American Journal of Sciences and Engineering Research
E-ISSN -2348 – 703X, Volume 2, Issue 5, October - 2019

Importance of Exclusive Breast Feeding and Complementary Feeding Among Infants

AshmIkA M
Department of Health Sciences, Faculty of Science, University of Mauritius, Réduit, Mauritius.

ABSTRACT: *The aim of this review is to document the advantages of exclusive breastfeeding along with concerns which may hinder the practice of breastfeeding and focuses on the appropriateness of complementary feeding and feeding difficulties which infants encounter. Breastfeeding, as recommended by the World Health Organisation, is the most cost effective way for reducing childhood morbidity such as obesity, hypertension and gastroenteritis as well as mortality. There are several factors that either promote or act as barriers to good infant nutrition. Factors which influence breastfeeding practice in terms of initiation, exclusivity and duration are namely breast engorgement, sore nipples, milk insufficiency and availability of various infant formulas. On the other hand, introduction of complementary foods, also known as weaning, is done around 4 to 6 months and mothers usually should start with home-made nutritious food. Difficulties encountered during the weaning process are often refusal to eat followed by vomiting, colic, allergic reactions and diarrhoea.*

Index Terms: *Exclusive breastfeeding, Weaning, Complementary feeding, Feeding difficulties.*

I. INTRODUCTION

development of children to their full potential1. It has been recognised worldwide that breastfeeding is beneficial for both the mother and child, as breast milk is considered the best source of nutrition for an infant 2. Economic and social benefits are also provided to the family, the health care system and the employer. The World Health Organization (WHO) recommends that infants be exclusively breastfed for the first six months, followed by breastfeeding along with complementary foods for up to two years of age or beyond 3. Exclusive breastfeeding can be defined as a practice whereby the infants receive only breast milk without mixing it with water, other liquids, tea, herbal preparations or food in the first six months of life, with the exception of vitamins, mineral supplements or medicines 4. Breastfeeding an infant exclusively for the first 6 months of life carries numerous benefits such as lowered risk of gastrointestinal infection, pneumonia, otitis media and urinary tract infection in the infant while mothers return to her pre-pregnancy weight very rapidly and have a reduced risk of developing Type 2 diabetes 5, 6, 7. Moreover, studies have shown that many mothers find it difficult to meet personal goals and to adhere to the expert recommendations for continued and exclusive breastfeeding despite increased rate of initiation 8. Some of the major factors that affect exclusivity and duration of breastfeeding include breast problems such as sore nipples or mother's perceptions of producing inadequate milk 4, 9, 11 and societal barriers such as employment, length of maternity leave 9, inadequate breastfeeding knowledge 11, lack of familial and societal support and lack of guidance and encouragement from health care professionals 2, 9. Another factor that leads to early cessation of breastfeeding is the advertisement of infant formulas which encourages mothers to opt for the use of pacifiers and bottle feeding 3, 9. Additionally, many mothers opt for breast milk substitutes because they need to resume work while others claim that they produce insufficient milk 10. To date, there are various types of infant formulas available on the market, and which are designed to meet the nutritional needs of infants with a variety of dietary needs 12. However, there are some problems associated with infant formulas such as the nutritional content either does not meet or exceeds the infant's needs. For instance, it was reported that some infants who were fed on formula milk have had occasional water soluble vitamins deficiencies 13. Another problem associated with bottle feeding involves high risk of exposing the child to pathogens owing to unhygienic practices during handling and preparation of infant formula 3. On the other hand, when breast milk or infant formula no longer supplies infants with required energy and nutrients to sustain normal growth and optimal health and development, solid foods should be introduced 14. This process is known as complementary feeding. According to the WHO recommendations, the appropriate age at which solids should be introduced is around 6 months 15 owing to the immaturity of the gastrointestinal tract and the renal system as well as on the neuro-

 Received- 22-09-2019, Accepted- 01-10-2019

physiological status of the infant 15. However there are concerns about the timing of complementary feeding as evidence demonstrates that this recommendation for delayed introduction of complementary foods may have detrimental consequences 17. Furthermore there are different types of weaning that mothers adopt namely child-led/natural, mother-led, gradual, partial or abrupt weaning 18. It should be noted that during the weaning process many mothers encounter infant feeding problems such as refusal- to-eat, colic, and vomiting among others 19. All these problems that mothers encounter during the feeding processes either directly or indirectly influence the feeding pattern.

