parts of water and can be stored in the refrigerator for 48 h after opening. 3. Powdered formula—is the least expensive, it is easily mixed by using one scoop of 60 ml for every 60 ml of water or one scoop of 30 ml for every 30mls of water. It is important to bear in mind the quantity of feed required depending on the infant's age.

6.3 Feeding the child using formula feeds

The first feeding of the formula is ideally given after the neonate's initial transition to extrauterine life. At birth, the baby's stomach is very small with a cherry-like size and volume capacity of about 20mls. In the first 24 to 48 h of life, a newborn will typically consume 15–30 ml of formula at each feeding. Intake gradually increases during the first week of life, most newborns are taking 90–150 ml at each feeding by the end of the second week or sooner. The newborn infant should be fed at least every 3–4 h, even if waking the newborn is required for the feeding. However, usually rigid feeding schedules are not recommended. Most newborns need six to eight feedings in 24 h and the number of feedings decreases as the infant matures and consumes more at each feeding. During feeding, parents are encouraged to sit comfortably, holding the infant closely in a semi-upright position with good head support. Feeding provides an opportunity to bond with the baby through touching, talking, and singing to the infant.

6.4 Preparation of powdered infant formula

According to the World Health Organization, parents using formula feeds should follow the following steps to prepare and feed their infants [31];

- a. Wash your hands with soap and water and dry using a clean cloth.
- b. Wash all feeding and preparation equipment thoroughly in hot soapy water. Use a clean bottle and teat brush to scrub the inside and outside of bottles and teats to make sure that all remaining feed is removed from the hard-to-reach places.
- c. Rinse thoroughly in safe water.
- d. Fill a large pan with water.
- e. Place the cleaned feeding and preparation equipment into the water. Make sure that the equipment is completely covered with water and no air bubbles are trapped.
- f. Cover the pan with a lid and bring to a rolling boil, making sure the pan does not boil dry.
- g. Keep the pan covered until the feeding equipment is needed.
- h. Clean and disinfect a surface on which to prepare the feed.
- i. Wash your hands with soap and water, and dry with a clean or disposable cloth.
- j. Boil some safe water. If using an automatic kettle, wait until the kettle switches off. If using a pan to boil water, make sure the water comes to a rolling boil.
- k. Read the instructions on the formula's packaging to find out how much water and how much powder you need. Adding more or less formula than instructed could make infants ill.
- l. Taking care to avoid scalds, pour the correct amount of boiled water (which has been allowed to cool to no less than 70°C) into a cleaned and sterilized feeding cup. Use a clean, sterile thermometer to check the temperature.
- m. Add the exact amount of formula to the water in the feeding cup.
- n. Mix thoroughly by stirring with a cleaned and sterilized spoon.
- o. Immediately cool to feeding temperature by holding the feeding cup under cold running tap water, or by placing it in a container of cold or iced water. So that you do not contaminate the feed, make sure that the level of the cooling water is below the top of the cup.
- p. Dry the outside of the cup with a clean or disposable cloth.
- q. Label the cup with information, such as formula type, infant's name or ID, date and time made, and preparer's name.

- r. Check the temperature of the feed by dripping a little onto the inside of your wrist. It should feel lukewarm, not hot. If it still feels hot, cool some more before feeding.
- s. Feed infant.
- t. Throw away any feed that has not been consumed within two hours.

For parents using the bottle for feeding their infants, the bottle should be held so that fluid fills the nipple and none of the air in the bottle is allowed to enter the nipple. The bottles, nipples, rings, and caps should be washed in warm soapy water, using a bottle and nipple brush to facilitate thorough cleaning. They should be placed in boiling water for 5 min and allowed to air dry, this should be done at least prior to the first use and thereafter unless they are cleaned in the dishwasher. However, due to difficulties associated with maintaining the hygiene of bottles, nipples, rings, and caps, parents are strongly advised to feed their infants using a cup and a spoon as described later in this chapter.

