IntechOpen

Selected Topics in Breastfeeding

Edited by R. Mauricio Barría P.

SELECTED TOPICS IN BREASTFEEDING

Edited by **R. Mauricio Barría P.**

Selected Topics in Breastfeeding
http://dx.doi.org/10.5772/intechopen.68517
Edited by R. Mauricio Barría P.

Contributors

Patricia Triviño, Emilio González-Jiménez, Touraj Shafai, Gaspar Ros, Esmat Aly, Aliaa Ali Darwish, Rubén López Nicolás, Carmen Frontela Saseta, René Mauricio Barría

First published in London, United Kingdom, 2018 by IntechOpen
eBook (PDF) Published by IntechOpen, 2019
IntechOpen is the global imprint of INTECHOPEN LIMITED, registered in England and Wales, registration number: 11086078, The Shard, 25th floor, 32 London Bridge Street
London, SE19SG – United Kingdom
Printed in Croatia

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Additional hard and PDF copies can be obtained from orders@intechopen.com

Selected Topics in Breastfeeding
Edited by R. Mauricio Barría P.

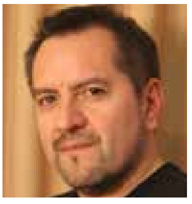
p. cm.

Print ISBN 978-1-78984-908-0

Online ISBN 978-1-78984-909-7

eBook (PDF) ISBN 978-1-83881-325-3

Meet the editor



R. Mauricio Barría P., DrPH, is a principal investigator and assistant professor at the Faculty of Medicine at Universidad Austral de Chile. He is currently Director of the Nursing Institute at the university. He was trained as an epidemiologist and received his MSc in Clinical Epidemiology from Universidad de la Frontera in Temuco, Chile, and his DrPH from Universidad de Chile in Santiago, Chile. His research interests lie in the areas of maternal-child health, neonatal care, and environmental health. He is skilled in epidemiological studies designs with special interest in cohort studies and clinical trials.

Contents

Preface XI

Chapter 1 **Introductory Chapter: A Comprehensive Approach to the Process of Breastfeeding 1**
René Mauricio Barría P

Chapter 2 **Bioactive Components of Human Milk: Similarities and Differences between Human Milk and Infant Formula 11**
Esmat Aly, Aliaa Ali Darwish, Ruben Lopez-Nicolas, Carmen Frontela-Saseta and Gaspar Ros-Berruezo

Chapter 3 **The Influence of Breastfeeding and the Infant's Social Environment on Neuroplasticity and Brain Development: The First 1000 Days 27**
Touraj Shafai, Monika Mustafa, Sandra Compsos and Lida Niake

Chapter 4 **Support for Breastfeeding 43**
Patricia Triviño Vargas

Chapter 5 **Breastfeeding and Reduced Risk of Breast Cancer in Women: A Review of Scientific Evidence 55**
Emilio González-Jiménez

Preface

Breastfeeding and human milk are the standard recommendation for infant feeding and nutrition resulting in improved infant and maternal health outcomes. This is based on extensive strong evidence of the benefits of breastfeeding to infants and mothers. However, even though efforts have been made to increase adherence to exclusive breastfeeding until six months, and in different countries policies have been implemented to support and promote breastfeeding, the objectives and goals established have not yet been achieved.

This book includes important topics related to breastfeeding. In five chapters that address relevant issues about breastfeeding, it seeks to contribute to the training of students and the updating of health professionals linked to the care of infants who face the process of breastfeeding.

Chapter 1 introduces global and fundamental aspects of neonatal care. This introductory chapter reviews the general aspects of breastfeeding and a conceptual framework that emphasizes the need to consider breastfeeding as a multifactorial phenomenon with important participation in sociocultural and psychological factors.

Chapter 2 describes the great potential of breastfeeding for mothers and babies and discusses the functionality of some components of human milk and its similarities and differences with infant formulas. This chapter presents current knowledge regarding evidence on the importance of breastfeeding, the functionality of selected human milk ingredients, infant formulas as a human milk alternative, and the similarities and differences between human milk and infant formulas.

Chapter 3 is based on evidence that breastfeeding and an enriched environment provide significant contributions to the infant's brain development, focusing its effect in the first 1000 days as the most significant period of an infant's life.

Chapter 4 reviews important elements to consider in the initiation and maintenance of breastfeeding, reviewing historical, physiological, and epidemiological aspects based on the guidelines of the World Health Organization and strategies to promote and support breastfeeding.

Finally, Chapter 5 shows an interesting review that provides scientific evidence regarding the relationship between breast cancer and certain aspects of pregnancy as breastfeeding period.

As described, this book includes various topics of interest for all those students and health professionals who are dedicated to child health care. It is necessary to thank each one of the authors, who through their contributions have allowed this interesting book to develop.

R. Mauricio Barría P., DrPH
Universidad Austral de Chile
Faculty of Medicine
Nursing Institute
Valdivia, Chile

Chapter 1

Introductory Chapter: A Comprehensive Approach to the Process of Breastfeeding

René Mauricio Barría P

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.82177

1. Introduction

Breastfeeding is a fundamental pillar of child nutrition, with important implications for the health welfare due to its impact on morbidity and mortality, especially among children under 1 year of age. Therefore, there is consensus among different organizations dedicated to the health of children about the importance of breast milk as a food of choice during the first 6 months of life, and it is considered a fundamental public health policy. The World Health Organization (WHO) recommends early initiation of breastfeeding within the first hour after birth and exclusive breastfeeding during the first 6 months of life [1]. Recently, the WHO defined the 2025 Global Nutrition Targets aimed at improving maternal, infant, and young child nutrition. Among these, breastfeeding has been prioritized in the fifth target: *"increase the rate of exclusive breastfeeding in the first 6 months up to at least 50%"* [2].

The United Nations Children's Fund (UNICEF) describes breastfeeding as an important indicator, noting that "*Breastmilk alone is the perfect food for all infants in the first six months of life.*" In addition to being an ideal nutritional source for infants, exclusive breastfeeding is associated with a lower chance of dying from diarrhea and acute respiratory infections and strengthens the infant immune system. It also protects against chronic diseases such as obesity and diabetes [3]. However, UNICEF recently communicated that many countries continue to underestimate the benefits of breastfeeding even when the evidence supports its short- and long-term effects such as protective role against childhood infections, an increased intelligence, and lower prevalence of diabetes and being overweight [4].

What is more, the American Academy of Pediatrics reaffirms the recommendation of exclusive breastfeeding for about 6 months, followed by continued breastfeeding as they introduce complementary foods, for 1 year or more, as mutually desired by the mother and baby, with medical contraindications to breastfeeding being rare [5]. Additionally, in their last policy statement regarding breastfeeding, they recognized that the decision to breastfeed should not be conceived by the mother, doctor, or society as a lifestyle option but as a basic and critical health decision that affects the welfare of the baby and the mother and therefore should be considered regardless of the parenting style or as a simple nutritional problem. They also emphasized that professionals must go beyond the maternal–infant binomial and incorporate new principles and concepts in daily activities to be true advocates and supporters of breastfeeding [6, 7].

In lower income countries, breastfeeding is associated with a significant reduction in infant mortality and disease, and it is estimated that a high degree of protection, promotion, and support for breastfeeding can potentially prevent 1.3 million child deaths per year [8]. It has been estimated that if children under 1 year of age were breastfed for at least 4 months, 56.4% of hospital admissions for infection of nonperinatal origin could be prevented [9]. In addition, there is evidence that breastfeeding decreases the incidence and severity of digestive, respiratory, urinary, and middle ear infections, as well as atopic diseases; producing a lower incidence of sepsis and necrotizing enterocolitis in preterm infants [10]. In the long term, breastfeeding has beneficial effects on cardiovascular risk factors, reduces the risk of obesity during childhood, and improves cognitive development. Additionally, breastfeeding women have a lower risk of developing breast cancer, better spacing of births, and lower risk of diabetes and ovarian cancer compared to women who have never breastfed [11].

2. Factors related to the breastfeeding initiation and duration

In general, the factors that influence the success or abandonment of breastfeeding have been classified into sociodemographic, biophysical, and psychosocial factors. Several factors have been linked to the initiation and duration of breastfeeding, which can be classified as nonmodifiable factors (**Figure 1**) and modifiable factors (**Figure 2**).

The main sociodemographic factors that influence the duration of breastfeeding are age, marital status, and income level. Therefore, successful long-term breastfeeding is less likely to occur in younger women with a low educational level, single women, and women with a lower income [12].

One review recently highlighted high impact factors such as smoking, mode of delivery, parity, separation of the mother-child dyad, maternal education, and maternal education on breastfeeding [13]. As an example, women who graduated from high school or higher educational institutions received education regarding breastfeeding, breastfeed within 1 hour after birth, and did not work had significantly higher rates of exclusive breastfeeding at 6 months. However, the breastfeeding rate in the first 6 months was significantly lower for women who lived with their parents and who were smokers [14]. Maternal age is directly associated with the duration of breastfeeding, observing that adolescents have lower breastfeeding rates, as well as a shorter duration [15].

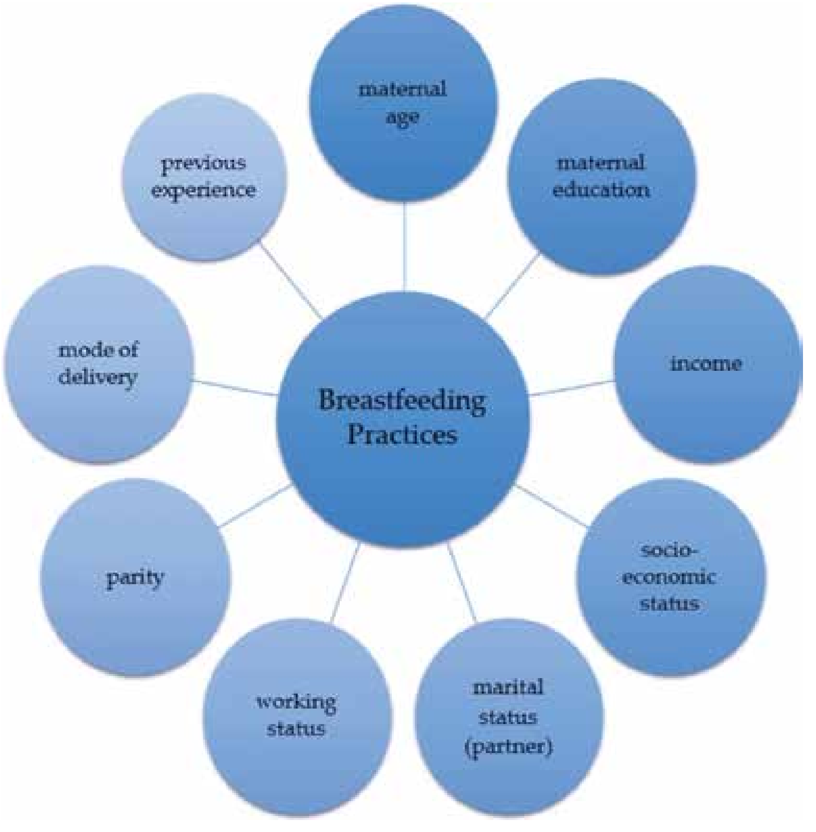


Figure 1. Nonmodifiable factors related to breastfeeding.

Adolescent mothers express that the decision to breastfeed is taken before birth and that the opinions of their partner and family members about the breastfeeding process may affect its onset. Influences on breastfeeding include its impact on social and intimate relationships, the availability of social support, the physical demands of breastfeeding, knowledge of breastfeeding practices and their benefits, and the sensation of comfort perceived by the mother regarding breastfeeding [16]. In this age group, mothers who have a better prenatal attitude to initiate breastfeeding, and with higher confidence levels in pre and postnatal care, are significantly more likely to maintain breastfeeding 4 weeks after birth [17].

In this way, breastfeeding has a multifactorial behavior. In addition to sociodemographic factors, clinical factors, and habits, a wide range of social, psychological, and cultural factors of each woman determines the decision and ability to successfully initiate breastfeeding; operating at different levels from the individual to society (**Figure 3**).

If the focus is placed on an anthropological approach to breastfeeding, the cultural norms of a society have a powerful influence on decisions regarding health, such as the choice of an infant feeding method. Therefore, attitudes and beliefs about breastfeeding are important and

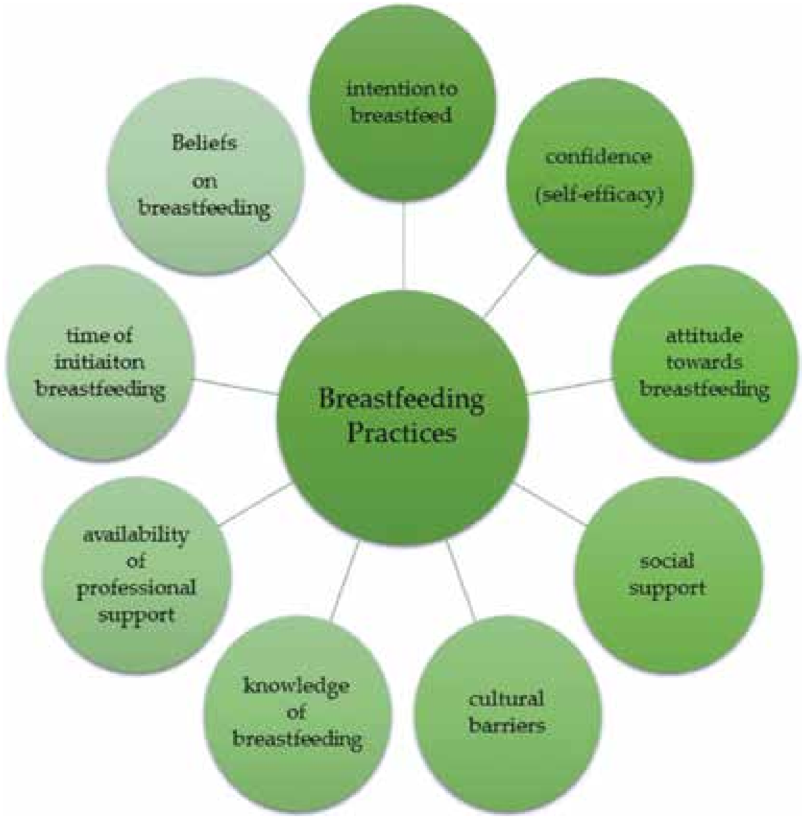


Figure 2. Modifiable factors related to breastfeeding.

should be considered in public breastfeeding campaigns [18]. In this sense, studies have been developed to understand the public's beliefs about breastfeeding policies.

In the United States, breastfeeding policies in the workplace and breastfeeding rooms in public places are the most accepted policies, especially among African-Americans and low-income populations. Additionally, the general population seems to approve breastfeeding in public, but less educated or older people (over 45 years) tend to do so less. Globally, there is relatively less public support for breastfeeding education in secondary schools [19]. There seem to be many beliefs and traditions surrounding breastfeeding, for example, in regard to the amount of breast milk a mother produces, which is a common concern and a major source of anxiety. The perception of insufficient breast milk is attributed to the mother's interpretation of the crying baby as a sign of hunger, as well as the resolution of breast engorgement, which the mother interprets as a sign of concern. Additionally, family members (particularly the woman's mother) are important sources of discouragement of breastfeeding; for example, it is believed that women are biologically incapable of breastfeeding.

The belief that the tendency to have insufficient milk production is inherited from mothers and mothers who have not breastfed their children may find it particularly difficult for their

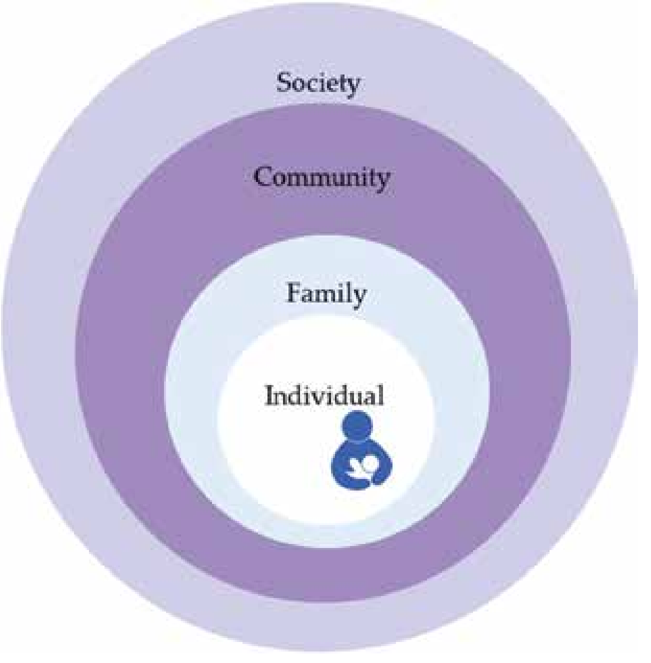


Figure 3. Levels that influence the process of breastfeeding.

own daughters to breastfeed successfully, as they believe that this may reflect their own skills to nourish their children [20]. It is then manifested that breastfeeding, besides being biological, is historical and social, with culture, beliefs, and taboos influencing its practice, interfering in the construction of sociocultural inheritance, and determining different meanings to breastfeeding for woman. Thus, the beliefs transmitted by relatives, medical guidelines, and the growth and development of the child are factors that may or may not stimulate breastfeeding [21].