The objectives of this study are to:

1. Appraise the advantages of exclusive breastfeeding.
2. Provide an overview of problems which hinder the practice of breastfeeding among mothers.
3. Discuss the appropriateness of complementary feeding and feeding difficulties which infants encounter.

II. Breastfeeding practices

The determinants of children's growth include genetic potentialities, family size, lifestyle, socio-economic environment, infections, nutrition and the availability of medical care20. However, nutrition is the most prominent factor which can either directly or indirectly influences children's future development. For instance, those children who are malnourished and manage to survive do not enjoy a good health and experience impaired development in the long run 21. Along, there is a rising concern about overweight and obesity in children. Therefore, proper nutrition and nurturing during the early years of life is crucial for an infant to achieve optimal health and well-being. Hence, there is no more precious gift in infancy than breastfeeding. "Breastfeeding is an unequalled way of providing ideal food for the healthy growth and development of infants; it is also an integral part of the reproductive process with important implications for the health of mother"22. Saha et al. 23 reported that the current recommendations of WHO and UNICEF on breastfeeding are as follows:

- Initiation of breastfeeding within the first hour after the birth;
- Exclusive breastfeeding for the first six months;
- Continued breastfeeding for two years or more and proper introduction of solid foods starting in the sixth month which are nutritionally safe and adequate.

III. EXCLUSIVE BREASTFEEDING

Exclusive breastfeeding as defined by WHO and UNICEF is the practice whereby an infant receives only breast milk from the mother or a wet nurse or expressed breast milk [24]. The WHO and UNICEF, both recommend that mothers should breastfeed their child exclusively for the first 6 months and continue breastfeeding up to 2 years

Although breastfeeding an infant exclusively for the first 6 months of life carries numerous benefits, many studies are centered on the "weanling's dilemma" in developing countries which involves choosing between the protective effects of exclusive breastfeeding against infectious diseases and the (theoretical) insufficient breast milk to meet the infants' energy and micronutrient needs beyond four months of age [26]. However, the author claimed that there is no data giving an estimate of the proportion of exclusively breastfed infants at risk of specific nutritional deficiencies.

IV. EXPRESSED BREAST MILK

Breastfeeding is beneficial both to the infant and the mother[27]. However, owing to certain circumstances, mothers are unable to breastfeed, so they wish to express their milk because it is the only opportunity for the infant to have the human milk [28]. Expressing is simply a way of taking milk from the breast without the baby suckling and this can be achieved either by the hand or manual pump or electric pump [29]. The reasons why some mothers express breast milk are shown in Figure 2.1.

While breast milk in a bottle is far superior to any infant formula, expressing or pumping breast milk do have some disadvantages unlike direct breastfeeding as shown in Figure 2.2.

 Received- 22-09-2019, Accepted- 01-10-2019

table. 1: Comparison of composition of human colostrum, human mature milk, cow's milk and standard formula[37]

nutrients	human Colostrum	human mature milk	Cow's milk	standard Formula
Kcal/100ml	67	67	67	67
CHO (Lactose- gm/dl)	5.7	7.1	4.7	7.0 - 8.5
Protein (gm/dl)	2.9	1.06	3.1	1.5 - 2.2
Whey : casein	80 : 20	0	18 : 82	60 : 40
Fat (gm/dl)	2.95	4.54	3.8	3.5 - 4.5
Sodium (g/1)	0.50	0.17	0.77	0.25
Potassium (g/l)	0.74	0.51	1.43	0.80
Chloride (g/l)	0.59	0.37	1.08	.057
Calcium (g/l)	0.48	0.34	1.37	46 - 73
Phosphorus (g/l)	0.16	0.14	0.91	32 - 56
Calcium/ Phosphorus	3.1	2.4	1.5	1.3 - 1.5
Magnesium (g/l)	0.04	0.03	0.13	5.6
Copper (mg/1)	1.34	0.51	0.10	0.40
Zinc (mg/l)	5.59	1.18	3.90	5.0
Iodine (mg/l)	0	0.06	0.08	0.01
Iron (mg/1)	1.0	0.50	0.45	0.15
Vitamin A (mg/1)	1.61	0.61	0.27	1.5
Vitamin D (IU)	0	4 - 100	5 -40	41 - 50
Tocopherol (mg/l)	14.8	2.4	0.6	8.liu
Thiamine (mg/l)	0.02	0.14	0.43	0.47
Riboflavin (mg/l)	0.30	0.37	1.56	1.0
VitaminB6 (mg/l)	0.0	0.18	0.51	0.50
Nicotinic Acid (mg/l)	0.75	1.83	0.74	6.7
Vitamin B12 (ug/l)	0.06	0.34	2.48	2.0
Pantothenic acid (mg/l)	1.83	2.46	3.4	3.0
Folic acid (ug/l)	5.0	14.0	90.0	10 - 13
Vitamin C (mg/1)	72	52	11	6.7
Osmolality	290 - 300	0	0	300 - 380