7. Infant and young child feeding in the context of HIV/AIDS

It is estimated that 20% of all Mother-To-Child-Transmission (MTCT) cases occur through infants acquiring HIV from their HIV-positive mothers after birth through breastfeeding [32]. However, with option-B plus, this risk is eliminated. According to the consolidated guidelines for prevention and treatment of HIV in Uganda, all HIV exposed infants should be exclusively breastfed for the first 6 months of age irrespective of HIV status [33]. Meanwhile, the infant's first Polymerase Chain Reaction (PCR) test should be taken at 6 weeks of age. The mother continues to be on HAART and exclusive breastfeeding. Complementary foods should be introduced at 6 months of age. The second PCR should be done at 9 months of age, 3 months following the introduction of complementary foods. If the infant remains HIV negative, the mother continues to breastfeed until the infant is 1 year of age after which the infant should entirely feed on family foods as discussed later in this chapter. The third PCR test should be done at 6 weeks after cessation of breastfeeding. For infants found to be HIV infected, the infant should be breastfed as per the general population until the infant is 24 months old and beyond. On the other hand, if the mother does not wish to breastfeed and Infant is HIV negative, the mother can consider discontinuing breastfeeding as early as possible and use replacement feeding if Affordable, Feasible, Acceptable, Sustainable, and Safe (AFASS).

7.1 Feeding HIV-negative infants (12: 24 months) of HIV-positive mothers

Mothers who are HIV positive and have babies with a negative second PCR at 9 months, will cease breastfeeding at 12 months of infant's age [33]. The mother will adopt alternative infant feeding options as described earlier under formula feeding. The third PCR will be taken at 6 weeks after cessation of breastfeeding and an HIV antibody test at 18 months of age. The Alternative forms of infant feeding will include other forms of milk such as cow's or goat's milk; of at least 500 ml (one cup) a day. In addition, the mother will continue to feed the infant 5 times a day, which includes three main meals of nutritious foods from locally available foods and two extra snacks.

8. Feeding a child (2: 6 years)

It is important to encourage mothers to give a variety of foods prepared from the family meal (each meal should consist of carbohydrate, protein, vegetables) at least 3 main meals a day. Encourage caregivers to give nutritious snacks between meals, such as fruit (banana, pawpaw, orange, and mangoes), an egg, bread, enriched thick porridge, or a glass of milk. Sick and improving infants and children should be fed on small, frequent meals that include porridge enriched with milk or groundnut paste, margarine, honey, oil, cooked skinned mashed beans, thickened soups, and many more others to aid quick recovery.

9. Common problems of breastfeeding

Breastfeeding problems cause difficulty in breastfeeding. May also cause insufficient breastmilk production, failure of the mother to give the breast to the infant, frustration of the infant, discontinuation of breastfeeding, and failure to thrive. These include breast engorgement, sore nipples, plugged or clogged milk ducts, mastitis, and insufficient or decreased milk production.

9.1 Breast engorgement

Breast engorgement is caused by overfilling of the breast due to infrequent or ineffective emptying of the breast [34]. It occurs around the 3rd–5th day postpartum. This condition is characterized by vascular congestion, increased vascularity, accumulation of milk in the breast tissue, and edema related to swelling and obstruction of lymphatic drainage. The breast is usually painful and tender on palpation, firm, and hot. The breast may appear shiny and the nipples may flatten. Management requires breastfeeding more frequently (every 2 h), massaging the breast as the baby breastfeeds, breastfeeding on one breast until it softens before changing to another one, cold compress may relieve swelling, expressing breastmilk may be done if the baby does not empty the breast completely, Non-Steroidal Anti-Inflammatory Drugs (NSAIDs) may be prescribed to relieve pain, a warm water bath before breastfeeding and use of cabbage leaves (put in a fridge and applied) may be helpful.

9.2 Sore nipple

Nipples may be tender, cracked, or bleeding due to poor attachment or poor latch-on, sucking, and monilial infection. Sore nipple causes pain during breastfeeding and thus disrupts infant feeding. The prevention and management involve correct positioning and attachment to the breast. To make the nipple less painful, the mother should first express some milk to moisten the nipple. If pain continues, the mother should check for proper breast–baby attachment. If pain continues, the mother should stop breastfeeding for a few minutes and start again, and should ensure that the baby's mouth is widely open for both the nipple and areola to enter. If pain continues, the mother should check for the presence of a short frenulum. If present, it should surgically be released. If both nipples have sores, the mother may breastfeed on the breast with a less sore nipple first followed by the more painful one. It is most important to clean the nipple with water after breastfeeding and also to express some milk and

spread it around the nipple to air dry. The mother should be advised to expose the nipple to the air as much as possible. She may apply purified lanolin cream to prevent further abrasion after breastfeeding. Antibiotics creams may be applied if nipples are extensively cracked. Other un-approved creams are not recommended.