Another socioanthropological aspect is that ethnicity is a determining factor for breastfeeding, as shown by a study conducted in Malaysian women, which found that Malay women with a higher education level and who received counseling regarding breastfeeding had a significantly more favorable attitude toward it, and that ethnicity was a significant determinant in the success of breastfeeding [22]. In Cameroon, 90% of women initiate breastfeeding but only 34% of these women breastfeed exclusively during the first 6 months. It is highlighted here that there are relevant issues related to breastfeeding practices, such as the preparation of women for breastfeeding exclusively, the cultural influences toward breastfeeding, and the perceived restrictions to breastfeeding [23].

Another example, from a different culture, shows that France has low breastfeeding rates, which are considered a reflection of their cultural perception of motherhood, breastfeeding, and the body image [24]. Understanding the local beliefs and customs that influence breastfeeding can help professionals provide culturally appropriate advice. Additionally, developing studies on beliefs and practices linked to breastfeeding within different communities could help health professionals provide culturally sensitive care for their patients. This information could help clinicians to encourage women to initiate and maintain breastfeeding [20].

3. Conceptual model of breastfeeding practice

When establishing a conceptual model of breastfeeding practice, all the factors that intervene in its development and the different levels that interact must be considered. It is possible to appreciate how the different levels interact and influence the individual decision to breastfeed or not (**Figure 4**).

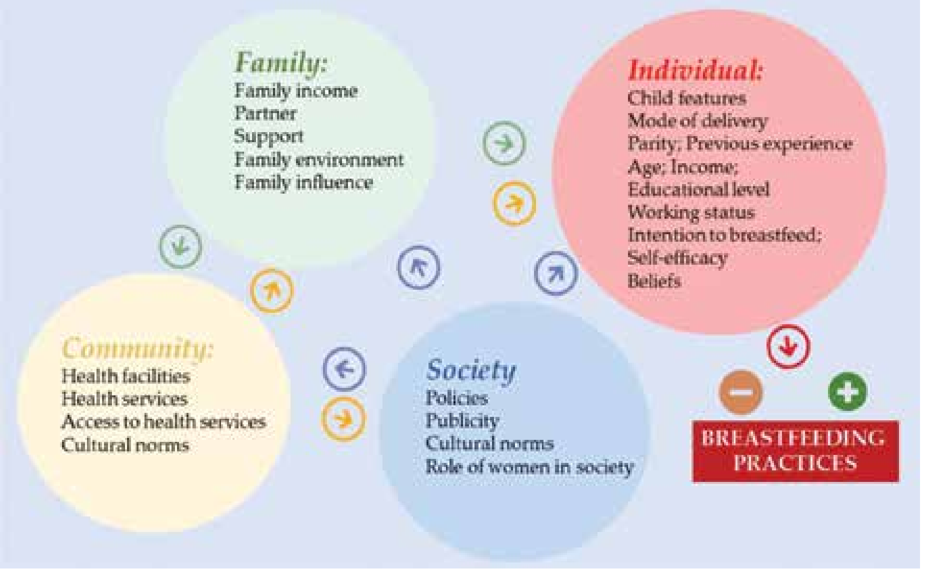


Figure 4. Conceptual model of breastfeeding practices (factors and levels). Note: Individual level: red arrow; Family level: green arrow; Community level: yellow arrow; Society level: blue arrow.

4. Conclusions

In recent years, exclusive breastfeeding rates until the sixth month have improved because of policies and strategies for breastfeeding promotion. However, in different countries, multiple programs have been implemented to promote breastfeeding and counteract the lack of adherence observed in mothers for feeding their children exclusively with breast milk, as a result of factors such as the incorporation of women into work, multiple offers of milk formulas, and scarce training of health personnel to address the concerns of mothers. Although overall there is evidence of an increase in breastfeeding rates, there is wide variability between countries and even within the same country, noting that some of the data are far from the expected health goal.

Therefore, it is essential to consider breastfeeding as a biological process that should be built socioculturally, where ideological, religious, cultural, and political convergences or divergences can be studied and interrelated. There is a need for integrated attention regarding the sociocultural context of the breastfeeding period, which should be broadened in order to support mothers and empower them to positively deal with adversity during this process. It is important to know what mothers think about breastfeeding in order to encourage the creation of practices to satisfactorily maintain this process as long as possible for both mothers and babies [25].

Conflict of interest

The author has no conflict of interests to declare.

Author details

René Mauricio Barría P

Address all correspondence to: rbarria@uach.cl

Faculty of Medicine, Institute of Nursing, Universidad Austral de Chile, Valdivia, Chile

References

[1] World Health Organization. Infant and Young Child Feeding. WHO 2018. Available from: http://www.who.int/en/news-room/fact-sheets/detail/infant-and-young-child-feeding. Accessed: 28-09-2018

[2] World Health Organization. Global Nutrition Targets 2025: Breastfeeding Policy Brief. Geneva: World Health Organization; 2014

[3] United Nations Children's Fund (UNICEF). The State of the World's Children 2014 in Numbers: Every Child Counts. Nueva York: UNICEF; 2014

[4] United Nations Children's Fund (UNICEF). The State of the World's Children 2016. A Fair Chance for Every Child. Nueva York: UNICEF; 2016

[5] Eidelman AI, Schanler RJ. American academy of pediatrics section on breastfeeding. Breastfeeding and the use of human milk. Pediatrics. 2012;**129**:e827-e841. DOI: 10.1542/peds.2011-3552

[6] Eidelman AI. The AAP's 2012 breastfeeding policy statement: Is there anything new? Breastfeeding Medicine. 2012;**7**:203-204. DOI: 10.1089/bfm.2012.9989

[7] Eidelman AI. Breastfeeding and the use of human milk: An analysis of the American academy of pediatrics 2012 breastfeeding policy statement. Breastfeeding Medicine. 2012;**7**:323-324. DOI: 10.1089/bfm.2012.0067

[8] Cattaneo A, Quintero-Romero S. Protection, promotion and support of breastfeeding in low-income countries. Seminars in Fetal & Neonatal Medicine. 2006;**11**:48-53. DOI: 10.1016/j.siny.2005.10.007

[9] Paricio Talayero JM, Lizan-Garcia M, Otero PA, Benlloch Muncharaz MJ, Beseler SB, Sanchez-Palomares M, et al. Full breastfeeding and hospitalization as a result of infections in the first year of life. Pediatrics. 2006;**118**:e92-e99. DOI: 10.1542/peds.2005-1629

[10] Kramer MS, Kakuma R. Optimal duration of exclusive breastfeeding. Cochrane Database Systematic Reviews. 2012;(8):CD003517. DOI: 10.1002/14651858.CD003517.pub2

[11] Victora CG, Bahl R, Barros AJ, Franca GV, Horton S, Krasevec J, et al. Breastfeeding in the 21st century: Epidemiology, mechanisms, and lifelong effect. Lancet. 2016;**387**:475-490. DOI: 10.1016/S0140-6736(15)01024-7

[12] Meedya S, Fahy K, Kable A. Factors that positively influence breastfeeding duration to 6 months: A literature review. Women and Birth. 2010;**23**(4):135-145. DOI: 10.1016/j.wombi.2010.02.002

[13] Cohen SS, Alexander DD, Krebs NF, Young BE, Cabana MD, Erdmann P, et al. Factors associated with breastfeeding initiation and continuation: A meta-analysis. The Journal of Pediatrics. 2018. DOI: 10.1016/j.jpeds.2018.08.008. In Press

[14] Yuzugullu DA, Aytac N, Akbaba M. Investigation of the factors affecting mother's exclusive breastfeeding for six months. Türk Pediatri Arşivi. 2018;**53**:96-104. DOI: 10.5152/TurkPediatriArs.2018.6262

[15] Wambach KA, Cohen SM. Breastfeeding experiences of urban adolescent mothers. Journal of Pediatric Nursing. 2009;**24**:244-254. DOI: 10.1016/j.pedn.2008.03.002

[16] Nesbitt SA, Campbell KA, Jack SM, Robinson H, Piehl K, Bogdan JC. Canadian adolescent mothers' perceptions of influences on breastfeeding decisions: a qualitative descriptive study. BMC Pregnancy and Childbirth. 2012;**12**:149. DOI: 10.1186/1471-2393-12-149

[17] Mossman M, Heaman M, Dennis CL, Morris M. The influence of adolescent mothers' breastfeeding confidence and attitudes on breastfeeding initiation and duration. Journal of Human Lactation. 2008;**24**:268-277. DOI: 10.1177/0890334408316075

[18] Vari P, Vogeltanz-Holm N, Olsen G, Anderson C, Holm J, Peterson H, et al. Community breastfeeding attitudes and beliefs. Health Care for Women International. 2013;**34**:592-606. DOI: 10.1080/07399332.2012.655391

[19] Li R, Hsia J, Fridinger F, Hussain A, Benton-Davis S, Grummer-Strawn L. Public beliefs about breastfeeding policies in various settings. Journal of the American Dietetic Association. 2004;**104**:1162-1168. DOI: 10.1016/j.jada.2004.04.028

[20] Osman H, El ZL, Wick L. Cultural beliefs that may discourage breastfeeding among Lebanese women: A qualitative analysis. International Breastfeeding Journal. 2009;**4**:12. DOI: 10.1186/1746-4358-4-12

[21] Ichisato SM, Shimo AK. Aleitamento materno e as crenças alimentares. Revista Latino-Americana de Enfermagem. 2001;**9**:70-76. DOI: 10.1590/S0104-11692001000500011

[22] Ishak S, Adzan NA, Quan LK, Shafie MH, Rani NA, Ramli KG. Knowledge and beliefs about breastfeeding are not determinants for successful breastfeeding. Breastfeeding Medicine. 2014;**9**:308-312. DOI: 10.1089/bfm.2013.0124

[23] Reinsma K, Bolima N, Fonteh F, Okwen P, Yota D, Montgomery S. Incorporating cultural beliefs in promoting exclusive breastfeeding. African Journal of Midwifery and Women's Health. 2012;**6**:65-70. DOI: 10.12968/ajmw.2012.6.2.65

[24] Trejo Hernandez P, Callahan S. Attributions of breastfeeding determinants in a French population. Birth. 2008;**35**:303-312. DOI: 10.1111/j.1523-536X.2008.00257.x

[25] Barría RM. La necesidad de una mirada integral del proceso de la Lactancia Materna en el contexto de la Atención Primaria de Salud: Desafío para la formación y práctica. Enfermería Universitaria. 2018;**15**:223-225. DOI: 10.22201/eneo.23958421e.2018.3.67213

Bioactive Components of Human Milk: Similarities and Differences between Human Milk and Infant Formula

Esmat Aly, Aliaa Ali Darwish, Ruben Lopez-Nicolas,
Carmen Frontela-Saseta and Gaspar Ros-Berruezo

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.73074

Abstract

Nowadays, there is an increasing awareness regarding the relationship between food, nutrition, and health. It is obvious that this relation starts from the birth. In the early stage of life, breastfeeding is considered the preferred choice for infant feeding and human milk is the optimal food for an infant to keep its nutritional and health status. Because it contains a large group of bioactive compounds such as proteins, vitamins, nucleotides, oligosaccharides, immunoglobulins, and some of the bioavailable minerals beyond its content of the essential nutrients, human milk is classified as the first functional food in the infant life. The various bioactive components of human milk play a pivotal role in preventing the gastrointestinal and respiratory infections, anemia, and bone-related problems as well as it enhances the immune function and helps in the maturation of the digestive system. The exclusive breastfeeding pattern during the first 6 months of infant life and introducing complementary foods after this period have a potential role in protecting against certain diseases in the adult stage of life. This chapter is underlying the great potential of breastfeeding for mothers and babies. Moreover, it discusses the functionality of some components of human milk and its similarities and differences between human milk and infant formulas.

Keywords: breastfeeding, human milk, bioactive components, lactoferrin, oligosaccharides, infant formulas

1. Introduction

Milk and dairy product are considered a main part of the healthy and balanced diet [1]. In this context, human milk is the most appropriate choice for feeding newborns and provides all the energy and nutrients needed to ensure proper growth and development [2]. Furthermore, human milk provides a large group of functional components which improve the newborn health, increase the immunity, and protect against the gastrointestinal and respiratory infections [3]. So, it was noted that breastfed infants suffer less gastrointestinal disorders and respiratory infections rather than formula-fed infants [4]. The exclusive breastfeeding pattern during the first 6 months of life was recommended by various health and breastfeeding organizations such as the American Academy of Pediatricians (AAP) and the American Academy of Family Physicians (AAFP) [5].

It is scientifically accepted that using the nutritional factors may decrease or prevent the extension of these diseases and its implications to the adult life. Nowadays, researchers and health and breastfeeding organizations are trying to discover the precise substances in human milk that seem to supply physiological benefits beyond its normal nutritional value which contribute earlier in delay, treatment or prevent some diseases [6]. Thus, these functional ingredients hold a great promise for future trends in human nutrition. Additionally, the relationship between milk consumption and human health requires a deeper understanding to uncover the protective role of some bioactive compounds, which naturally present in human milk.

Although human milk is considered the optimal food and supplies all the nutrient and some bioactive components, it is no longer sufficient to meet all the necessary nutritional requirements after 4–6 months of infant life [7]. In this case, infant formulas play an indispensable role in infant feeding. The formulas should be similar to mature human milk regarding its micronutrient and macronutrient contents. During the evolution of infant formulas, the manufacturers should take into account the necessary nutritional requirements of the newborns and infants and enrich the formulas with the functional ingredients which are naturally present in human milk [8]. The aim of this review is to present current knowledge regarding evidence on the importance of breastfeeding, the functionality of selected human milk ingredients, infant formulas as a human milk alternative, and the similarities and differences between human milk and infant formulas.

2. Meaning of breastfeeding for mothers and babies

It is well established that breastfeeding pattern of newborn provides more benefits for both mothers and their babies. It is well documented that breastfeeding not only provides the optimal nutrition [9] but also has many health benefits for both children and their mothers [10]. Breastfeeding pattern is positively associated with maternal sensitivity and with bonding between mother and infant [11]. It helps to build up a safe and full-of-feeling relationship between the mother and her infant and offers numerous other positive advantages. Breastfeeding mothers suffer less from certain serious diseases: reduced risk of certain cancers, including ovarian and breast cancer, type 2 diabetes, delayed resumption of menses, and more rapid postpartum weight loss. So, breastfeeding mothers are likely to be more health conscious, and, therefore, to promote healthy habits, which are likely to prevent overweight and obesity later in childhood [12].

http://dx.doi.org/10.5772/intechopen.73074

On the other hand, breastfeeding pattern provides the protection against childhood-related diseases. In this regard, breastfed infants showed higher resistance to infectious disease and stronger immune systems, leading to lower rates of chronic diseases as compared to formula-fed infants. The ideal composition of human milk provides nutritional, growth, and developmental advantages to the child [13]. By the way, lower risk of gastrointestinal infection, otitis media, asthma, allergies, respiratory tract infection, type 1 diabetes, and sudden infant death syndrome are observed in breastfed infants. Other benefits include evidence of protection against childhood obesity, which may persist into adulthood, and less cognitive development and behavioral problems in breastfed children compared with children not breastfed [14]. Based on the abovementioned, breastfeeding should be actively recommended and supported as the most preferred method of infant feeding at both nutritionally and healthy states.

3. Nutritional significance of breastfeeding

It is well established that infancy is the most important stage of human life where newborns are growing with high rate allowing to duplicate the infant weight in only 4–5 months. So, an adequate supply of nutrients represents paramount importance in this early stage of infant life. The breastfeeding of infants is obviously important to provide the needed nutrients and energy for the synthesis and deposition of new tissues from birth until 4–6 months of infant life.

The high metabolic requirements contrast with the limited ability of young infants to compensate for an inadequate supply of nutrients due to the diminished body reserves of nutrients and the immature homeostatic mechanisms. For example, the activity of some metabolic pathways and the kidney's ability to concentrate the urine are still low during the first 3–4 months of life. Young children may not be able to synthesize sufficient amounts of certain substrates considered as nonessential or dispensable since the limited capacity of the specific metabolic synthesis is not always sufficient to achieve the high requirements. Some nutrients considered nonessential in adults and older children can become indispensable for young infants that would be supplied in the diet [15].

In addition to the immediate consequences of infant feeding on growth, body composition, health, and wellness, a number of recent studies have also provided indications that the quantity and quality in the supply of nutrients during childhood has important long-term consequences in the development and function of the organs, health, and risk of disease as well as in the cognitive ability [16]. Human milk is nowadays universally recognized as the optimal feeding choice for every infant [17] where it contains many nutritional components that are able to conserve his development.

The nutritional components of human milk are classified into two categories: macronutrients and micronutrients [18]. Macronutrients of human milk include protein, fat, and sugar. The concentration of human milk macronutrients differed during the course of lactation and between the mothers as well as differed between term and preterm milk. The latter has a higher content of protein and fat. Generally, the mean macronutrient composition of term mature human milk is presented in **Table 1** as compared with cow milk, the most common milk type used in infant formula manufacturing.