a. **Atopic dermatitis:**

It has been noted that the results of several studies have been conflicting in regard of the protective effect of breastfeeding on the development of atopic dermatitis. According to Ghaderi&Makhmalbaf[43], general studies have revealed that formula fed infants or those who have consumed soy based protein milk have a higher incidence of atopic dermatitis and wheezing illnesses in early childhood. On the other hand, Dattner[44] reported that other studies have shown that exclusive prolonged breastfeeding (i.e 9 months or more) were associated with AD and food hypersensitivity at 5 years of age and with food sensitivity at 11 years of age in those with a family history of allergy. Additionally, a study carried out in Denmark revealed that current breastfeeding was not associated with AD while exclusive breastfeeding for the first 4 months was, however linked to the incidence of AD whose parents had no history of allergy [44]. Nevertheless, Ghaderi&Makhmalbaf[43] highlighted the reasons for this controversy being methodological differences and flaws in the studies done to date, the immunologic complexity of breast milk itself and, possibly, differences in the genetic profile among patients that would affect whether breast-feeding was protective against the development of allergies or is in fact sensitizing. Therefore, one way to reduce the risk of AD among infants is that mothers need to reduce their intake of dietary allergens that increase the risk of translocation of allergenic and pharmacologically active peptides across her own gut barrier into her milk, provoking AD [44].

b. **Acute otitis media:**

Acute Otitis Media (AOM) is a common childhood infection which arises from an upper respiratory tract infection. There are many studies which have demonstrated that breastfeeding protects against several infections including AOM whereby breast milk which contains immunoglobulins with antibody activity against common bacteria such as Haemophilus influenzae and Streptococcus pneumonia.

 Received- 22-09-2019, Accepted- 01-10-2019

c. **Gastrointestinal infections:**
Gastrointestinal infections are very common among infants and many studies have shown that breastfeeding protects against the risk of diarrhea morbidity which is more commonly present in infants who were not breast fed. It is suggested that factors such as immunoglobulin (IgA) oligosaccharides, lactoferrin and other nutrients available in breast milk may protect the infant from various infections through passive immunity.

d. **Lower respiratory tract diseases:**
There are many infants who are hospitalized with moderate to severe respiratory infection which is caused by respiratory syncytial virus (RSV) infection. It has been reported that severe lower respiratory tract diseases may eventually leads to childhood asthma. And this risk can be reduced in infants of less than 1 year of age if they were breastfed exclusively for 4 months or more unlike those who are formula fed.

e. **Asthma:**
Studies regarding the effect of breastfeeding on asthma are controversial whereby it has been shown that there is a greater reduction in the risk of asthma in infants under 10 years of age who were breastfed for 3 months and had a family history of asthma. While the association was weaker in subjects without a family history of asthma and who were breastfed for 3 months. Moreover, it was also shown that formula fed infants regardless of having a family history of asthma were more likely to suffer from the bronchial disorder. Nevertheless, the author reported that it is still to be confirmed if this association changes for older children.

f. **Cognitive development:**
Several studies have shown little or no evidence for an association between cognitive development and breastfeeding in infancy.