9.3 Plugged or clogged milk ducts

Plugging of milk ducts is due to poor feeding, delayed or missed feeding. It is important to apply a warm compress to the affected area, this may promote the emptying and release of the plug. Breastfeeding more frequently is preferred and while breastfeeding, the baby should begin with the affected breast to ensure emptying.

9.4 Mastitis

Mastitis is the inflammation of the breast [35, 36]. It is usually caused by staphylococcus, streptococcus, and *Escherichia coli* (E-coli). The condition presents with fever, chills, body aches, and headache initially. On examination, the breast is tender, warm and reddened. It is caused by poor breast hygiene, inadequate emptying of the breast during breastfeeding, plugged ducts, sudden decrease in number of feedings, abrupt weaning, and cracked nipples. Management includes administration of antibiotics (penicillins or cephalosporins plus metronidazole) for 10–14 days, NSAIDs for the pain and inflammation can be prescribed, warm compress to relieve pain, and emptying of the breast while breastfeeding. If the breast cannot be emptied by breastfeeding, the mother is encouraged to express the remaining breastmilk. The mother should have enough rest, take plenty of oral fluids, and a balanced diet. In case of a breast abscess, surgical intervention is required.

9.5 Insufficient or decreased milk production

Insufficient milk production is one of the biggest challenges faced by mothers currently [37]. It can result from any of the following causes; insufficient glandular tissue—some women may not have enough milk-making ducts to meet the baby's needs, endocrine problems, such as hypo or hyperthyroidism, hormonal contraceptive methods, previous breast surgery—for either cosmetic or medical reasons reduces breast ducts and create scarring within the breast, taking medications or herbs containing anti prolactin agents, such as bromocriptine, pseudoephedrine, and methergine, sucking difficulties—due to poor attachment, not feeding at night—women who do not breastfeed at night may produce less breastmilk because prolactin hormone is higher at night, scheduling feedings—infrequent breastfeeding such as in working women may make the breast to be full for a long time and this leads to a reduction in milk secretion, birth jaundice or birth medications—medications for epidural anesthesia may affect baby's breastfeeding for close to a month. Jaundice may make the infant sleepier and not able to breastfeed, supplementation—when breastfeeding is supplemented, the baby becomes satisfied soon and may not breastfeed to empty the breast. When less breastmilk is removed through breastfeeding, less is produced by the breast leading to low breastmilk production. Lastly, the nutritional status, psychological and physical health of a mother plays a significant role in breastmilk production. Mothers who are breastfeeding should eat a well-balanced diet, take plenty of fluid, be psychosocially supported and be free from illness for adequate breastmilk to be produced.

9.6 Measures to correct insufficient breastmilk

Every breastfeeding woman's wish is to produce adequate breastmilk for the baby. This can be achieved through ensuring good maternal nutrition, good maternal psychological and physical health, breastfeeding at least 2-hourly and on both breasts for 12–20 min or until breasts are empty, good breast attachment, avoiding medications that interfere with lactation, treating endocrine disorders that may interfere with breastmilk production, always breastfeeding at night, stopping hormonal birth control offenders, managing jaundice if any and stopping or avoiding unjustified infant feeding supplementation.

10. Breastfeeding and working

Working women usually face difficulties breastfeeding their infants, especially after their maternity leave. Maternity leave is short (3 months), especially in Uganda. At 3 months of age, the mother is still required to exclusively breastfeed and the infant does not feed on any other feeds except breastfeeding. Some working conditions may not favor some mothers to fulfill this obligation. If such mothers are not supported, they are left with no choice other than to opt for mixed feeding, breastfeeding supplementation, or for replacement feeding. Breastmilk produced becomes less and does not meet the baby's nutritional requirements resulting in malnutrition. Mothers who fall in such category may be advised on appropriate replacement feeding if they are able to fulfill the AFASS criteria or else express breastmilk and employ someone else to feed the baby using a cup.