Proteins provide amino acids for growth as well as are presented in the form of polypeptides that facilitate digestion [19], the defense of the guest [20], and other functions [21]. Fats provide energy, but some have antiviral properties [22]. Carbohydrates provide energy and can also stimulate the absorption of minerals [23], and various human milk oligosaccharides (HMOs) play a pivotal role in the microbial intestinal balance. Energy estimates range from 65 to 70 kcal/dL and are highly correlated with the fat content of human milk. Butte et al. [24] also clearly showed that intakes of energy, protein, fat, and carbohydrate were lower in breastfed than in formula-fed infants at 3 and 6 months. The differences in composition between human milk and infant formulas seem to affect the growth pattern between breastfed infants and formula-fed infants [25]. However, no apparent consequences were associated with the lower intake and slower weight gain of breastfed infants where they do not differ in activity level, and they suffer less gastrointestinal and respiratory infections and have higher cognitive development [26].

Because human milk is considered the optimal and first functional food for infant feeding, nowadays, especially in the USA, pasteurized donor milk represents the suitable alternative provided for an infant that is in high risk [28]. However, infant formulas become necessary for infant feeding when human milk is unavailable or the mother cannot breastfeed her infant. So, special efforts are needed to ensure an adequate diet composition in young infants [25].

Various negative consequences are noted with very low- or very high-specific nutrients [29]. For example, cow's milk is not an ideal food during the first year of life. The ingestion of protein for the infants fed with cow's milk is higher than that for those fed with human milk, and this leads to overload renal solutes [30]; in addition, a high-protein intake can cause hypercalciuria [31]. On the other hand, high consumption of cow's milk below the first year of life is one of the most important risk factors for the development of iron deficiency anemia. Cow's milk is low in iron, and much of that iron is attached to the casein micelles, which interferes with its absorption. Additionally, its low content in vitamin C does not favor the absorption of the little iron that contains [32].

Overall, the breastfeeding pattern is the preferred choice of infant nutrition and human milk provides all the nutritional components during 4–6 months of life. It also provides a large group of bioactive components, which play an indispensable role in protecting the infant health.

Components	**Content (mg/100 g)**	
	Human milk	**Cow milk**
Protein	1.2	3.2
Fat	3.7	3.7
Sugar	7	4.9
Energy (kcal)	65	66

Adapted from [27].

Table 1. Macronutrient concentration of human milk and cow milk.

4. The bioactive components of human milk

Increasing evidence currently shows that short- and long-term benefits of human milk feeding are resulted by its content of various components named functional or bioactive components. These functional components involved a large group of several compounds such as protein (such as lactoferrin (Lf)), carbohydrates (especially human milk oligosaccharides), fats (polyunsaturated fatty acids), vitamins, nucleotides, minerals, and immunoglobulins. In this section, the occurrence, variation, and functionality of selected components of human milk are discussed.

4.1. Lactoferrin: for anemia fighting

Lactoferrin (Lf) is the second most abundant protein in human milk belonging to the transferrin family [33]. It is a glycoprotein first isolated from cow's milk and second from human milk [34]. It is well known as the principal iron-binding protein in mammals' milk [35] and the first-line defense molecule against infections [33]. The highest content of Lf is found in human colostrum (7 g/L), and this content declined after 2 weeks after birth reaching 2–4 g/L of mature human milk [36]. While Lf content in cow colostrum and milk is 10-fold lower [37]. Structurally, Lf is an iron-binding glycoprotein consisting of a single polypeptide chain distributed to two lobes (N and C lobes). Both human Lf and bovine Lf are sharing a sequence homology of about 70%, and their 3D structures (**Figure 1**) are very similar but not identical [38]. Each lobe of Lf contains an iron-binding site with a high affinity and a glycan-binding site. N and C lobes have very similar conformations but show slight differences in their affinity for iron [39]. **Table 2** presents the differences between human and bovine Lf.

Due to its distribution in several parts of the body and its involvement in several physiological processes, Lf is considered as a multifunctional protein. Moreover, numerous studies have been carried out to uncover the wide range of activities of Lf and its peptides [42, 43]. Iron absorption enhancement by Lf is one of the most observed activities especially in breastfed as compared to formula-fed infants. In this context, the high affinity of Lf to bind iron is a key characteristic of this beneficial role. Although iron is the main cation bound by Lf, other metals such as Cu^{2+}, Zn^{2+}, and Mn^{2+} ion can be bound by Lf [44]. Lf exists in three forms, according

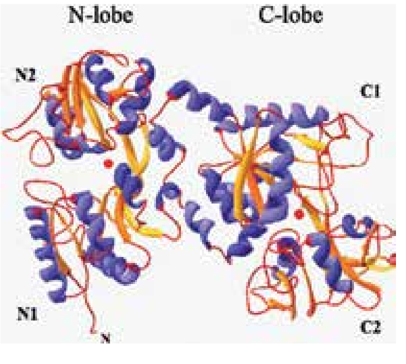


Figure 1. Protein structure of human Lf. Source: Ref. [41].

Characteristics	Human Lf	Bovine Lf
Molecular weight (kDa)	80	77
Amino acids	711	689
N lobe	1–332	1–233
C lobe	344–703	345–689
α-Helix	333–344	334–344
Adapted from [38, 40].		

Table 2. Structure of human Lf and bovine Lf.

to its saturation degree with iron: apo-lactoferrin (iron free), mono-ferric form (one ferric iron), and holo-lactoferrin (binds two Fe^{3+} ions) [45]. Apo-lactoferrin is the secreted form of Lf in human milk where its saturation degree does not exceed 10%, whereas its saturation degree in cow milk is about 20% [46].

The apo-Lf molecule is an open molecule, whereas the holo-Lf is a closed molecule [47]. Thus, apo-Lf is less stable than holo-Lf against gastrointestinal enzymes [48]. In view of this, the stability of Lf against gut enzymes is determined by its degree of saturation with iron. Interestingly, media pH plays a key role in iron release from Lf. So, bovine Lf retains the metal over a wide range of pH and starts to release its iron below pH 4 and at pH 2 iron is completely released, while it starts to release at pH 3 in human Lf [42].

Among the principal factors that influence the iron bioavailability is its distribution in milk where 20–45% of iron in human milk is mainly bound to Lf, while 24% of iron in cow milk is bound to casein micelles [49]. This distribution resulted in a high iron bioavailability from human milk. Moreover, the high iron absorption from human milk was attributed to its high content of Lf. This hypothesis was supported by the discovery of species-specific receptors with high affinity for Lf (Lf receptors) in the enterocytes. This would explain the high bioavailability of iron from human milk, as only human lactoferrin releases iron to the enterocyte by this mechanism [48]. Additionally, Lf can increase the gene expression of divalent metal transporter 1 (DMT1) receptors that may play a central role in enhancing Fe uptake via proton-coupled mechanism [50]. It was also reported that Lf may be useful as a natural solubilizer of iron for food products, and it was suggested that Lf, orally administered, could solubilize ferric Fe in the intestine [51]. The endocytosis, another possible mechanism, was speculated to explain the role of Lf in iron absorption. The enterocytes catch Lf-iron complex through the endocytosis and then release its iron, through Lf degradation, at the intracellular level [52]. The released iron inside the cell is quickly complexed, forming another protein named ferritin, and then, apo-form of Lf comes back again to mucosa surface to catch another iron to start another transport process [53]. **Figure 2** shows the possible mechanisms of iron absorption enhancement by Lf.

Overall, Lf is a multifunctional glycoprotein and has a central role in decreasing the gastrointestinal and respiratory infections and protecting the newborn from anemia.

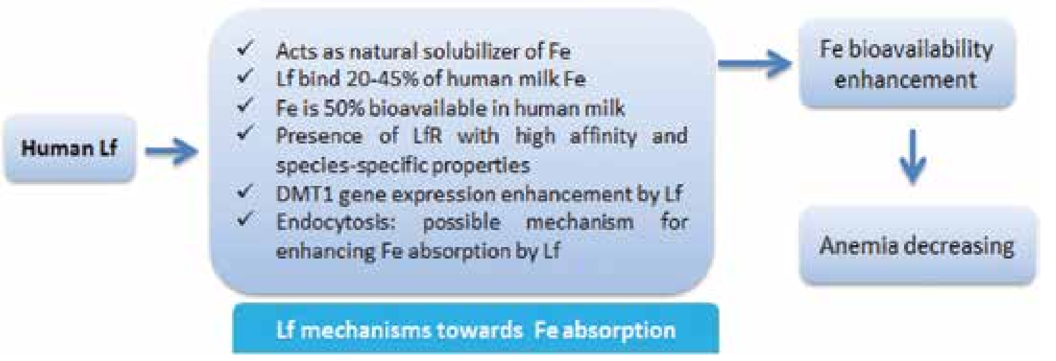


Figure 2. Possible mechanisms and characteristics of Lf associated with Fe bioavailability enhancement.

4.2. Oligosaccharides

Human milk oligosaccharides (HMOs), the third most abundant component of human milk, are another multifunctional milk ingredient. Its content is higher in colostrum (15–23 g/L) than mature milk, which contains 8–12 g/L [54]. Structurally, human milk contains more than one hundred oligosaccharides with diverse structure and functions. A wide range of activities were reported for HMOs [55]. The prebiotic activity of HMOs has been observed by various studies [54] where it acts as a bifidogenic molecule that improves the beneficial microflora growth. It also provides functional capacity including anti-adhesive and immunomodulators [56].

HMOs are nondigestible substances, and this property is the main key to its physiological role. HMOs can survive against the gastrointestinal conditions, digestive enzymes, and pH and thus reach the colon in an intact form where these serve as fermentable substances, leading to improvement in the beneficial bacteria growth and activity [57], preferably Bifidobacteria [58]. The fermentation of prebiotics is accompanied by organic acid production and pH decrease. Hence, prebiotic fermentation may create an environment in the colon that inhibits the growth and activity of pathogens. In addition, prebiotics fermentation may enhance the beneficial bacteria in the colon that can produce various antibacterial factors, leading to pathogen growth inhibition. Additionally, HMOs possess direct activities resulted in pathogen inhibition where it has anti-adhesive effects that reduce or prevent the pathogen biofilm formation through its ability to reduce pathogens binding to colonocytes [59]. Similarly, HMOs also act as receptor analogues to inhibit the adhesion of pathogens on the epithelial surface, and this evidence is seen as a passive defense of the host [60].

HMO's structure and diversity represent another difference among human milk, cow milk, and infant formulas. As well known that human milk is structurally very complex and has huge diversity [61], identical structures are not available for use in infant formulas [62]. Thus, several researchers proposed using oligosaccharides much simpler such as GOS and FOS or that derived from cow milk [63]. Thus, breastfed infants have less gastrointestinal infections and their stools contain more beneficial bacteria, *Lactobacilli* and *Bifidobacteria*, as compared to formula-fed infants. The positive microbial intestinal balance partially attributed to HMOs plays a pivotal role in improving the gut health.

4.3. Nucleotides

Nucleotides, another bioactive ingredient of human milk, are nitrogenous compounds which play a main role in various metabolism processes, such as energy transfer, nucleic acid synthesis (DNA and RNA), and carbohydrates, lipids, and proteins synthesis. Nucleotides are found in human milk in free form as ribonucleotides and ribonucleosides accounting 2–5% of non-protein nitrogen and participate in protein utilization by breastfed infants [35]. Free nucleotide content is higher in human milk than cow milk. Additionally, some related components such as nucleosides, purine and pyrimidine bases, nucleic acids, and products derived from them (such as uridine diphosphate galactose) have been found in human milk [64]. Human milk contains a higher content of free nucleotides than cow milk. Thus, it is recommended to enrich cow milk-based formulas with the nucleotide level similar to that found in human milk [65]. Recently, legislation allows the addition to infant formulas and follow-on formula, nucleotides in quantities of: 1.5 mg adenosine-5-phosphate/100 kcal, 2.5 cytosine-5-phosphate/100 kcal, 0.5 kcal guanosine-5-phosphate/100 mg, 1.75 mg uridine-5-phosphate/100 kcal, 1 mg inosine-5-phosphate/100 kcal, until a total concentration of 5 mg/100 kcal, which is similar to the amounts of free ribonucleotides in milk (4–6 mg/100 kcal) [25]. Also in this context, Koletzko et al. [15] reported that ESPGHAN supports the optional addition of nucleotides in amounts not to exceed 5 mg/100 kcal as adverse effects have been seen with higher concentrations.

Addition of nucleotides to infant formulas have been found to increase the probiotic bacteria counts and reduce the pathogen counts in stool samples in infants fed on nucleotide-supplemented formula as compared to whose fed standard infant formula, but probiotic counts in the stool of breastfed infants were still higher. The intestinal microflora modulation attributed to nucleotides due to that nucleotides serve as an energy source of intestinal microflora. Because probiotic bacteria are characterized by a higher growth rate than pathogenic bacteria, they limit the growth of pathogens. Thus, supplementation with nucleotides able to positively modulate the intestinal microbial balance, leading to increase probiotic growth and limit the growth of the pathogens [66].

5. Infant formula: looking for the best alternative

Although human milk contains all nutrients and provides diverse bioactive ingredients and considered the first functional food in infant life, it is not generally attractive, adequate, or acceptable or it is not available; in some cases, the infants cannot be breastfed. Thus, looking for a suitable alternative is of importance.

In these cases, infant formulas play an indispensable role in infant nutrition. All efforts of industry are aimed to resemble human milk composition [67]. The accumulated knowledge about human milk composition highly assists in infant formula development. However, the human milk composition is not stable, since it changes along breastfeeding period [68], as well as depending on different factors such as environment, mother's diet, and so on. Nowadays, companies and research centers are devoted to prepare these formulas focused on enhancing the quality of infant formulas, not only adapting the concentration of macronutrients and micronutrients but also the composition of bioactive compounds to make it as similar as possible to human milk [69] where the final aim of infant formula development is not necessarily to mimic the composition of human milk in every respect but to achieve physiological effects as in breastfed infants [70].

Nowadays, there are numerous infant formulas adapted to special physiological state and infant formula based on soy or without lactose, among others. But, in this chapter, we are focused on those formula based on supplemented cow milk with functional ingredients. The current trend of infant formula manufacturing is to enrich it with the functional ingredients that naturally found in human milk. Thus, these ingredients such as probiotics, prebiotics (oligosaccharides), proteins such as lactoferrin and α-lactalbumin, nucleotides,and polyunsaturated fatty acids (mainly docosahexaenoic and arachidonic acids) among others are incorporated in infant formulas to make them more functional [71]. In fact, many studies revealed the higher efficacy of infant formulas supplemented with certain bioactive ingredients than the unsupplemented ones [72].

5.1. Nutritional components of infant formula

Human milk must be always selected as the first option for the best infant nutrition. However, when it is impossible, an adequate substitute should be found. Historically, milk from different animals was studied, obtaining the best results for the cow. However, some problems have been found after using cow milk as a substitute, since the high-protein content, the different protein composition, and the sodium content, among others, could induce some metabolic problems to the not fully developed gastrointestinal system of newborns. From last decades until now, the infant formula has been developed trying to mimic to human milk in macronutrients and energy density, but it is in the most recent past when the functional ingredients are included in the infant formulation to simulate the beneficial health effects of breast milk. **Table 3** shows the composition of infant formula supplemented or not including legal limits according to the European Commission [73].

As can be seen, different compounds are included in supplemented infant formulas in different concentrations. The caloric values have also been considered to establish a minimum or maximum legal limit for each one. Prebiotics (FOS and GOS) are considered as key compounds in human milk in order to promote an adequate intestinal microbiota; for this reason, infant formulas should be adequately supplemented. Beneficial bacteria of human milk should be also included in infant formulas; however, it is very difficult that added bacteria achieve colon as live microorganisms with beneficial effects on health.

5.2. Functional components of infant formula: resembling the standard model

One of the functional ingredients added to infant formula is oligosaccharides (fructo- and/ or galactooligosaccharides) since they are in human breast milk providing a beneficial effect

	Standard infant formula	Supplemented infant formula	Supplemented infant formula	
			Minimum limit	Maximum limit
Energy (kcal)	68	67	60	70
Protein (g)	1.3	1.5	1.1	2.1
Fat (g)	3.8	3.5	2.6	4.2
α-Linoleic (mg)	586	500	300	840
α-Linolenic (mg)	55.9	61.5	30	70
AA (mg)	—	8.7	—	42
DHA (mg)	—	8.6	12	35
Carbohydrate (g)	7.2	7.5	5.4	9.8
FOS (g)	—	—	—	0.1
GOS (g)	—	0.5	—	0.7
Others				
L-Carnitin (mg)	—	1.1	0.8	—
Taurin (mg)	1.0	6.0	—	8.4
Nucleotides (mg)	—	3.2		3.5

Source: Ref. [73].

Table 3. The composition of different infant formulas. Values are expressed as grams per 100 mL of reconstituted formula.

on newborns due to its prebiotic activity. Furthermore, these compounds show anti-adhesive properties, protecting the intestinal epithelium against pathogens as well as enhancing the immune system that, in infants younger than 6 months, is not still fully developed.

Polyunsaturated fatty acids can be produced by newborns using its precursors (linolenic and linoleic acid), but this transformation pathway is not fully developed at this age. For that, most infant formulas are enriched with arachidonic and docosahexaenoic acids (ARA and DHA, respectively), since they play an important role in neuronal function and cognitive and visual development [74].