g. **obesity:**
It has been stated that relationship between the types of postnatal feeding and the subsequent development of fat and fat-free mass are quite complex and depends on several factors including differences in food composition (human milk versus formula), food delivery (breast versus bottle), food "lifestyle" (breastfeeding versus formula feeding) and food behavior (self-regulation and feeding on demand versus set schedules of feeding of predetermined amounts). It is worth noting that the kinetics of breast fed infants differs from that of formula fed infants whereby the latter exhibit a higher weight and lengths gains unlike breast fed children. Furthermore, it has been stated that breast fed infants have a different suckling pattern and appeared to have a better control on meal sizes and feeding intervals unlike formula-fed infants. Moreover, anthropometric and behavioral differences between breast fed and formula- fed infants may arise due to diet related differences in the circulating levels of biochemical markers (such as leptin, ghrelin, insulin-like growth factors, and other compounds) which are used in energy metabolism during infancy. Overall, it can be concluded that there is a strong association between breastfeeding during infancy and a reduction in the risk of being overweight or obese in adolescent and adult life.

h. **Risk of cardiovascular diseases:**
While some studies have shown significant reductions in blood pressure and amount of serum LDL, others have found little or no evidence that breastfeeding protects against the development of cardiovascular diseases. Thus, further investigation is required to prove the association of breastfeeding and the risk of developing heart diseases.

i. **type I diabetes:**
Several studies have shown a positive association between breastfeeding and reduction in type I diabetes through passive immunity conferred by breast milk which is enriched with secretory immunoglobulin A antibodies. Also, breast milk promotes an increased â cell proliferation or delayed exposure to foreign food antigens especially in those infants who were exclusively breastfed. On the other hand, cow's milk has been associated with diabetogenecity whereby â-lactoglobulin which is a specific milk protein found in cow's milk causes a defect in the immune system of the infant leading to type I diabetes.

j. **type 2 diabetes:**
There is a rising concern about type 2 diabetes which is increasing especially among children and adolescents. Type 2 diabetes is developed when the body develops a resistance to insulin and no longer uses insulin properly. One of the meta-analysis performed have shown that those infants who were breastfed have a lesser risk of developing type 2 diabetes in later life as compared to those who

 Received- 22-09-2019, Accepted- 01-10-2019

were not breast fed.

k. **Childhood Leukemia:**
Leukemia is one of the most commonly found cancers among children .It has been reported that the common cause of leukemia are viruses, but the majority of human leukemias and lymphomas do not have a specific etiology. Since breastfeeding confers passive immunity, studies have shown that breastfeeding is implicated in reducing the risk of leukemia in infants especially in those children who were breast fed for at least 6 months.

l. **Infant mortality:**
Infant mortality is decreasing in both developed and developing countries. For instance according to Statistics Mauritius [45], infant mortality rate in *Mauritius* was decreased by 8.8% in 2010. It has been demonstrated that breastfeeding eventually reduces the rate of infant mortality by decreasing the risk of infectious diarrhea and respiratory diseases which are the leading cause of infant mortality. However, it is less clear if breastfeeding prevents infant deaths in developed countries.

V. COMPOSITION OF BREAST MILK

Human milk is species-specific and is superior to any other breast milk substitute [32] and it is also assumed to the ideal food for infant during the first 4-6 months, ensuring proper growth and development [33]. Human milk which is the most natural food available for infant is unique whereby its nutritional composition varies from mother to mother, from day to day, during the day and during a feed [34, 35]. Human milk contains several factors such as immunoglobulin, T lymphocytes, enzymes such as lysozymes, phagocytes among others which are not present in breast milk substitute [36]. A comparison of composition of human colostrum, human mature milk, cow's milk and standard formula is depicted in Table 2.1.

Characteristics of breast milk

"Breast milk is unique in its physical structure and types and concentrations of protein, fat, carbohydrate, vitamins and minerals,enzymes, hormones, growth factors, host resistance factors, inducers and modulators of the immune system, and anti-inflammatory agents" [12]. There are three phases of milk namely, colostrum, transitional milk and mature milk each with distinct characteristics.