10.1 Expressing breastmilk

Expressing breastmilk may be necessary especially when a mother goes to work and leaves the baby at home. It may also be necessary to feed a baby who is too weak and cannot breastfeed such as those who are ill and those with low birth weight. Other situations include a baby who cannot latch on due to an inverted nipple, breast engorgement. All mothers should learn how to express their milk so that they know what to do if the need arises. Breast milk can be stored for about 8 h at room temperature or up to 24 h in a refrigerator.

10.2 How to express breastmilk by hand

The woman should sit comfortably and upright. She should prepare a clean dry container for Expressed Breastmilk (EBM); she can use a cup, glass, jug, or jar with a wide mouth. She should hold the container near her breast. Put her thumb on her breast above the nipple and areola, and her first finger on. The breast below the nipple and areola, opposite the thumb. She supports the breast with her other fingers. Press her thumb and first finger slightly inwards toward the chest wall. She should avoid pressing too far or she may block the milk ducts. The mother should press her breast behind the nipple and areola between her finger and thumb. She should press on the larger ducts beneath the areola. Press and release, press and release.

At first, no milk may come, but after pressing it a few times, milk starts to drip out. It may flow in streams if the oxytocin reflex is active. The mother should press the areola in the same way from the sides to make sure that milk is expressed from all segments of the breast. Avoid rubbing or sliding her fingers along the skin. The movement of the fingers should be more like rolling. Avoid squeezing the nipple

itself. Pressing or pulling the nipple cannot express the milk. It is the same as the baby sucking only the nipple.

The mother should express one breast for at least 3–5 min until the flow slows; then express the other side; and then repeat both sides. She can use either hand for either breast and change when they tire. The mother should express the breast milk adequately over 20–30 min, especially in the first few days when only a little milk may be produced. Express as often as the baby would breastfeed. This should be at least every 3 h, including during the night. If she expresses only a few times, or if there are long intervals between expressions, she may not be able to produce enough milk.

10.3 How to stimulate oxytocin reflex

Help the mother psychologically by reducing any sources of pain or anxiety, sitting quietly and privately or with a supportive friend, and holding her baby with skin-to-skin contact if possible. The mother can be assisted to hold her baby on her lap while she expresses herself, warm her breasts by applying a warm compress, or warm water, or have a warm shower. She can also be told to stimulate her nipples, and massage or stroke her breasts lightly. The helper can rub her back.

10.4 How to store expressed breastmilk

Choose a suitable container made of glass or plastic that can be kept covered. Clean it by washing in hot soapy water, and rinsing in hot clear water. If the mother is hand expressing, she can express directly into the container. If storing several containers, each container should be labeled with the date. The mother should use the oldest milk first. The baby should consume expressed milk as soon as possible after expression. Feeding of fresh milk (rather than frozen) is encouraged. Frozen breastmilk may be thawed (unfrozen) slowly in a refrigerator and used within 24 h. It can be defrosted by standing in a jug of warm water and used within one hour, as it is warm. The mother should not boil milk or heat it in a microwave as this destroys some of its properties and can burn the baby's mouth.

Fresh breast milk should be stored at 25–37°C for 4 h, at 15–25°C for 8 h, and below 15°C for 24 h. Milk should not be stored above 37°C. Refrigerated (2–4°C) milk can be stored for up to 8 days. Frozen Breast Milk can be kept in a freezer compartment inside the refrigerator for 2 weeks. If milk is put in a freezer part of a refrigerator (freezer), it can be kept for a period of 3 months, and if in a separate deep freeze, it can stay for a period of 6 months. To de-freeze or warm breast milk, do not freeze for 24 h or place the container in warm water to thaw quickly.