Other important bioactive compounds present in human milk are polyamines that are nitrogen compounds and are present in a very low concentration in cow's milk. Nowadays, based on different studies, polyamines should be added to infant formula; however, due to the scarce information found in the literature about its specific function and the effect on human health on medium-long term, more studies should be developed. Studies performed show an interesting role of polyamines in the maturation of intestinal and immune systems of infants [75].

Studies in infant formula composition must be studied in detail. Related to this, there is no doubt that the proteins in human milk provide an important source of amino acids to rapidly growing breastfed infants. However, this is not the only one role of milk proteins since many of them also play a role in facilitating the digestion and uptake of other nutrients in breast milk. Included in this group of functional proteins are lactoferrin and haptocorrin, which may assist in the absorption of iron and vitamin B12, respectively [76]. Vitamin B12 in human milk is mostly bound to haptocorrin, and these proteins have also been suggested to inhibit pathogenic bacterial growth by tightly binding and withholding vitamins and minerals from the bacteria [77].

Another important human milk protein is alpha-lactalbumin (15% of the total protein content). This protein is responsible, in the mammary gland, for lactose synthesis, but it is also secreted in the milk. This functional protein is easily digested, forming peptides that may provide different bioactivities in the upper gastrointestinal tract (duodenum and jejunum) [78]. Alpha-lactalbumin, after gastrointestinal digestion, serves as a good source of essential amino acids.

6. Conclusion

Breastfeeding during the first 6 months of infant life represents the cornerstone of building his body and maintaining his health status. Feeding of an infant during this critical period of life has several short-term and long-term effects. So, breastfeeding is recommended exclusively after birth till 6 months; then, the complementary food must be included to meet the increasing nutrients needed. As we know, human milk is the optimal food during this early stage of life. In some cases, infant formulas represent the best alternative for infant feeding which must resemble human milk composition not only in its macronutrients but also in its functionality.

Author details

Esmat Aly[1], Aliaa Ali Darwish[2], Ruben Lopez-Nicolas[3], Carmen Frontela-Saseta[3] and Gaspar Ros-Berruezo[3]*

*Address all correspondence to: gros@um.es

1 Special Foods and Nutrition Department, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

2 Dairy Technology Research Department, Food Technology Research Institute, Agricultural Research Center, Giza, Egypt

3 Food Science and Nutrition Department, Faculty of Veterinary Sciences, University of Murcia, Espinardo, Spain

References

[1] Howie PW, Forsyth JS, Ogston SA, Florey CD. Protective effect of breastfeeding against infection. British Medical Journal. 1990;**300**:11-16

[2] Giribaldi M, Cavallarin L, Baro C, Di Nicola P, Coscia A, Bertino E. Biological and nutritional aspects of human milk in feeding of preterm infants. Food and Nutrition Sciences. 2012;**3**:1682-1687. DOI: 10.4236/fns.2012.312220

[3] Picciano MF. Nutrient composition of human milk. Pediatric Clinics of North America. 2001;**48**(1):53-67. DOI: 10.1016/S0031-3955(05)70285-6

[4] Wang M, Li M, Wu S, Lebrilla CB, Chapkin RS, Ivanov I, Donovan SM. Fecal microbiota composition of breast-fed infants is correlated with human milk oligosaccharides consumed. JPGN. 2015;**60**:825-833

[5] American Academy of Pediatrics. Breastfeeding and the use of human milk section on breastfeeding. Pediatrics. 2012;**129**(3):e827-e841

[6] Duijts L, Jaddoe VW, Hofman A, Moll HA. Prolonged and exclusive breastfeeding reduces the risk of infectious diseases in infancy. Pediatrics. 2010;**126**(1). Available at: www.pediatrics.org/cgi/content/full/126/1/e18

[7] Butte NF, Garza C, Smith EO, Nichols BL. Human milk intake and growth in exclusively breastfed infants. Journal of Pediatrics. 1984;**104**(2):187-195

[8] European Commission. Commission Directive of 14 May 1991 on infant formulae and follow-on formulae (91/321/EEC). OJ L 175, p. 35, last consolidated 25 May 1999

[9] Abiona TC, Onayade AA, Ijadunola KT, Obiajunwa PO, Aina OI, Thairu LN. Acceptability, feasibility, and affordability of infant feeding options for HIV-infected women: A qualitative study in south-west Nigeria. Maternal and Child Nutrition. 2006;**2**:135-144

[10] Kramer MS, Kakuma R. Optimal duration of exclusive breastfeeding. Cochrane Database Systematic Review. 2002;**1**:1-106

[11] Britton JR, Britton HL, Gronwaldt V. Breastfeeding, sensitivity, and attachment. Pediatrics. 2006;**118**:e1436-e1443

[12] WHO. Long-term effects of breastfeeding: A systematic review. 2013:1-67

[13] U.S. Department of Health and Human Services [USDHHS], 2000

[14] Chang YS, Montgomery E, Taylor C, Chadderton Z, Bick D. Breastfeeding support for women following cesarean birth. An exploratory study. Maternal and Child Nutrition. 2015;**11**(2):26-27

[15] Koletzko B, Baker S, Cleghorn G, Fagundes Neto U, Gopalan K, Hernell O, Hock QS, Jirapinyo P, Lonnerdal B, Pencharz P, Pzyrembel H, Ramirez-Mayans K, Shamir R, Turck D, Yamashiro Y, Zong-Yi D. Global Standard for the Composition of Infant Formula: Recommendations of an ESPGHAN Coordinated International Expert Group. Journal of Pediatric Gastroenterology and Nutrition. 2005;**41**:584-599. November 2005 ESPGHAN Committee on Nutrition

[16] Lucas A. Programming by early nutrition: An experimental approach. The Journal of Nutrition. 1998;**128**:401S-406S

[17] Fanaro S, Vigi V. Feeding the term infant: Human milk and formula. In: Buonocore G, Bracci R, Weindling M, editors. Neonatology. A Practical Approach to Neonatal Diseases: A Practical Approach to Neonatal Management. Milan: Springer; 2012. pp. 290-297. DOI: 10.1007/978-88-470-1405-3_44

[18] Ballard O, Morrow AL. Human milk composition: Nutrients and bioactive factors. Pediatric Clinics of North America. 2013;**60**(1):49-74. DOI: 10.1016/j.pcl.2012.10.002

[19] Goldman A, Smith CW. Host resistance factors in human milk. The Journal of Pediatrics. 1973;**82**:1082-1090

[20] Klagsbrun M. Human milk stimulates DNA synthesis and cellular proliferation in cultured fibroblasts. Proceedings of the National Academy of Sciences of the United States of America. 1978;**75**:5057-5061

[21] Welsh JK, Skurrie IJ, May JT. Use of Semiliki forest virus to identify lipid-mediated antiviral activity and anti-alphavirus immunoglobulin A in human milk. Infection and Immunity. 1978;**19**:395-401

[22] Wasserman RH. Lactose stimulate absorption of calcium: A theory. Nature. 1964;**201**:997-999

[23] Mehta NR, Jones JB, Hamosh M. Lipases in preterm human milk ontogeny and physiologic significance. Journal of Pediatric Gastroenterology and Nutrition. 1982;**1**:317-326

[24] Butte NF, Wong WW, Hopkinson JM, Smith EO, Ellis KJ. Infant feeding mode affects early growth and body composition. Pediatrics. 2000;**106**:1355-1366

[25] European Commission. Report of the Scientific Committee on Food on the Revision of Essential Requirements of Infant Formulae and Follow-on Formulae. April, 2003. 213 p

[26] Rao MR, Hediger ML, Levine RJ, Naficy AB, Vik T. Effect of breastfeeding on cognitive development of infants born small for gestational age. Acta Paediatrica. 2002;**91**:267-274

[27] Jensen R. Handbook of Milk Composition. San Diego: Academic Press; 1995

[28] Arslanoglu S, Ziegler EE, Moro GE. Donor human milk in preterm infant feeding: Evidence and recommendations. Journal of Perinatal Medicine. 2010;**38**(4):347-351. DOI: 10.1515/jpm.2010.064

[29] Fomon SJ. Infant feeding in the 20th century: Formula and beikost. The Journal of Nutrition. 2001;**131**:S409-S420

[30] ESPGHAN. European Society for Pediatric Gastroenterology, Hepatology and Nutrition. Committee on Nutrition: Aggett PJ, Agostini C, Axelsson I, Bresson JL, Goulet O, Hernell O, Kolezko B, Lafeber HL, Michaelsen KF, Micheli JL, Rigo J, Szajewska H, Weaver L. Iron metabolism and needs in early childhood: Do we know enough? Journal of Pediatric Gastroenterology and Nutrition. 2002;**34**:337-345

[31] NIH Consensus Development Panel on Osteoporosis. Prevention, diagnosis and therapy. Journal of the American Medical Association. 2001;**285**:785-795

[32] Ferrer-Lorente B, Dalmau-Serra J. Fórmulas de continuación y fórmulas de crecimiento. Acta Paediatrica. 2005;**63**:471-475

[33] Conneely OM. Anti-inflammatory activities of lactoferrin. Journal of the American College of Nutrition. 2001;**2**(5):389S-395S

[34] Losnedahl KJ, Wang H, Aslam M, Zou S, Hurley WL. Antimicrobial Factors in Milk. Illini Dairy Net Papers: University of Illinois; 1998

[35] Baró L, Jiménez J, Martinez-Férez A, Boza JJ. Bioactive compounds derived from human milk. Ars Pharmaceutica. 2001;**42**(1):21-38

[36] Sacrino ML. A sideways glance: Take it or leave it? The role of lactoferrin in iron sequestration and delivery within the body. Genes Nutrition. 2007;**2**:161-162. DOI: 10.1007/s12263-007-0054-1

[37] Wakabayashi H, Yamauchi K, Takase M. Lactoferrin research, technology and applications. International Dairy Journal. 2006;**16**:1241-1251. DOI: 10.1016/j.idairyj.2006.06.013

[38] Steijns JM, van Hooijdonk ACM. Occurrence, structure, biochemical properties and technological characteristics of lactoferrin. British Journal of Nutrition. 2000;**1**:S11-S17

[39] Kaim W, Schwedereski B. Transport and storage of iron. In: John Wiley & Sons, editors. Bioinorganic Chemistry: Inorganic Elements in the Chemistry of Life. England: Bookcraft (Bath) Ltd.; 1994. pp. 162-165. Midsomer Norton, Somerset

[40] Van der Strate B, Beljaars L, Molema G, Harmsen M, Meijer D. Antiviral activities of lactoferrin. Antiviral Research. 2001;**52**(3):225-239. PMID: 11675140

[41] Van Veen H. Production and characterization of recombinant human lactoferrin [Ph.D thesis]. Leiden University, Netherlands, 2008. 113 p

[42] Aly E, Ros G, Frontela C. Structure and functions of lactoferrin as ingredient in infant formulas. Journal of Food Research. 2013;**2**(4):25-36

[43] Zhang Y, Lima CF, Rodrigues LR. Anticancer effects of lactoferrin: Underlying mechanisms and future trends in cancer therapy. Nutrition Reviews. 2014;**72**:763-773

[44] Baker EN, Baker HM. Molecular structure, binding properties and dynamics of lactoferrin. Cellular and Molecular Life Sciences. 2005;**62**:2531-2539

[45] Jameson GB, Anderson BF, Norriss GE, Thomas DH, Baker EN. Structure of human apolctoferrin at 2.0 a resolution. Refinement and analysis of ligand-induced conformational change. Acta Crystallographica. 1998;**D54**:1319-1335. DOI: 10.1107/S0907444998004417

[46] Makino Y, Nishimura S. High performance liquid chromatographic separation of human apo-lactoferrin and mono-ferric and di-ferric lactoferrin. Journal of Chromatography. 1992;**579**:346-349. DOI: 10.1016/0378-4347(92)80402-C

[47] Sharma AK, Rajashankar KR, Yadav MP, Singh TP. Structure of mare apo-lactoferrin: The N and C lobes are in the closed form. Acta Crystallographica. Section D, Biological Crystallography. 1999;**55**:1152-1157

[48] Gonzalez-Chavez S, Arevalo-Gallegos S, Rascon-Cruz Q. Lactoferrin: Structure, function and applications. International Journal of Antimicrobial Agents. 2009;**33**:301.e1-301.e8. DOI: 10.1016/j.ijantimicag.2008.07.020

[49] Lonnerdal B. Dietary factors affecting trace elements absorption in infants. Acta Paediatrica Scandinavica. 1989;**S351**:109-113. DOI: 10.1111/j.1651-2227.1989.tb11220.x

[50] Zhu L, Glahn RP, Yeung CK, Miller DD. Fe uptake by Caco-2 cells from NaFeEDTA and $FeSO_4$: Effects of ascorbic acid, pH, and a Fe (II) chelating agent. Journal of Agricultural and Food Chemistry. 2006;**54**:7924-7928

[51] Ushida T, Oda T, Sato K, Kawakami H. Availability of lactoferrin as a natural solubilizer of iron for food products. International Dairy Journal. 2006;**16**:95-101. DOI: 10.1016/j.idairyj.2005.01.013

[52] Sanchez L, Calvo M, Brock JH. Biological role of lactoferrin. Archives of Disease in Childhood. 1992;**67**:657-661. DOI: 10.1136/adc.67.5.657

[53] Sigel A, Sigel H. Transferrin, the transferrin receptor, and the uptake of iron by cells. In: Sigel AY, Sigel H. editors. Metal Ions in Biological Systems. Vol. 35. New York: Marcel Dekker; 1988. pp. 586-631

[54] Euler A, Mitchell D, Kline R, Pickering L. Prebiotic effect of fructooligosaccharide supplemented term infant formula at two concentrations compared with un-supplemented formula and human milk. Journal of Pediatric Gastroenterology and Nutrition. 2005; **40**:157-164

[55] Wu S, Grimm R, German JB, Lebrilla CB. Annotation and structural analysis of sialylated human milk oligosaccharides. Journal of Proteome Research. 2011;**10**:856-868

[56] Kunz C, Rudloff S, Baier W, Klein N, Strobel S. Oligosaccharides in human milk: Structural, functional, and metabolic aspects. Annual Review of Nutrition. 2000;**20**:699-722

[57] Gibson G, Roberfroid M. Dietary modulation of the human colonic microbiota: Introducing the concept of prebiotics. The Journal of Nutrition. 1995;**125**:1401-1412

[58] Roberfroid M. Prebiotics and probiotics: Are they functional foods. The American Journal of Clinical Nutrition. 2000;**71**:1682S-1687S

[59] Lane JA, Mehra RK, Carrington SD, Hickey RM. The food glycome: A source of protection against pathogen colonization in the gastrointestinal tract. International Journal of Food Microbiology. 2010;**142**:1-13

[60] Boehm G, Stahl B. Oligosaccharides. In: Mattila-Sandholm T, editor. Functional Dairy Products. Cambridge: Woodhead Publishing, 2003;203-243

[61] Bode L. Recent advances in structure, metabolism, and function of human milk oligosaccharides. The Journal of Nutrition. 2006;**136**:2127-2130

[62] Boehm G, Fanaro S, Jelinek J, Stahl B, Marini A. Prebiotic concept for infant nutrition. Acta Paediatrica. 2003;**91**:64-67

[63] Barile D, Marotta M, Chu C, Mehra R, Grimm R, Lebrilla CB, German JB. Neutral and acidic oligosaccharides in -Friesian colostrum during the first 3 days of lactation measured by high performance liquid chromatography on a microfluidic chip and time-of-flight mass spectrometry. Journal of Dairy Science. 2010;**93**:3940-3949

[64] Gil A, Uauy R. Nucleótides and related compounds in human and bovine milks. 1995. In: Jensen RG, editor. Handbook in Milk Composition. New York: Academic Press; 1995. pp. 436-464

[65] Pickering LK, Granoff DM, Erickson JR, Masor ML, Cordle CT, Schaller JP, Winship TR, Paule CL, Hilty MD. Modulation of the immune system by human milk and infant formula containing nucleotides. Pediatrics. 1998;**101**:242-249

[66] Yu VY. The role of dietary nucleotides in neonatal and infant nutrition. Singapore Medical Journal. 1998;**39**:145-150

[67] Alles MS, Scholtens PASM, Bindles J. Current trends in the composition of infant milk formulas. Current Pediatric. 2004;**14**(1):51-63. DOI: 10.1016/j.cupe.2003.09.007

[68] Trabazo RL. Tendencias actuals en la formulación de alimentos para niños. Anales de Pediatria. 2005;**3**(1):3-15

[69] Dorca J. Ingredientes funcionales en las fórmulas infantiles. Boletín de Pediatría. 2008; **48**:347-352

[70] Gomez-Gallego GC, Pérez-Conesa D, Bernal Cava MJ, Periago-Castón MJ, Ros G. Functional compounds in breast milk. Revista Electrónica Cuatrimestral de Enfermería Global. 2009;**8**(16):1-14. DOI: 10.4321/S1695-61412009000200020

[71] Joeckel RJ, Phillips SK. Overview of infant and pediatric formulas. Nutrition in Clinical Practice. 2009;**24**(3):356-362

[72] Aly E, López-Nicolás R, Darwish AA, Frontela-Saseta C, Ros-Berruezo G. Supplementation of infant formulas with recombinant human lactoferrin and/or galactooligosaccharides increases iron bioaccessibility as measured by ferritin formed in Caco-2 model. Food Research International. 2016;**89**:1048-1055

[73] European Commission, Official Journal of the European Union (EU). Commission delegated regulation (EU) 2016/127 of 25 September 2015

[74] Corkins KG, Shurley T. What's in the bottle? A review of infant formulas. Nutrition in Clinical Practice. 2016;**31**(6):723-729

[75] Sabater-Molina M, Larque E, Torrella F, Plaza J, Lozano MT, Muñoz A, Zamora S. Effects of dietary polyamines at physiologic doses in early weaned piglets. Nutrition. 2009;**25**:940-946

[76] Manzoni P, Rinaldi M, Cattani S, Pugni L, Romero MG, Messner H, et al. Bovine lactoferrin supplementation for prevention of late-onsetsepsis is very low-birth-weight neonates: A randomised trial. Journal of the American Medical Association. 2009;**302**(13):1421-1428

[77] Gullberg R. Possible influence of vitamin B12-binding protein in milk on the intestinal flora in breastfed infants. Scandinavian Journal of Gastroenterology. 1973;**8**:497-503

[78] Lonnerdal B. Bioactive proteins in human milk-potential benefits for preterm infants. Clinics in Perinatology. 2017;**44**(1):179-192

Chapter 3

The Influence of Breastfeeding and the Infant's Social Environment on Neuroplasticity and Brain Development: The First 1000 Days

Touraj Shafai, Monika Mustafa,
Sandra Compsos and Lida Niake

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.73209

Abstract

There is substantial evidence that breastfeeding and an enriched environment provide significant contributions to the infant's brain development. In the past 2 decades, there have been overwhelming data on the benefits of breastfeeding for 1 year and longer and its association with higher intelligence in later life. There is clear and convincing evidence from a number of disciplines, neuroscience, genetics, animal experiments and magnetic imaging techniques that indicate breastfeeding results in optimal brain development and higher IQ in later life. Magnetic imaging studies of infants, children and adolescents have provided significant evidence that the higher IQ in later life in breastfed infants is associated with larger brain size and higher degree of myelination of the white matter. Furthermore, observational studies of infants have provided clear evidence that breastfeeding and mother-baby sensory interaction result in significant cognitive and behavioral development of breastfed as compared to formula fed infants. Large-scale longitudinal studies of infants' development have shown clear and convincing evidence of higher intelligence in children who were breastfed during infancy, and that the higher IQ persists through adulthood. In this communication, we provide evidence that breastfeeding and an enriched environment result in accelerated developmental potentials in the first 1000 days last a life time. The first 1000 days last the rest of our lives.