Infant's first milk:

The first milk that is synthesized by the breast for the baby right after birth is thick, yellow- coloured fluid called colostrum. The yellow color is owing to the high concentration of beta-carotene, a precursor of vitamin A which is required for the protection against infection and for early retinal development [38]. It has also been stated that the amount of colostrum obtained is limited but it rich in nutrients and substances that the infant needs in the first days of life [12]. The "liquid gold" is rich in proteins, fat-soluble vitamins, minerals, and immunoglobulins A- sIgA[33]. It should be noted that IgA protects the infant's immune system by identifying and destroying foreign objects such as bacteria and viruses[12]. Another advantage of colostrum is that the mother will have less blood loss because the uterine contracts as the baby suckle. Furthermore, colostrum also contains white cells which help to prevent infection in the infant and it also consists of lactose which prevents hypoglycemia and at the same time helps the newborn to pass meconium [38]. This in turn, promotes the excretion of bilirubin.

transitional milk:

Transitional milk is used to describe the postcolostral period (7 to 21 days post partum) when the composition of the milk changes more slowly than in the first few days following parturition[39]. The content of transitional milk includes high levels of

1. **milk-based infant formula:**
This is commonly consumed by infants and it is made from modified cow's milk with added carbohydrate, (usually lactose), vegetable oils, and vitamins and minerals.
2. **Iron-Fortified Infant Formula:**
This type of milk is usually recommended by the American Academy of Pediatrics (AAP), as the most appropriate milk from birth to 12 months for infants who are not receiving breast milk or who are partially receiving breast milk. It ensures that formula-fed infants receive an adequate amount of iron which is important during the first year so as to lower the risk of iron deficiency anemia as

 Received- 22-09-2019, Accepted- 01-10-2019

shown by some studies.

3. **Low Iron Infant Formula:**
This type of infant formula contains approximately 5 milligrams of iron per quart of formula. And some parents opt for low iron infant formula for their infants because they believe that iron enriched formula milk causes gastrointestinal problems, such as colic, constipation, diarrhea, or vomiting owing to the iron. Nevertheless, it has been shown that gastrointestinal problems are no more frequent in infants consuming iron-fortified than low-iron infant formula. It should be noted that AAP discourages the use of this type of milk because a proper amount of iron is required for normal infant growth and cognitive development [32].
4. **soy-Based Infant Formula:**
This type of formula milk has been developed for infants who cannot tolerate modified cow's milk. It consists of soy protein isolate made from soybean solids as the protein source, vegetable oils as the fat source, added carbohydrate (usually sucrose and/ or corn syrup solids), and vitamins and minerals.AAP stated that this type of milk is safe and effective but has no advantage over modified cow's milk.
5. **hydrolysed Formulas (hypoallergenic formulas):**
These are also known as "predigested" milk whereby the protein content has been broken into smaller proteins that can be easily digested. A study done by concluded that extensively hydrolysed casein formula reduced the incidence of atopic dermatitis but not that of asthma. On the other hand, Fisher [64] stated that prolonged supplementation with hydrolysed formula as opposed to cow's formula or exclusive breastfeeding, does not reduce the risk of allergy. It should be noted that hypoallergenic formulas cost more than regular formulas.

Foremilk:

Foremilk is the first milk available in large amount at the beginning of a feeding which is watery thus, providing all the water the baby needs from it. Therefore, no other drinks such as water or juice are required before 4-6 months, even in hot climate
[40]. Foremilk is rich in proteins, lactose and other essential nutrients but contains less fat [33].

sore nipples/ nipple trauma:

One of the reasons why mothers discontinue breastfeeding and opt for early weaning is owing to sore nipples [54]. This usually occurs while the baby is latching during the first week or two and it eventually makes the women feel a mild pain and discomfort. According to Giugliani[56], the causes of pain during breastfeeding are shown in Figure 2.4.

Sore nipples can be prevented by teaching proper techniques on the initiation of breastfeeding [58]. Additionally, the breast should be allowed to air-dry for some minutes after a feeding and nursing pads should be changed regularly to prevent milk flow [56,
57]. Other precautions include expressing breast milk if the breasts are engorged and avoiding use of soap, alcohol and extra water on the breast [57].