10.5 Feeding EBM to a baby using a cup

Wash your hands. Put breastmilk into a small cup, approximately 60 mls. Hold the baby on your lap in a sitting upright or semi-upright position, the baby should not lie down too much. Hold the small cup or glass to the baby's lips. Tip it so that the water just reaches the lips, the edges of the cup touch the outer part of the baby's upper lip, and the cup rests lightly on his lower lip. This is normal when a person drinks. At this point, a real baby becomes quite alert and opens his mouth and eyes. He makes movements with his mouth and face, and he starts to take the milk into his mouth with his tongue. Babies older than about 36 weeks gestation try to suck. Some milk may spill from the baby's mouth. You may want to put a cloth on the baby's front to protect his clothes. Spilling is commoner with babies of more than about 36 weeks gestation, and less common with

smaller babies. Do not pour the milk into a baby's mouth; just hold the cup to his lips. When a baby has had enough, he closes his mouth and will not take any more of this feed. If he has not taken the calculated amount, he may take more next time, or he may need feeds more often. Measure his intake over 24 h, not just at each feed.

10.6 How much should a baby take in 24 hours?

Babies who weigh 2.5 kg or more can take 150 ml milk per kg body weight per day. Divide the total into eight feeds, and give 3-hourly. Babies who weigh less than 2.5 kg (Low-birth-weight); start with 60 ml/kg body weight. Increase the total volume by 20 ml per kg per day, until the baby is taking a total of 200 ml per kg per day. Divide the total into 8–12 feeds, to feed every 2–3 h. Continue until the baby weighs 1800 g or more, and is fully breastfeeding. Check the baby's 24-hour intake. The size of individual feeds may vary. If the baby was previously receiving other milk, reduce the amounts of other milk gradually as the breast milk production goes up. It is normal for the amount of milk that a baby takes at each feed to vary, whatever the method of feeding, including breastfeeding. Babies feeding by cup may take more or less than the calculated amount. If possible, offer a little extra, but let the baby decide when to stop. If a baby takes a very small feed, offer extra at the next feed, or give the next feed early, especially if the baby shows signs of hunger. Low-birth-weight (LBW) babies need only very small volumes during the early days. If the mother can express even a small amount of colostrum, it is often all that her baby needs.

11. Feeding the premature babies

A premature baby is one who is born alive before 37 weeks of pregnancy are completed. In other terms, this baby is usually referred to as one born too soon. Factors that are associated with preterm labor that later result in preterm baby include infections, multiple pregnancies, maternal diseases, and conditions such as diabetes, hypertension, or incompetent cervix. Other factors may be maternal abdominal trauma and at times, pregnancies are terminated prematurely on medical grounds to save the life of the mother. However, in some cases, the cause of preterm birth is not known. Preterm babies are usually classified as extreme preterm, very preterm, and moderate preterm. Extreme preterm babies are those who are born before 28 weeks of pregnancy, very preterm ones are those born between 28 and 32 weeks and moderate ones are those delivered between 32 and 37 weeks. About 15 million preterm babies are born annually worldwide, representing a global preterm birth rate of about 11% [38]. Of these, over 60% of preterm births occur in Africa and South Asia [38]. According to the WHO report, 12% of babies are born too soon compared with 9% in higher-income countries [38].

About one million preterm babies die due to preterm birth before age of 5 years, and this accounts for about 18% of all deaths among children under 5 years. Preterm deaths are highest in low- and middle-income countries especially those that are in South East Asia and Sub-Saharan Africa [38]. The challenge of preterm birth and death is worth to be squarely addressed if countries are to achieve Sustainable Development Goal 3 number 3.2 that aims at ending all the preventable deaths of newborn babies and children aged under 5 years by 2030. The common causes of preterm death are complications usually associated with feeding, breathing, body temperature, and infections. Preterm babies usually have feeding problems because their gastrointestinal system and accessory muscles are not yet well developed. They may not be able to coordinate sucking,

swallowing, and breathing. They may not be able to take enough volume of milk from the breast before tiring due to weak muscle tone. Premature babies have a long neck that provides little support for the jaw, weak sensation around the mouth, slow and incomplete root, and gag reflexes. They have incompetence of the lower esophageal sphincter, have delayed gastric emptying, and decreased intestinal motility that may affect feeding tolerance. Preterm babies are also more likely to have feeding challenges because of impaired rectal sphincter reflex which can cause a delay in evacuating stool. There are other important considerations that may cause nutritional deficiencies. Preterm babies usually have a high growth rate and metabolic needs that require additional nutritional requirements. Premature babies also have inadequate nutritional stores and poorly developed physiological systems. Many times, preterm babies also suffer from various illnesses such as infections which as well increase nutritional demands [39].