Keywords: breastfeeding, oxytocin, neuroplasticity, myelination, brain development, enriched environment

IntechOpen

1. Introduction

The newborn's brain grows at an accelerated rate during the first 1000 days and this is associated with myelination of the white matter. Furthermore the brain growth and myelination correlates with the stages of brain development, including motor, speech, vision, acquisition of social skills, attachment, learning math and logic. All aspects of infant's growth and development are contingent on his genetic code "nature". However gene expression is influenced by epigenetic factors "nurture". The positive environmental factors result in neurobiological changes and improved neuroplasticity. The neurobiological effects of environmental enrichment was first reported by landmark work of Volkmar and Greenough which clearly demonstrated the superior problem solving abilities of rats raised as pets compared with rats raised without such human interactions [1]. Anatomically the environmental enrichment resulted in greater cerebral volumes, larger number of synapses and increased complexity of dendritic branches [1]. Extensive animal research demonstrate that maternal grooming and nurturing can lead to changes in DNA methylation, resulting in gene suppression or histone acetylation, up-regulation of the gene expression, which increase grooming in the offspring when it matures and the cycle repeats itself [2].

2. The role of oxytocin on brain development

Neuropeptide hormones and their receptors have properties that identify them as candidates for the induction of early life experiences into both short and long-term behavioral changes [3].

Animal research has provided a vast knowledge on the significance of the role of mother-baby interaction in child development. The elegant experiments on prairie voles, small monogamous mammals, point to the significant role of oxytocin on our behavior. Injection of oxytocin receptor blockers resulted in changes in pair-bonding behavior in these mammals [3]. Additionally oxytocin is implicated in all aspects of romantic and maternal love, including courtship, mating, pregnancy, childbirth and breastfeeding [3].

Anthropological studies demonstrate significant differences between the breast milk of large primates such as humans, monkeys and apes, referred to as "carrying mammals" vs. "nested mammals". Carrying mammals' breast milk contains lower amount of fat and sugar, while the nested mammals' breast milk contains much higher sugar and fat. Therefore carrying mammals require to breastfeed their infants more frequently than nested mammals.

The human infant's central nervous system depends on a micro-environment that is similar to the maternal uterine environment which is full of sensory exchanges involving heat, sound, movements, transportation, feelings, touch, smell and access to nutrients in the mother's breast milk. For species such as primates, the mother is the environment (Sarah Blaffer Hrdy).

3. The first 1000 days last a life time

The first 1000 days is the most significant period of an infant's life. During the first 3 years there is great potential for the infant and toddler to acquire immense cognitive, visual, speech, motor and emotional development.

Newborn infant's brain is quite immature, however it has great potentials to grow and most of the growth occurs in the first 1000 days of his life. Normal brain function requires rapid messaging which is mediated by the myelinated nerve fibers. However myelination depends on a number of factors including the genetic makeup of the infant "nature" and the infant's social environment "nurture". The trajectory of infant's brain growth and myelination is more robust in breastfed than in formula-fed infants. Therefore developmental milestone, speech, social skills, emotional and motor development are achieved at an earlier age in breastfed than in formula-fed infants. Furthermore we postulate that the infants who were fed breast-milk via a bottle, without sensory interactions with the mother may not reach their fullest potentials. Therefore we make a distinction between breastfeeding as the infant being on the mother's breast and not receiving breast-milk via a bottle, a cup or any other gadgets. Many maternal hormones including estrogens are present in the mother's milk and estrogens are transcriptional promoters for oxytocin and its receptor's genes [4, 5]. Oxytocin is released from supra-optic (SON) and peri-ventricular nuclei (PVN), only upon infant's sensory stimulations, auditory, tactile, visual and vestibular. The rise of oxytocin level in the infant's brain is associated with improved neuroplasticity. The magnitude of environmental influence on the infant's brain development may be ascertained by comparing the white matter growth using magnetic imaging of breastfed infants and infants given breast-milk via a bottle. Alternatively salivary cortisol level measurements may be an index of blood oxytocin because of their inverse relationship [3].

4. Breastfeeding in the twenty-first century

Mother's breast milk is an extension of her placenta which provides nutrients, hormones and epigenetic factors that carry messages to the infant to regulate his metabolic pathways.

World Health Organization (WHO) recommends breastfeeding for 2 years. Extended breastfeeding up to 3 and 4 years of age is highly recommended for additional calories, proteins, lipids, vitamins and factors that regulate the child's metabolic processes. The myelination of the nerve fibers continues, although at a slower pace until early adolescence.

The global breastfeeding rate in the past 10 years has improved only marginally from 33% in 1995 to 37% in 2014 [4]. Suboptimal breastfeeding results in higher health care expenditure for pediatrics and maternal care, and global productivity-related economic losses of $302 billion or 0.49% of world gross income annually [4].

Maternity and pediatric care providers in many parts of the world do not follow the recommendations of WHO on breastfeeding for 2 years or longer. The policies of several governments do not support breastfeeding including the Chinese government which subsidizes domestically manufactured formulas and US government that provides free formulas to low income families on WIC, Women, Infants and Children's program. WIC program was originally only intended for low income mothers who were breastfeeding their infants, however the program was extended to formula feeding mothers 2 years later [5].

International efforts to promote and protect breastfeeding on a global scale began in 1981 by WHO and World Alliance of Breastfeeding, WABA, in Geneva, Switzerland. The conference resulted in a significant document, International Code of Marketing of Breast Milk Substitutes. This was followed in 1990 by Innocenti Declaration and the Baby Friendly Hospital Initiative which promotes breastfeeding and rooming in for every newborn resulting in an increase in breastfeeding initiations. Many college educated mothers are cognizant of numerous benefits of breastfeeding and choose to breastfeed their infants.

Majority of nations have ratified the International Code of Marketing of Breast Milk Substitutes, however there are serious violations of marketing by formula industry and court challenges to overturn the marketing code. It is not unusual to hear that some unscrupulous providers in 3rd world countries will give samples of formula to the mothers upon delivery to feed their newborn and deprive the newborn from the benefits of colostrum feeding and later breastfeeding.

There are many obstacles to exclusive breastfeeding of a newborn in US hospitals, some of which are due to flawed hospital policies for newborn jaundice and neonatal hypoglycemia. Some physicians wrongly believe that exclusive breastfeeding will place the newborn at risk of developing hypoglycemia as well as severe jaundice which may lead to kernicterus. Other obstacles to exclusive breastfeeding include the use of pacifiers, nipple shields and providing the mothers with a breast pump to give the breast milk via a bottle to feed the newborn infants.

The high rate of cesarean section in some countries is an obstacle to breastfeeding, because of reduced oxytocin and delayed lactation [6]. Additionally epidural block may result in lower oxytocin release due to the inhibitory effect on Ferguson reflex [6]. Pitocin infusion may result in reduced release of oxytocin via a feed-back inhibitory effect [6]. Therefore it is clear that natural child-birth without epidural block and pain medications result in better outcomes immediately after birth with the newborn latching on and suckling at the mother' breast. Infants born vaginally have higher oxytocin level than infants born by cesarean section, 69 pg/ml vs. 33 pg/ml [6].

Newborns placed on the mother's chest latch on to the mother's breast, attracted to the Montgomery glands around the nipples, which secrete a lubricating liquid. Newborns latch on to both nipples, however when one nipple is washed with soap and water the newborn would latch on only to the unwashed nipple. When the mother's amniotic fluid was applied to the washed nipple, the newborn latched to that nipple. It is generally believed that the liquid discharge from the Montgomery glands have the scent of the mother's amniotic fluid [7]. We have also encountered the statement from the breastfeeding mothers that for the first 2–3 weeks their infants refuse to breastfeed immediately after a shower.

There is strong and convincing evidence that attachment and bonding between the mother and infant is associated with the release of oxytocin from hypothalamic nuclei, peri-ventricular and supra-optic and its binding to peri-aqueductal gray (PAG), insula, inferior and posterior temporal nuclei [8].

Oxytocin and many of the maternal hormones are present in the mother's breast milk. However the concentration of breast milk oxytocin is very low and decreases quickly. Oxytocin is probably digested in the infant's stomach and is not absorbed from the intestinal tract into the circulation. However oxytocin activates cholecystokinin which then activates sensory vagal nerves which release oxytocin from the infant's hypothalamic nuclei [6]. Sucking in the newborn is associated with infant's oxytocin release. Furthermore sensory interactions between

http://dx.doi.org/10.5772/intechopen.73209

mother-infant dyad result in the rise in oxytocin in infant's brain. All the sensory stimuli are transmitted via nucleus tractus solitarius (NTS) to release oxytocin from the hypothalamic nuclei, SON and PVN [6]. The act of suckling in calves at the udder result in oxytocin release, however drinking from a bucket is not associated with a rise in oxytocin [6].

5. Attachment parenting

During the early and mid twentieth century there was a gradual decline in breastfeeding rate in industrialized nations. This decline is attributed to the global conflicts when bread-winners went to war and the women went to work. The infants and young children were left with a relative to care for them and the majority were given breast milk substitute (formula) or cow's milk. In England, majority of infants and young children were placed in large nurseries in the countryside away from London during World War II. The mothers were allowed to visit their children occasionally. Many children were noted to develop behavior problems and maladjustment as they grew older. The emotional and behavioral problems were attributed to maternal deprivation. Several prominent psychologists and psychiatrists promoted the concept of maternal separation as the root cause of delinquent and maladaptive behavior. Sir John Bowlby who was a member of an aristocratic family was the most prominent of these researchers who was personally affected by maternal deprivation. It was customary in the aristocratic families in England to employ a nanny to take care of the infants and young children. They believed that close contact between the mother and their infants and young children would spoil them. Sir John Bowlby writes that he was only allowed to see his mother for an hour after her evening tea. Naturally he developed attachment to his nanny and when she suddenly left the household when he was only 4 years old, he was quite devastated like losing a mother. Bowlby states that his early life experiences provided the idea of what he later called the theory of attachment parenting. When he was 10 years old he was sent to a boarding school, which was common in aristocratic families in England. After completion of high school he studied psychology, medicine and psychiatry. John Bowlby wrote his first paper in 1958, titled, the nature of the child's tie to his mother, which was followed by a number of papers and books on attachment parenting. However his writings do not include the benefits of breastfeeding, primarily because of the lack of knowledge regarding young infants' nutrition at the time. Subsequently there have been a great number of articles and books which have been published on the subject of attachment parenting which still lack the prominent role of breastfeeding and its role in mother-baby bonding. A number of researchers including Marshall Klaus and later John Kennel have published articles and books regarding the benefit of breastfeeding in bonding and attachment between mother and her newborns [9, 10]. They recommended that the newborns should stay with their mothers and breastfeed as soon as possible after they are born. They also stated that early breastfeeding enhance the mother-infant bonding, increase the likelihood of breastfeeding, improves child development and prevent child abuse and neglect. Furthermore Klaus stated that early mother-baby bonding is the result of the rise in oxytocin in both mother and infant's brain [10]. Critics had made comments regarding the feeling of guilt by the parents who were not able to bond with their newborns in the hospital and to breastfeed their babies [11].

The theory of attachment parenting is based on psychological principles and lack of solid scientific foundation. The massive data in the past 2 decades have provided strong and convincing evidence that long term breastfeeding and providing an enriched environment result in every child achieving his fullest potential.

6. Breastfeeding and infant's brain development

There is clear and convincing evidence that breastfeeding for 1 year or longer contributes significantly to the higher IQ during adulthood [12]. The relation between length of breastfeeding and adult intelligence may be difficult to substantiate because of the confounding factors including the maternal IQ, which has been substituted with maternal education [13, 14]. Recent studies on the association of breastfeeding and higher IQ demonstrate that higher IQ is associated with larger brain size and higher degree of myelination of the white matter [15, 16]. It is further believed that one or more ingredients of breast milk are implicated in brain growth and optimal brain function. In the past 2 decades comprehensive studies on a number of breast milk ingredients have been carried out to evaluate the causal association of these ingredients with brain growth and IQ of the child. Two major ingredients of breast milk which have generated major interest in scientific circles as well the food industry are docosahexaenoic (DHA) and arachidonic (ARA) acids, which are the components of myelin. A number of published reports have claimed that additional intake of DHA during pregnancy and lactation may improve the IQ of the infants. Furthermore there were claims of supplementation of DHA and ARA of the infant formula result in improved IQ, compared to formulas without supplementation. This resulted in DHA and ARA supplementation of all infant formulas, marketed by the major formula companies, beginning in 2002. More recent studies have demonstrated that these studies are flawed and DHA and ARA supplementation of pregnant and nursing mothers do not increase the IQ of the child [17]. Furthermore supplementation of infant formulas with DHA and ARA did not increase the IQ of the children who were given the supplemented formulas [18].

Breast milk has significantly higher concentration of cholesterol than infant formula and breasted infants at 6 months have higher cholesterol levels than formula-fed infants [19, 20]. Cholesterol is a significant component of myelin and availability of cholesterol is a rate limiting factor in brain maturation in mice [21]. Therefore it could be argued that higher cholesterol in breast milk result in enhanced synaptic connection, higher degree of myelination of the white matter and higher IQ.

Human milk contains significant numbers of maternal hormones and growth factors, oxytocin, thyroxin, estrogens, nerve growth and epidermal growth factors, which could influence myelin production and white matter development. Breast milk estrogens are transcriptional promoters for oxytocin and its receptors in the infant's central nervous system [22]. Oxytocin has a central role in milk ejection and oxytocin knockout (OTKO) mice are unable to nurse their pups [22]. Oxytocin binds to a large number of oxytocin receptors and is implicated in regulating homeostatic functions, social recognition and fear conditioning [22]. Additionally oxytocin reduces

http://dx.doi.org/10.5772/intechopen.73209

neuroendocrine stress signaling and anxiety and depression symptoms [22]. Activation of beta estrogen receptors increases oxytocin gene transcription and reduces anxiety-related behavior [22]. Endogenous oxytocin can suppress corticotrophin releasing factor, CRF, and therefore reduce the activation of HPA axis and reduce the ACTH and cortisol levels [22].

Oxytocin is a neurotransmitter for oxytocinergic system and therefore involved in homeostatic processes [22]. Adults who were breastfed during infancy have lower total and LDL cholesterol, lower blood pressure and lower risk of cardiovascular disorders [13].

7. First and second messengers

The onset of labor begins with a decrease in maternal progesterone blood level, which results in a rise of maternal estrogens to progesterone ratio. Estrogens are transcriptional promoters of oxytocin gene which initiate uterine contractions. Furthermore estrogens are also transcriptional promoters of oxytocin genes in SON and PVN nuclei in the maternal central nervous system. Oxytocin is transported to the posterior pituitary which then enters the maternal circulation and result in the milk ejection from the breast.