Insufficiency of milk*:*

Another reason causing early termination of breastfeeding is insufficient breast milk [59]. Most women produce sufficient milk according to the baby's needs, however, the complaint of "insufficient milk" is not just owing to the wrong perception of the mother but the latter lacks confidence on her ability to breastfeed [56].Other reasons that make mothers perceive that they are not producing "sufficient milk" are ineffective suckling and/or infrequent feeding routines, conditions of the baby, such as illness or ankyloglossia, condition of the mother such as fatigue, stress, and use of certain medications, psychological inhibition, pregnancy, and smoking[38].

 Received- 22-09-2019, Accepted- 01-10-2019

Formula feeding practices:

According to the National Academy of Sciences [61], multiple health organisations endorse breastfeeding as the optimal form of nutrition for infants for the first year of life. However, not all mothers are able to breastfeed either temporarily or permanently, owing to a small number of health conditions of the infant or the mother [62]. Hence, many infants who were unable to be breastfed were wet-nursed (given breast milk by a woman other than the child's mother) while others, who were unfortunate were "dry-nursed". Dry nursing refers to home prepared mixture which consisted of a liquid, either water or milk mixed with finely ground grains. Over time, cow's milk was modified to feed infants who were unable to breastfeed.

Infant formulas are food products designed to provide for the nutritional needs of infants under 1 year old[63]. They include powders, concentrated liquids, or ready-to-use forms. The first commercial infant formula consisted of wheat flour, cows' milk, malt flour and potassium bicarbonate. Thereafter, new kinds of formula milk were developed whereby certain modifications were needed to make it safe and palatable for human infants[61]. The birth of infant formula industry became more apparent owing to the process of modifying cow milk for large-scale production in the 1920s.

Currently, there are more than 40 formulas for healthy term infants which are being sold [64] and FDA monitors infant formula manufacturers to ensure that the product provides the appropriate nutrition for all infants. Fisher [64] pointed out that each product has a unique and desirable feature for optimal development of the infant as explained in Table 2.4.

Late weaning:

A study by Kuo et al. 70 has shown that late weaning may cause deficiencies of zinc, protein, iron and vitamins B and D that leads to the suppression of growth and cause feeding problems. Iron deficiency anaemia and rickets are also found to be more prevalent among infants who are weaned after 6 months 14.

types of weaning:

There are different ways by which weaning can happen. Table 2.5 shows the different types of weaning.

Complementary foods:

The best way to help a baby's digestive system to get used to solid foods is by introducing the foods gradually and one new food at a time so that if the infant has had any allergy, it can be spotted easily 69. Starting new foods is a critical step for the baby and it usually takes some time for infants to get used to this new way of eating. It is usually best to start weaning (around 6 months) the infant with the foods shown in Figure 2.8.

I t is impor tant to note that good complementary foods should be rich in energy, protein and micronutrients (especially iron, zinc, calcium, vitamin A, vitamin C and folate) and should be clean and safe (free from pathogens, chemicals, toxins, bones or hard bits) to ensure the proper growth and development of the child 68.

Common feeding difficulties in infants:

Many parents have concerns and questions about infant feeding and eating issues whereby the most common feeding difficulties are colic, poor appetite, food refusal or selective eating 75. It is important to treat feeding difficulties which can later leads to failure to thrive, nutritional deficiencies, impaired parent/child interactions and chronic aversion with socially stigmatizing mealtime behavior

76. According to Liu & Stein 77, feeding problems can be a result of medical disorders and inappropriate food selection. Some common feeding problems are depicted in Table 2.6.

VI. CONCLUSION

Breastfeeding is the gold standard of infant feeding up to 6 months.It remains the most cost effective way for reducing the risk of diseases such as obesity, hypertension, eczema, type diabetes among others in later life as well as mortality. Breast engorgement, sore nipples, milk insufficiency and availability of various infant formulas are the main factors which influence breastfeeding practice in terms of initiation, exclusivity and duration. On the other hand, complementary foods in terms of nutrient-dense are normally introduced around 4 to 6 months.

 Received- 22-09-2019, Accepted- 01-10-2019

Difficulties encountered during the weaning process are often refusal to eat followed by vomiting, colic, allergic reactions and diarrhoea. Given related problems associated with breastfeeding, it is highly likely that in the future, nutrigenomics (or nutrigenetics) based research will provide opportunities towards personalized modification of breast milk for optimum health of neonates[78].

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