Survival rates of preterm infants can greatly improve if the emphasis is put on optimizing nutritional demands. The goals of feeding in preterm babies are three-fold—(i) to meet the nutritional requirements of the baby, (ii) to prevent feeding-related complications, especially Necrotizing Enterocolitis (NEC), and (iii) to optimize short- and long-term growth outcomes. In view of all above, it is usually advisable that the feeding abilities of all premature babies based on many factors, such as age, weight, and clinical status be assessed shortly after birth by a qualified health worker. The health worker will provide nutritional support to the mother or caretaker depending on the findings and the diagnosis.

American Academy of Pediatrics recommends the use of human milk for premature babies as the enteral feeding choice. In addition to nutritional values, human breast milk provides premature babies with immunological defense, hormones, and enzymes that are essential to growth and development. The smaller the preterm baby, the higher the nutritional demand, and the longer fortification of feeds will be required. It should be remembered that about 60% of total iron stores are accrued during the last trimester of pregnancy. Also, during fetal development, transfer of calcium and phosphorus from the mother to the fetus occurs in the third trimester, especially between 32 and 36 weeks of gestation. Therefore, premature babies are at higher risk of developing anemia and osteopenia. To prevent these conditions, it is recommended that their feeds are fortified with iron, calcium, and phosphorus. Usually, 2 mg per kg of iron is provided through a supplement of multivitamin for 12 months. Calcium and phosphorus supplements are also recommended as well.

If the baby has a birth weight of 1500 g or less and is stable, feeding is started with Expressed Breast Milk (EBM) of 5mls and is increased carefully by 5 mls until the baby is ready for the transition. If the baby is between 1500 g and 2000 g and is stable, then feeding can be started with 7.5 mls of EBM and is also increased according to as above. If the premature baby has a weight of more than 2000 g, 10 mls of EBM is given and is also increased steadily as explained earlier. In all cases, EBM should initially be given through a nasogastric tube because the baby may not be able to swallow effectively. However, if the baby has suckling reflexes, he/she should be progressively attached to the breast as well to stimulate sucking and swallowing. Cautious feeding then should continue as close monitoring for growth, nutritional needs, feeding, and developmental milestones.

12. Summary and conclusion

Infant feeding challenges continue to manifest in developed and developing countries. Worldwide, more than 80% of babies are breastfed in the first few weeks

of birth. About 37%, 25%, and less than 1% are exclusively breastfed at 6 months of age in Africa, the United States of America, and the United Kingdom, respectively. These statistics are far below the World Health Organization targets of 50% and 70% by 2025 and 2030, respectively. Complementary feeding practices are varied as well due to nonadherence to Infant and Young Child Feeding (IYCF) guidelines among parents. This accounts for the current trends in malnutrition in children under 5 years of age, adolescents and the youth, and leads to intergeneration malnutrition. Breastfeeding is important for the proper nutrition, health, survival, growth, and development of children. This issue is more critical when it comes to the girl child. Inappropriate Infant feeding and malnutrition in the girl child adversely affect her reproductive organs, growth, and development and is one of the contributing factors to a difficult childbirth, maternal morbidity, and mortality. Malnutrition in the girl child has implications on the ability of the girl to perform in school, remain in school and consequently impacts women's education and socioeconomic empowerment. Appropriate infant feeding can be achieved if mothers can initiate breastfeeding within the first hour of birth, exclusively breastfeed their infants until 6 months of age, complement breastfeeding after 6 months with appropriate and safe complementary feeds as well as continue to breastfeed until the infant is 24 months of age and beyond. Mothers who are unable to breastfeed can feed their infants on expressed breastmilk or replace breastmilk with appropriate homemade or commercial formula as recommended. Optimal infant feeding is recommended to achieve a healthy and economically able future generation. Both global and regional innovation strategies and efforts, however, are needed to boost rates of exclusive breastfeeding as well as breastfeeding infants up to 24 months of age and even beyond.

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