Estrogens in the breast milk enter the newborn's circulation and cross the blood brain barrier. Estrogens act as transcriptional promoter for oxytocin gene in the hypothalamic SON and PVN nuclei. Oxytocin is then transported to a number of oxytocin receptors in the newborn's brain. Imaging studies comparing the activation of oxytocin receptor sites in breastfeeding and formula feeding mothers demonstrate significant enhancement of oxytocin receptors in breastfeeding mothers, which correlates with greater neural response [8] (**Figure 1**) Additionally plasma and salivary concentration of oxytocin are reported to be higher in breastfeeding compared to formula feeding mothers, 36% in plasma and 23% in saliva, respectively [23]. Furthermore the 24 hour urine concentration of oxytocin in breastfeeding mothers is significantly higher compared to formula-feeding mothers [8] (**Figure 2**). Postpartum depression appears to be associated with formula feeding and there is an association between Edinburgh postpartum depression scale and urinary oxytocin concentration [8] (**Figure 3**). Similarly other neuropsychiatric disorders which are highly associated with depression and anxiety may share the low oxytocin levels [3].

There is significant evidence that maternal bonding is mediated by oxytocin and the periaqueductal gray matter (PAG), the limbic system and the lateral orbitofrontal cortex are identified with maternal behavior [8]. There is strong evidence that an enriched environment result in increased release of oxytocin from the hypothalamic nuclei and have permanent effects on the physiology and behavior of mammalian species [9, 24–27]. Furthermore the oxytocinergic system appears to regulate the sensory, emotional, motivational and cognitive pathways which are affected in individuals with neurodevelopmental disorders.

Steroid hormones have significant roles in pregnancy. Progesterone is important in maintenance of gestation and estrogens play a significant role in parturition and lactation. The mother provides the first messenger, estrogens during the labor, via the placenta, to the unborn

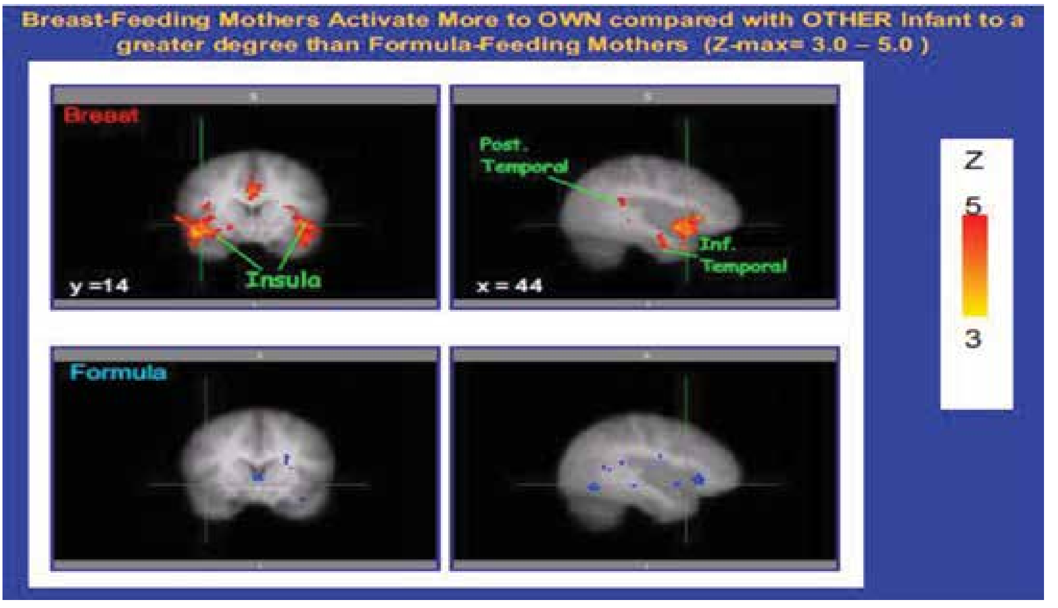


Figure 1. Brain imaging comparing the oxytocin receptors' enhancement in breastfeeding and formula feeding mothers. From Bartel and Zeki [8].

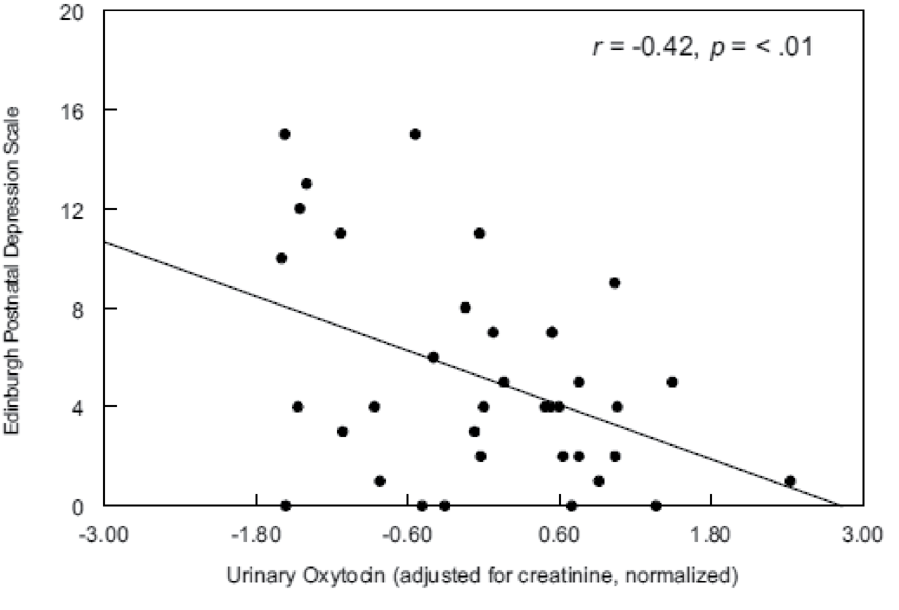


Figure 2. Urinary excretion of oxytocin in post-partum mothers and Edinburgh post-partum depression scale. From Grewen et al. [23].

infant, and after the delivery through her breast milk. Estrogens are transcriptional promoters of oxytocin and its receptors. The second messenger, oxytocin is released by the infant's hypothalamic nuclei, after breastfeeding and mother-baby sensory interactions. A single dose

http://dx.doi.org/10.5772/intechopen.73209

Figure 3. Comparison of urinary excretion of oxytocin in breastfeeding and formula feeding mothers. From Grewen et al. [23].

of estradiol results in an increase in plasma oxytocin level in women [28]. Oxytocin binding with oxytocin receptors result in profound changes in the infant's central nervous system. Other ingredients of breast milk, DHA, ARA and cholesterol significantly augment the role of oxytocin in brain development. However it appears that oxytocin has a central role in brain development and lack of oxytocin or the use of oxytocin blockers significantly alter the behavior and neurodevelopment of mammalian species.

The stages of infant and child development have been well-established and correlate with the stages of neuronal migration and myelination [29, 30] (**Figures 4** and **5**). There is clear evidence that any interruption of neuronal migration and myelination result in impaired brain function. Myelination is an ongoing process into early adolescence, in response to neural activity. Neuropsychiatric and neuro-developmental disorders are strongly considered to be associated with synaptic disconnectivity involving early white matter development.

The incidence of neuro-developmental and neuropsychiatric disorders far exceeds all the other genetic, congenital and sporadic causes of mental deficiencies. Most infants with developmental delays, 30–40 years ago, had chromosomal anomalies (the Downs syndrome), birth defects, cerebral palsy, kernicterus and congenital athyroidism. Autism was quite rare and most physicians had never heard of this disorder. Many physicians are still baffled by it and try to avoid taking care of children with autism. Some physicians do not know what causes autism and believe that the child is born with autism trait. There is also no consensus on which specialist should make the diagnosis and which specialist should be taking care of the child with autism. We believe that autism spectrum disorder is the most common cause of developmental delay in developed countries, because of formula feeding, early weaning and lack of mother-baby sensory interactions [31, 32].

Approximately 50 years ago, Dr. Julius Richmond, who was my first pediatrics professor and later became US Surgeon General, characterized that child development is the basic science of pediatrics [33]. This statement is still true now, because of the ever increasing knowledge accumulated in the past 2 decades on child development.

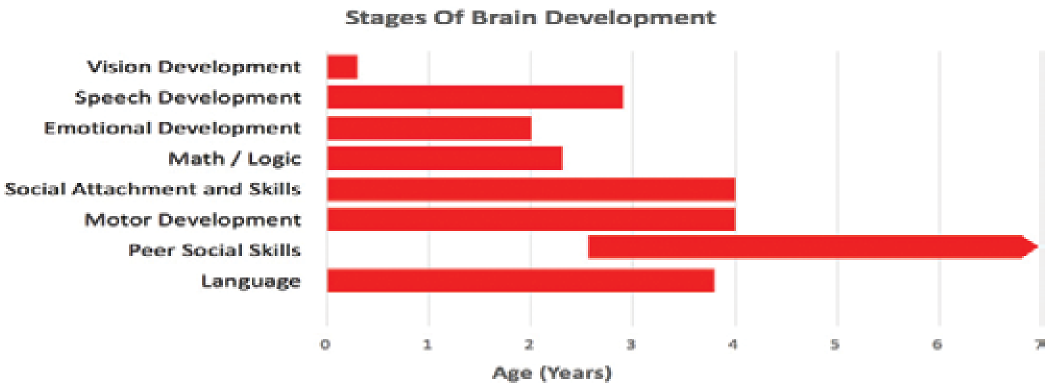


Figure 4. Stages of brain development during infancy and childhood. From Deoni et al. [35].

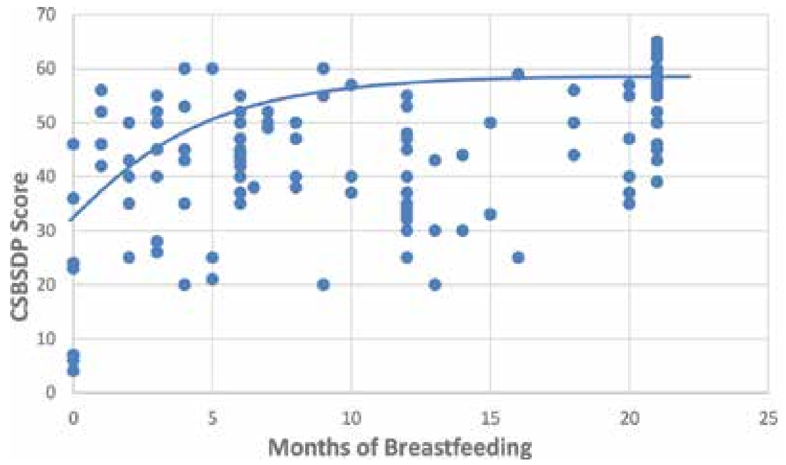


Figure 5. The relationship of CSBSDP scores with the duration of breastfeeding.

8. Infant and toddler developmental screening

We have previously reported on the association of formula feeding and early weaning with autism spectrum disorder using retrospective parent's report [31, 32]. In the present communication we report on the association of breastfeeding and improved developmental milestones using prospective and longitudinal infant and toddler developmental screening.

8.1. Material and methods

All infants had developmental evaluation at the following ages during their well-baby visits, 6, 9, 12, 15, 18 and 24 months. All infants were seen by a pediatrics provider and the mother or the father was asked to answer the questions on the evaluation form. The evaluation form was then scored by the provider and the results were discussed with the parent. Therefore this is a longitudinal and prospective evaluation of infants and toddlers that identifies the areas of risk and referral for further evaluation and treatment. We have utilized this screening tool to evaluate the association of the score at 24 months of age with the length of breastfeeding. Our hypothesis is that increasing the length of breastfeeding will be associated with a higher score. We are utilizing CSBS DP infant and toddler developmental screen that measures seven language predictors, emotion and eye gaze, communication, gestures, sounds, words, understanding and object use [34]. CSBS DP has been successfully tested for validity and reliability with large samples of children [34]. CSBS DP is not predictor for the child's IQ, however it identifies children at risk of communication disorders and more specific, autism spectrum disorder.

8.2. Results

One hundred and ten children were screened beginning at 6 months of age. The breastfeeding history of the infants were monitored at every well child visit and recorded. All infants including infants with prematurity, chromosomal disorders, birth defects, congenital infections and genetic disorders were also screened for developmental delay; however, they were excluded from this report. The CSBS DP scores were plotted in relation to the duration of breastfeeding as shown in **Figure 5**.

8.3. Discussion

We have previously reported the association of early weaning and formula feeding with autism spectrum disorder [31, 32]. The present study which was based on our direct observation and prospective evaluation of infants and toddlers is further support that breastfeeding results in better developmental outcome. CSBC DP is predictive of the risk of communication disorders and speech problems in toddlers and we have been able to seek services to assist the families with toddlers as young as 18 months of age. Early diagnosis and treatment of at risk children result in better outcome.

In our previous study we reported on the impact of the infant feeding methods on the development of the autism spectrum disorder [32, 33]. With the current study we are able to predict that breastfeeding longer than 1 year is associated with higher CSBS DP score and lower risk of developmental delays.

United States may have the highest rate of autism in the world because of the lack of paid maternity leave. Many mothers who work in low paying jobs return to work 2 weeks after delivery of their infant and a majority do not breastfeed their babies. Modernization has reduced mother-infant sensory interactions. The infants spend more time in the infant seat on the back seat of the family car, in a stroller or a play pan. Mothers do not hold their babies during feeding and the formula bottle is frequently propped up in the infant's crib or the car seat. The combination of formula feeding and absence of mother-baby sensory interaction increases the risk of developmental delay in the child.

Imaging studies of infants and children as young as 10 months to 4 years of age were performed to compare the myelination of the brain on children who were breastfed for at least

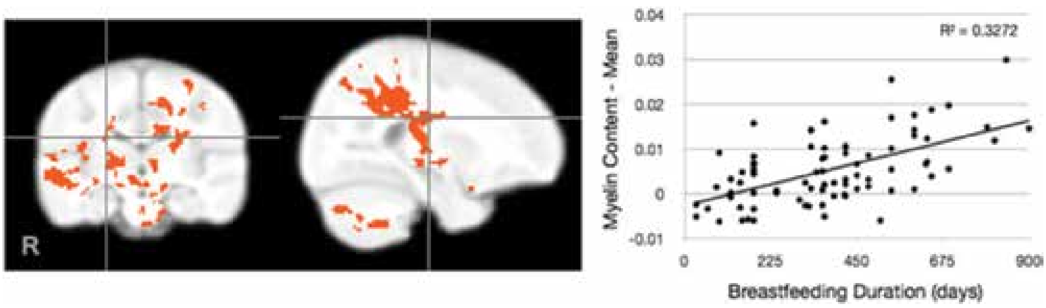


Figure 6. Association of improved myelination with duration of breastfeeding. From Deoni et al. [35].

3 months, those who were only formula-fed and those who were given mixed breast and formula [35]. The results of this study provide further evidence that breastfed infants have higher degree of myelination compared to the other two groups of children who were formula-fed or given mixed feeding. Furthermore longer duration of breastfeeding results in greater brain myelination as shown in **Figure 6**. The myelination occurs primarily in frontal and temporal white matter, peripheral aspects of the internal capsule and corticospinal tracts, superior longitudinal fasciculus and superior occipital-frontal fasciculus. These regions and pathways are associated with higher order cognition, executive functioning, planning, social-emotional functioning and language [35]. Therefore we can connect structure and function, increased level of myelination with increasing breastfeeding duration. Additionally the percentage of breast milk in an infant's diet has been correlated with cortical thickness in the parietal lobe as well as verbal IQ in adolescents [16].

8.4. Conclusion

We have documented the superiority of breastfeeding and an enriched environment resulting in higher cognitive ability and IQ. We have also shown that infants should be at least breastfed for the first 3 years of life to realize the maximal benefits of breastfeeding. We have presented strong and convincing evidence from various disciplines that breastfeeding result in higher IQ and cognitive functions that last into adulthood. Early weaning and formula feeding are associated with higher prevalence of childhood communicable diseases, diabetes, childhood leukemia, sudden infant death and autism. Additionally formula feeding strains the health care and public education systems with increased demands and higher expenditures.

The first 1000 days last a life time the rest of our lives, and every child deserves to reach his fullest potentials.

Acknowledgements

Touraj Shafai MD, PhD (Biochemistry), Fellow of the American Academy of Pediatrics and Fellow of the Academy of Breastfeeding Medicine. He is Assistant Clinical Professor at University of California, Riverside, School of Medicine.

http://dx.doi.org/10.5772/intechopen.73209

Monika Mustafa MD, Fellow of American Academy of Pediatrics, Assistant Clinical Professor of Pediatrics at University of California, Riverside, School of Medicine.

Sandra Campos PAC, assisted in data collection.

Lida Niake, Research Assistant, assisted in data collection and creating the graphs for the manuscript, Undergraduate biology major.

Conflict of interest

The opinions expressed in this manuscript are only the opinions of the authors. The authors declare no competing interest.

Author details

Touraj Shafai[1]*, Monika Mustafa[1], Sandra Compsos[2] and Lida Niake[2]

*Address all correspondence to: shafaidocs@yahoo.com

1 University of California, School of Medicine, Riverside, California, USA

2 Children's Medical Group, Riverside, California, USA

References

[1] Volkmar FG, Greenough WT. Rearing complexity affects branching of dendrites in the visual cortex of the rat. Science. 1972;**176**:1445-1447

[2] Weaver ICG, Chevroni N, Champagne FA, et al. Epigenetic programming by maternal behaviour. Nature Neuroscience. 2004;**7**:848-854

[3] Carter CS. Developmental consequences of oxytocin. Physiology & Behaviour Elsevier Inc. 2003;**79**:383-397

[4] Infant and Young Child Feeding, Fact Sheet, World Health Organization on Global Rates of Breastfeeding; February 2015 Bulletin

[5] Shafai T, Mustafa M, Hild T. The promotion of exclusive breastfeeding in low income families by improving the WIC food package for breastfeeding mothers. Breastfeeding Medicine. 2014;**9**:375-376

[6] Unvas-Moberg K, Prime DK. Oxytocin effects in mothers and infants during breastfeeding. Infant. 2013;**9**:886-897

[7] Klaus M. Mother and infant: Early emotional ties. Paediatrics. 1998;**102**(Supplement E1): 1244-1246

[8] Bartel A, Zeki S. The neural correlates of maternal and romantic love, Elsevier. NeuroImage. 2004;**21**:1155-1165

[9] Klaus MH, Kennell JH. Maternal-Infant Bonding. CV Mosby Publishing; 1976

[10] Klaus MH, Kennell JH. Parent-Infant Bonding. CV Mosby Publishing; 1982

[11] Brody J. Mother-infant theory on bonding at birth is now questioned. New York Times, Science section. March 29 1983

[12] Mortensen EL, Michaelsen KF, Sanders SA, Reinisch JM. The association between duration of breastfeeding and adult intelligence. JAMA. 2002;**287**(22):2946-2950

[13] Lau J. Breastfeeding and maternal and infant health outcomes in developed countries, number 153. Agency for Healthcare Research and Quality, US Department of Health and Human Services. 2007

[14] Kramer MS, Aboud F, Mironova E, et al. Promotion of Breastfeeding Intervention Trial (PROBIT) Study Group. Breastfeeding and child cognitive development: New evidence from a large randomized trial. Archives of General Psychiatry. 2008;**65**(5):578-584

[15] Kafouri S, Kramer MS, Leonard G, et al. Breastfeeding and brain structure in adolescence. International Journal of Epidemiology. 2013;**42**:150-159

[16] Isaacs E, Fischl R, Quinn B, et al. Impact of breast milk on IQ, brain size and white matter development. Pediatric Research. 2010;**67**:357-362

[17] Campoy C, Escolano-Margarit V, Anjos T, Szajewska H, Uauy R. Omega 3 fatty acids on child growth, visual acuity and neurodevelopment. British Journal of Nutrition. 2012;**107**:S85-S106

[18] Qwasmi A, Landeros-Weisenberger A, leckman J, Bloch M. Meta-analysis of long-chain polyunsaturated fatty acid supplementation of formula and infant cognition. Pediatrics. 2012;**129**(6):1141-1149

[19] Uauy R, Mize CE, Castillo-Duran C. Fat intake during childhood: Metabolic responses and effects on growth. The American Journal of Clinical Nutrition. 2000;**72**:1354S-1360S

[20] Harit D, Faridi MM, Aggrawal A, Sharma SB. Lipid profile of term infants on exclusive breastfeeding and mixed feeding: A comparative study. European Journal of Clinical Nutrition. 2008;**62**:203-209

[21] Saher G, Brugger B, Mobius W, et al. High cholesterol level is essential for myelin membrane growth. Nature Neuroscience. 2005;**8**:468-475

[22] Acevedo-Rodriguez A, Mani SK, Handa RJ. Oxytocin and estrogen receptor beta in the brain: An overview. Frontiers in Endocrinology. 2015;**6**:160-176

[23] Grewen KM, Davenport RE, Light KC. An investigation of plasma and salivary oxytocin responses in breast and formula feeding mothers of infants. Psychophysiology. 2010;**47**:285-332

[24] Insel TR, Young IJ. The neurobiology of attachment. Nature Neuroscience. 2001;**2**:120-136

[25] Meany MJ. Maternal care, gene expression and the transmission of individual differences in stress reactivity across generations. Annual Review of Neuroscience. 2001;**24**: 1161-1192

[26] Kendrick K. Oxytocin, motherhood and bonding. Experimental Physiology. 2000;**85**: 111-124

[27] Csaba G. Receptor ontogeny and hormonal imprinting. Experientia. 1986;**42**:750-759

[28] Chiodera P, Volpi R, Capretti R, et al. Effect of estrogen on insulin-induced hypoglycaemia on plasma oxytocin levels in bulimia and anorexia nervosa. Metabolism. 1991;**40**: 1226-1230

[29] Voight RG, Macias MM, Myers SM. Developmental and Behavioural Pediatrics, Published by the American Academy of Pediatrics; 2010

[30] Committee on Integrating the Science of Early Childhood Development. From Neurons to Neighbourhoods: The Science of Early Childhood Development. Washington, DC: National Academic Press; 2000

[31] Richmond JB. Child development: A basic science for pediatrics. Pediatrics. 1967;**39**: 649-658

[32] Shafai T, Mustafa M, Hild T, Mulari J, Curtis A. The association of early weaning and formula feeding with autism spectrum disorder. Breastfeeding Medicine. 2014;**9**:375-376

[33] Shafai T, Mustafa M, Mulari J, Curtis M. Impact of infant feeding methods on the development of autism spectrum disorder. In: Fitzgerald M, Yip J, editors. Autism - Paradigms, Recent Research and Clinical Applications. Rijeka: Intech; 2017

[34] Pierce K, Carter C, Weinfeld M, Desmond J, Hazin R, Bjork R, Gallahger N. Detecting, studying, and treating autism early: The one-year well-baby check-up approach. The Journal of Pediatrics. 2011;**159**:458-465

[35] Deoni SCL, Dean DC, Piryatinsky I, O'Muircheartaight J, Waskiewicz N, Lehman K, Han M, Dirks H. Breastfeeding and early white matter development: A cross-section study. NeuroImage. 2013;**82**:77-86

Chapter 4

Support for Breastfeeding

Patricia Triviño Vargas

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.80383

Abstract

Breastfeeding support for mothers of newborn babies in neonatal units is the basis for successful breastfeeding. With this, health professionals should educate the key members of the family and the environment surrounding the family about the benefits of breast milk in the first months of life and how to encourage and support the mother in the first months of life breastfeeding days. Exclusive breastfeeding is the most effective intervention to reduce infant morbidity and mortality and is estimated to prevent 13% of infant mortality under 5 years in low-income countries. However, the rate of exclusive breastfeeding is alarmingly low in developing countries. Mothers who face problems in breastfeeding immediately turn to high-quality milk formulas. Therefore, it is very important to assume the responsibility of health professionals to identify and adequately manage breastfeeding problems. UNICEF/World Health Organization, through the Baby Friendly Hospital Initiative (BFHI), has recommended good health care practices that support breastfeeding to increase the likelihood of optimal breastfeeding. The focus of breastfeeding in preterm infants and hospitalized term infants should must worry on the physical, emotional, legal, and social difficulties that may occur in the mother. It is necessary to consciously strengthen these terms for a successful breastfeeding.

Keywords: support for breastfeeding, newborns, premature infant, neonatal hospitalization

1. Introduction

Support for the production of breast milk in neonatal units is essential for the survival of preterm and term newborns [1–4]. This support is achieved with the conviction that this natural food is essential and irreplaceable in the first days of a newborn's life. Breastfeeding is the natural way to feed babies, providing nutritional, immunological, psychological and economic benefits. These qualities are especially important in preterm infants due to their vulnerability [5]. Sometimes it is contrasted with the lack of education, education, conviction and eventually the infrastructure that provides spaces to stimulate and encourage breastfeeding through manual extraction or with artifacts that facilitate the extraction in the neonatal units. These are the place of breast milk, extraction.

2. A historical perspective

2.1. Body research methods

A prospective study investigated the frequency of use of breast milk for the delivery of preterm infants of a high-risk neonatal unit. These are 244 preterm infants and were performed at a Hospital Friends of Children. The observed frequency of breast milk use at discharge from the neonatal unit was 94.6%. The finding that preterm infants were receiving breast milk reflects a well-structured program to promote breastfeeding of preterm infants at this institution, which is based on an interdisciplinary team to provide adequate support to mothers [6].

3. Physiology

With regard to the physiology of the creation of breast milk should be taken into account the stage of embryology. From that period on, the basic components of the genesis of the organs are developed.

In the intrauterine period the amniotic fluid contains amino acids, proteins, vitamins, minerals, hormones and growth factors. Although the concentration of these nutrients is much lower than that found in human milk, the large volumes of amniotic fluid ingested (up to one liter per day in the last stage of gestation, considerably more than the newborn after birth). Have a significant impact on growth and maturation of both the fetus and the fetal intestine. This makes it beneficial for his extrauterine life especially in the period of prematurity. Animal studies and limited human observations suggest that ingested amniotic fluid accounts for approximately 15% of fetal growth. The stage of prematurity, less than 37 weeks gestational age, affects the milk of mothers who give birth prematurely as it differs from women who give birth at term. The milk of the premature newborn, according to studies, is initially in concentration higher in proteins, fats, free amino acids and sodium, but during the first weeks after the birth these levels decrease. Keep in mind that the mineral content of preterm milk is similar to that of full-term milk, with the following exceptions: calcium is significantly lower in preterm milk than term milk and apparently does not seem to increase in over time.

With respect to carbohydrates in breast milk, lactose is the main carbohydrate. This disaccharide is an important source of energy, according to studies, it is relatively low in colostrum (first secretion of the mammary gland) and increases over time with more dramatic increases in preterm milk. Complex oligosaccharides are the second most abundant carbohydrate in breast milk. These oligosaccharides of human milk (HMO) are not digestible by host glycosidases

http://dx.doi.org/10.5772/intechopen.80383

and, however, are produced in large quantities with very variable structures by the mother. HMOs have three important functions: prebiotic (stimulation of commensal bacteria containing glycosylated bacteria to deconstruct and consume HMOs), strategy (structural similarity with glucans in enterocytes allows HMOs to competitively bind to pathogens) and the supply of fucose and sialic acid that appears to be important in host defense and neurodevelopment, respectively. In addition, preterm milk is relatively more variable in the HMO content. The differences between mothers are due to genetic diversity. Glycosaminoglycans (GAGs) also appear to act as decoys that provide binding sites for pathogenic bacteria to avoid adherence to the enterocyte. Premature milk is richer in GAG than full-term milk. We have to know the components of this stage of prematurity to contain and guide the mother in its extraction and access of premature to breast milk.

In turn, biological molecules actively in human milk are important components of the innate immune system. The differences in cytokines, growth factors and lactoferrin between premature milk and full-term milk are more important in colostrum and early milk and, in most cases, resolve after 4 weeks after delivery. Leptin is produced by the mammary glands, secreted in human milk, and may be important in postnatal growth. The leptin in human milk does not seem to differ between the milk to the preterm newborn and the milk of the term newborn. The activity of the lipase stimulated by the bile salt is similar in the term and in the preterm milk while the activity of the lipoprotein lipase is higher in the milk at term. The physiological basis of the composition of breast milk in its states of prematurity in the newborn provides us with guiding elements in the importance of the promotion of breast milk and the constant support that should be provided to the mother in neonatal units.

4. Successful breastfeeding

The success of breastfeeding lies in the interaction that is received from the mother–child binomial, the stimulation of the mammary gland and the coordinated hormonal aspects in the mother's organism.

In turn, several randomized and quasi-experimental studies have investigated the influence of early postnatal contact on the initiation or continuation of breastfeeding and, in some cases, on other aspects of the interaction between mother and child. Studies of early contact in suction focused on comparing two groups of newborns assigned (by decision of the midwife and the mother) to a "contact" group or a "separation" group immediately after delivery. The 38 newborns of the first group were in contact with their mother from the time of delivery for at least 1 hour. After an average of 49 minutes, 24 of them nursed correctly. The 34 newborns of the second group started contact immediately after delivery, but they separated from it at 20 minutes and returned with their mother another 20 minutes later. Only 7 of them breastfed effectively, and the difference was significant ($p < 0.001$) [7]. The contact is significant at the time of breastfeeding precociously.

Numerous previous studies about the importance of early contact of mothers with their newborns and the permanence of effective breastfeeding is demonstrated in the following investigations between the years 1980 and 1990. Four studies show that early contact produced a significant increase in the prevalence of breastfeeding after 2 or 3 months [8–11]. One study only found an effect after one week [12], and in two studies no significant effects were found [13, 14]. Sosa et al. studied 40 Guatemalan mothers, randomly distributed in a group with early contact and a control group, followed by home visits [8]. Early contact began after delivery of the placenta and suture of the episiotomy, and lasted 45 minutes. According to the study of Sosa, the control group had their first contact 24 hours after delivery. Three months later, 72% of mothers with early contact performed breastfeeding to their son/daughter, and only 42% did not, in the control group. The mean duration of lactation was 196 days (six and a half months) in the group with early contact and 104 days (three and a half months) in the control group ($p < 0.05$). According to the study by De Château and Wiberg they studied 40 primiparous women in Sweden [9]. The mothers were randomly assigned to a control group to another intervention group with "extra contact" (15 to 20 minutes of suction and skin-to-skin contact during the first hour after delivery). At 3 months, 58% of the mothers in the additional contact group continued to breastfeed, compared to 26% in the control group ($p < 0.05$). Mothers with more contact spent more time kissing and looking at their children's eyes, while they smiled more and cried less. The study by Thomson, Hartsock and Larson compared the effect of early contact, initiated 15 to 30 minutes after delivery and continued for 15 to 20 minutes, with routine contact less than 5 minutes immediately after delivery, followed by a separation of 12 to 24 hours, in 30 primiparas who were destined to breastfeed [10]. Two months after delivery, breastfeeding without milk supplements was more common in the early contact group than in the control group (9/15 versus 3/15, $p < 0.05$). According to the study by Ali and Lowry they compared routine contact (starting around 9 a.m.) with early contact (45 minutes immediately after delivery, and then separation until 9 a.m.) in 74 Jamaican mothers, randomized [12]. The prevalence of complete breastfeeding was higher in the group with early contact, both at 6 weeks (76 versus 49%, $p < 0.02$) and at 12 weeks (57 versus 27%, $p < 0.05$). Observed at 12 weeks, mothers with early contact talked more with their children, and got up and followed them in greater proportion when someone took the baby. Strachan-Lindenberg, Cabrera and Jiménez studied the effect of early contact, the promotion of breastfeeding and joint accommodation on the initiation and continuation of breastfeeding in the Nicaraguan primipara [12].

Immediately after delivery, the mothers were assigned to a control group, with complete separation until discharged (12 to 24 hours after delivery), or to an early contact group, in which mother and child were in contact for 45 days. Minutes immediately after delivery and then completely separated until discharged. Full breastfeeding, 1 week later, was significantly more prevalent in the group with early contact than in the control group, but no differences were observed at 4 months. It was not adjusted for age, although about half of the mothers were teenagers. A meta-analysis of these seven studies concluded that early contact had a positive effect on the duration of breastfeeding at 2 or 3 months ($p < 0.05$). However, it warns that "the effect of the size between the studies was heterogeneous", and some studies included other interventions (guidance on breastfeeding, presence of the father during the early contact), which could have contributed independently to increase breastfeeding [15]. A cross-sectional study of 726 primiparae in the USA. A study found that the prevalence of exclusive breastfeeding in the hospital was lower if the first blowjob took place between 7 and 12 hours after delivery (adjusted odds ratio = 0.5, 95% confidence interval). More than 12 hours after delivery (adjusted OR = 0.2; 95% CI, 0.1–0.4) [16].

The success of breastfeeding corresponds without a doubt to policies, in health centers, written that contemplates the necessary steps for a successful breastfeeding, assuring that the practice of early nursing is maintained and assistance to the mother of a premature newborn is priority in the promotion of early milk extraction. These policies focus on: training the personnel in the technique and practice of early breastfeeding and extraction, informing the mothers of the benefit, encouraging them to breastfeed within the hour following the birth and promoting the creation and establishment of support groups for the Breastfeeding in neonatal hospitalization units.

5. Risk factors

The risk factors that lead to the failure of access to breast milk related to the mother and the newborn, the clear majority are presented together. Although, the problems raised do not contemplate the suspension of breast milk if one way to solve them is to continue breastfeeding.

According to some problems that appear in the prematurity stage, the Breastfeeding Section of the American Academy of Pediatrics issued a policy statement that represents a significant change from the previous statements in its recommendation that all premature babies should receive human milk, pasteurized breast milk instead of premature infant formula the preferred alternative cannot provide adequate volume. The current recommendation, according to the studies, is based on an extraordinary variety of benefits that breast milk provides to highly vulnerable newborns such as premature infants, including the reduction of late onset infection rates, necrotizing enterocolitis (NEC) and retinopathy of prematurity, fewer readmissions in the first year of life and better results of neurodevelopment.

Preterm infants receiving breast milk have lower rates of metabolic syndrome, lower blood pressure and low density lipoprotein levels and less resistance to insulin and leptin when they reach adolescence, compared to premature infants who receive formula.

What has been shown in different studies is that the most determining benefit is that feeding with human milk decreases the appearance of NEC, given its high prevalence (5–10% of all newborns with birth weight < 1500 grams), high mortality and morbidity, long-term complications such as stenosis, cholestasis, short bowel syndrome and poor growth and alterations in neurodevelopment. According to these results, it is understood that there is a dose–response effect of feeding with breast milk. For example, breast milk >50 ml/kg/day reduces the risk of late-onset infection and NEC compared to <50 ml/kg/day, and for every 10 ml/kg/day increase in milk, there is a 5% reduction in the recurrent hospitalization rate. According to studies, the mechanisms by which breast milk protects the premature newborn against NEC are probably multifactorial. Human milk IgA, lactoferrin, lysozyme, bile salt stimulating lipase, growth factors and HMOs provide protective benefits that could contribute to the reduction of NEC. Clinicaltrials.gov (NCT00854633) published a multicenter randomized clinical trial, concerning bovine lactoferrin treatment, which decreased late-onset sepsis but not NEC in preterm infants. Recombinant human lactoferrin assays are currently being carried out in preterm infants. In animal models, epidermal growth factor (EGF) and pooled HMOs prevent NEC, but have not yet been tested in premature infants. These studies are carried out in order to evaluate the safety, toxicity and efficacy of talactoferrin in reducing the incidence of nosocomial infections in preterm infants. Even the support and authenticity are being evaluated in the United States.

On the other hand, it is believed that microbial colonization plays an important role in the risk of NEC. Breastfeeding is one of the many factors that influence the composition of the intestinal microbiota in full-term infants; Limited studies suggest that diet may have a lesser effect on the composition of the gut microbiota in the premature baby than other factors (such as the administration of antibiotics). The new bioinformatics tools to correlate the wide range of fecal metabolites and fecal microbiota offer great promise to understand the factors that influence the premature baby's microbiota. Studies to date suggest that metabolites that differ between infants fed human milk and those fed formula that are most closely associated with the conformation of the microbiota include sugars and fatty acids. It is unknown whether these metabolites differ functionally in the extremely premature newborn and in what way.

Other potential benefits of human milk to premature infants have been studied with mixed results. There do not appear to be consistent benefits of human milk in premature infants in relation to feeding tolerance, time to full enteral feeding, or allergic/atopic outcomes. Providing human milk has been postulated to decrease parental anxiety, increase skin-to-skin contact and parent-infant bonding, but data to support these hypotheses are limited. The provision of human colostrum in the form of oral care for intubated premature infants has been proposed as a method of stimulating the oropharyngeal-associated lymphatic tissue and altering the oral microbiota, but data to support this intervention are Lacking [17].

Studies of the benefits of human milk in premature infants to date have predominantly compared mother's own milk to premature infant formula. Whether pasteurized donor human milk (which generally is provided by women who delivered at term) provides similar or superior protection is unclear. In premature infants receiving only mother's own milk or pasteurized donor human milk (no formula), increasing amounts of mother's own milk correlate with better weight gain and less NEC. A meta-analysis in 2007 concluded that formula feeding was associated with both increased short term growth and increased incidence of NEC compared to donor human milk feeding number needed to harm 33 with no differences in long term growth or Neurodevelopment [18]. However, of the 8 studies included in the meta-analysis, 7 were published before 1990, during which time nutritional comparisons were limited. For example, several of the reviewed studies did not include formulas designed for premature infants and none included nutrient-enriched donor milk. One study, initiated in 1982 followed a cohort of premature infants that received either premature infant formula or unfortified donor human milk with the latter group showing decreased blood pressure and improved lipoprotein profiles as adolescents. In the single included study published since 1990, infants whose mothers were unable to provide sufficient milk for their extremely premature infants (< 30 weeks gestation) were randomly assigned to receive supplementation with either premature infant formula or nutrient-enriched donor human milk; donor human milk led to slower weight gain but did not decrease episodes of sepsis, or ROP, length of hospital stay or mortality compared to supplementation with premature infant formula.

The incidence of NEC decreased in the group of human milk donors to almost half compared to the formula group, but this did not reach statistical significance due to the small sample size. It is noteworthy in this study that, despite the increase in supplementation in the donor

http://dx.doi.org/10.5772/intechopen.80383

milk group, 20% of the children switched to formula due to poor growth. A more recent comparison of own breast milk with pasteurized human donor milk showed better growth and less ECN with the former.

All these risk factors lead to high rates of hospitalization and sequelae that are installed for the rest of their lives in the term newborn and especially prematurity.

6. Promotion of breastfeeding

6.1. Measures to promote progress in the increase of exclusive breastfeeding

The following evidence-based recommendations should be applied at the appropriate scale in order to achieve progress on the 2025 global target for exclusive breastfeeding.

1. Provide capacities in hospitals and health centers to support exclusive breastfeeding, including revitalizing, expanding and institutionalizing the initiative of child-friendly hospitals in health systems.

   - Maintaining the effectiveness of the initiative of hospitals friendly to the child requires institutionalization in the health system to allow certification and recertification of hospitals, as well as continued investments in training, monitoring and supervision of health personnel.
   - Sustainability also requires monitoring progress and measuring the number and proportion of non-domiciliary deliveries that take place in hospitals and other health centers that are child-friendly.
   - The promotion of breastfeeding and the corresponding support measures should be integrated throughout the spectrum of maternal and child health care, especially in the prenatal and puerperal periods.

2. Implement community strategies to support exclusive breastfeeding, which includes the implementation of communication campaigns adapted to the local context.

   - It is necessary to ensure that there is a strong link between the strategies in the centers and in the community. The influence on exclusive breastfeeding of health-based programs, such as the child-friendly hospital initiative, may decrease when women return home and need community support.
   - It is necessary to provide ongoing family and community support through community leaders and various other communication channels.
   - In countries with low rates of hospital delivery, community support can be provided through home visits or support groups.
   - Communication channels and messages must be adapted to the context based on the literacy levels of the recipients, their use of the different means of communication, as well as their access to them, and contact with health professionals. Behavioral change messages

must be adapted to specific barriers and motivating factors at the national or subnational level in relation to exclusive breastfeeding that is identified. Individual counseling and peer counseling are effective, but group counseling also improves rates of exclusive breastfeeding, and a combination of these approaches appears to be particularly effective [19]. Support for mothers can come from people—professionals or not—properly trained, and reaches its maximum effectiveness when both health centers and community members offer information and coherent messages, practical support and referral to the appropriate services.

3. Significantly limit the aggressive and inadequate promotion of breast-milk substitutes by strengthening surveillance, compliance and legislative action in relation to the International Code of Marketing of Breast-milk Substitutes and subsequent relevant resolutions of the World Health Assembly.

   - Countries are urged to enforce laws, regulations or other measures that are legally enforceable in order to implement the International Code of Marketing of Breast-milk Substitutes, as well as to actively monitor for possible violations and establish and apply effective sanctions in case of violation [20].

4. Train women to practice exclusive breastfeeding by introducing a mandatory 6-month paid maternity leave, as well as policies that encourage women to breastfeed their children at work and in public places.

   - Labor policies should support all working women - both in the formal economy and the informal economy sector - to continue breastfeeding their children upon return to work (e.g., through day care centers in the center) of work, breaks for breastfeeding or milk extraction, and comfortable and intimate areas in which women can express and store milk safely).

5. Invest in training and capacity building for the protection, promotion and support of breastfeeding.

   - In addition to training on infant and young child feeding practices, it is necessary to strengthen training in problem solving and counseling, and to identify mechanisms for monitoring and mentoring professionals after training.
   - Be aware of the differences in skill profiles and information needs among the different types of health professionals.

7. Conclusion

Breast milk remains the preferred food for all children, including premature and sick babies. Advising mothers of hospitalized newborns increases the incidence of initiation of breastfeeding and the extraction of human milk without increasing maternal stress and anxiety. Early Kangaroo mother significantly increased exclusive breastfeeding and direct breastfeeding in very low birth weight infants [21].

The potential long-term benefit of receiving breast milk in the NICU for very low birth weight infants may be to optimize cognitive potential and reduce the need for early intervention and special education services [22].

The implementation of a program to promote breastfeeding in the NICU has a marked positive effect on the rate of exclusive early breastfeeding after discharge. Exclusive breastfeeding is the most effective intervention to reduce infant mortality, and infant mortality in low-income countries is estimated to prevent 13 per cent of children under five [18].

With this bibliographic review it is clear that the use of promotional strategies is a resource that improves behavior against breastfeeding. This support helps to improve health and exercise greater control over newborn and own care. This is achieved through different actions aimed at promoting education, communication, public policies, legislation, community development, and training, among others. The summary of the effectiveness of interventions for support in breastfeeding according to the evidence lies in education in breastfeeding pregnant women and mothers, support by peers, implementation of the Baby-Friendly Hospital policy and the mother of WHO and UNICEF [23].

Probably effective are professional support, early attachment promotion in maternity wards, mass media strategies. According to the literature the less effective interventions are the delivery of promotional packages for breastfeeding and delivery of printed material [24].

As we learn more evidence in support of breastfeeding mothers with hospitalized newborns better survival will have these patients [25].

Author details

Patricia Triviño Vargas

Address all correspondence to: patriciatrivino@uach.cl

Instituto de Enfermería UACh, Valdivia, Chile

References

[1] Sisk P, Lambeth T. Necrotizing Enterocolitis and growth in preterm infants fed predominantly maternal milk, pasteurized donor milk, or preterm formula: A retrospective study. American Journal of Perinatology. 2017;**34**(7):676-683

[2] Kumar R, Singhal A. Optimizing nutrition in preterm low birth weight infants-consensus summary. Frontiers in nutrition. 2017;**26**(4):20

[3] Ingram J, Johnson D, Greenwood R. Breastfeeding in Bristol: Teaching good positioning, and support from fathers and families. Midwifery. 2002;**18**(2):87-101

[4] Mathur N, Dhingra D. Breastfeeding. Indian Journal of Pediatrics. 2014;**81**(2):143-149

[5] Schandler S, Thomas C, Cohen M. Spatial learning deficits in preschool children of alcoholics. Alcoholism, Clinical and Experimental Research. 1995;**19**(4):1067-1072

[6] Nascimento M, Issler H. Aleitamento materno em prematuros: manejo clínico hospitalar. The Journal of Pediatrics. 2004;**80**

[7] Righard L, Alade M. Effect of delivery room routines on success of first breast-feed. Lancet. 1990;**336**(8723):1105-1107

[8] Sosa R, Klaus M, Urrutia J. Feed the nursing mother, there by the infant. The Journal of Pediatrics. 1976;**88**(4Pt 1):668-670

[9] De Château P, Wiberg B. Long-term effect on mother-infant behaviour of extra contact during the first hour post partum. II. A follow-up at three months. Acta Paediatrica Scandinavica. 1977;**66**(2):145-151

[10] Thomson E, Hartsock G, Larson C. The importance of immediate postnatal contact: its effect on breastfeeding. Canadian Family Physician. 1979;**25**:1374-1378

[11] Ali Z, Lowry M. Early maternal-child contact: Effects on later behavior. Relevant Medicine and Child Neurology. 1981;**23**(3):337-345

[12] Lindenberg C, Cabrera Artola R, Jiménez V. The effect of early post-partum mother-infant contact and breast-feeding promotion on the incidence and continuation of breast-feeding. International Journal of Nursing Studies. 1990;**27**(3):179-186

[13] Salariya E, Easton P, Cater J. Duration of breast-feeding after early initiation and frequent feeding. Lancet. 1978;**2**(8100):1141-1143

[14] Taylor P, Taylor F, Campbell S, Maloni J, Cannon M. Extra early physical contact and aspects of the early mother-infant relationship. Acta paediatrica Scandinavica. Supplement. 1985;**316**:3-14

[15] Pérez-Escamilla R, Pollitt E, Lönnerdal B, Dewey K. Infant feeding policies in maternity wards and their effect on breast-feeding success: An analytical overview. American Journal of Public Health. Jan 1994;**84**(1):89-97

[16] Kurinij N, Shiono P. Early formula supplementation of breast-feeding. Pediatrics. 1991; **88**(4):745-750

[17] Mathur N, Dwarkadas A, Sharma V, Saha K, Jain N. Anti infective factors in preterm human colostrums. Acta Paediatrica Scandinavica. 1990;**79**:1039-1044

[18] Dall'Oglio I, Salvatori G. Breastfeeding promotion in neonatal intensive care unit: impact of a new program toward a BFHI for high-risk infants. Acta Paediatrica. 2007;**96**(11): 1626-1631

[19] Haroon S, Das J, Salam R, Imdad A, Bhutta Z. Breastfeeding promotion interventions and breastfeeding practices: A systematic review. BMC Public Health. 2013;**13**

[20] Bhandari N, Kabir A, Salam M. Mainstreaming nutrition into maternal and child health programmes: Scaling up of exclusive breastfeeding. Maternal & Child Nutrition. 2008;**4**

[21] Jayaraman D, Mukhopadhyay K. Randomized Controlled Trial on Effect of Intermittent Early Versus Late Kangaroo Mother Care on Human Milk Feeding in Low-Birth-Weight Neonates. Journal of Human Lactation. 2017;**33**(3):533-539

[22] Vohr B, Poindexter B, Dusick A. Beneficial effects of breast milk in the neonatal intensive care unit on the developmental outcome of extremely low birth weight infants at 18 months of age. Pediatrics. 2006;**118**(1):e115-e123

[23] UNICEF. Breastfeeding on the Worldwide Agenda: Findings from a Landscape Analysis on Political Commitment to Protect, Promote and Support Breastfeeding. Nueva York; 2013. http://www.unicef.org/eapro/breastfeeding_on_worldwide_agenda.pdf

[24] World Health Organization. Nutrition. Children's Hospital Initiative. Archived: Baby-Friendly Hospital Initiative Revised, updated and expanded for integrated care. http://www.who.int/nutrition/publications/infantfeeding/bfhi_trainingcourse/en/

[25] Pinchevski-Kadir S, Shust-Barequet S. Direct Feeding at the Breast Is Associated with Breast Milk Feeding Duration among Preterm Infants. Nutrients. 2017;**9**(11):1

Chapter 5

Breastfeeding and Reduced Risk of Breast Cancer in Women: A Review of Scientific Evidence

Emilio González-Jiménez

Additional information is available at the end of the chapter

http://dx.doi.org/10.5772/intechopen.72688

Abstract

Recent research shows that women who breastfed their children are at considerably less risk of developing breast cancer. Nonetheless, the results of other studies show that this greater protection only applies to pre-menopausal women. Based on the above results, there is still a certain controversy as to whether breastfeeding protects women against breast cancer. The main objective of this chapter is to provide a review of the scientific evidence regarding the relationship between breast cancer and certain aspects of pregnancy as breastfeeding period. For this purpose, it was conducted a systematic review in four databases (Web of Science, MEDLINE, Scopus and CINAHL), using the MeSH terms (Breast Feeding, Primary Prevention, Breast Neoplasms). The available scientific evidence justifies that breastfeeding for periods of over 6 months results in statistically significant reductions in the risk of developing breast cancer, the most common gynecological tumor in young women. However, it remains to be studied further whether the observed risk reduction applies to women with inherited susceptibility to develop breast cancer.

Keywords: breastfeeding, breast, cancer, prevention, women

1. Introduction

Breast cancer is the most common gynecological tumor in women [1, 2]. Actually, the highest breast cancer incidence appears in high-income regions: population of North America, in population of Western Europe, Australia and New Zealand [3]. In fact, in developed countries, breast cancer is the leading cause of cancer death in women of 35–64 years of age. Each year, about 22% of new cancer cases diagnosed in women are breast cancer [4]. However, 17–36% of all breast cancers occur in women under the age of 40 [5].

The rapid increase in the incidence of breast cancer is a new social challenge as a result of a large number of risk factors, among them genetic causes and altered socio-economical conditions such as occupational exposure, rotating shift work and environmental factors (increased atmospheric pollution, sedentary lifestyle, and inadequate nutritional habits combined with an unbalanced diet). Other risk factors to be considered are lower age at menarche (below 10 years), late maternal age at first full-term pregnancy (over the age 30–40 years), and short periods of breastfeeding [6].

In the last years, different breast cancer prevention studies have been carried out internationally. Their main objective was to evaluate how a woman's chance of developing breast cancer was affected by breastfeeding as well as by pregnancy and childbirth. The results of these studies provide evidence about the influence of hormonal and reproductive factors in the development of breast cancer [7–9].

2. Methodology

A systematic review literature was conducted between March and April 2017; articles were collected from four databases (Web of Science, MEDLINE, Scopus and CINAHL), as well as from references in published research and reviews. The search strategy for potentially eligible studies included the following MeSH terms and combinations: Breast Feeding and Primary Prevention and Breast Neoplasms. The reference lists of included studies were also searched for additional eligible studies. Article inclusion criteria were as follows: (1) original studies and articles reporting on human females, (2) written in English and published in peer-reviewed journals, and (3) studies conducted in developed countries (Organization for Economic Co-operation and Development countries as defined by the World Bank). The following exclusion criteria were used: (1) studies using qualitative methodology, and (2) studies where analytic methods were not clearly reported. Titles and abstracts of retrieved studies were screened to assess whether inclusion criteria were met. Full texts were assessed when the abstract was found insufficient to make conclusions about inclusion. A total of 48 scientific articles were found, 41 in Web of Science, 2 in MEDLINE, 3 in Scopus, and 2 in CINAHL. Out of potentially relevant citations retrieved from electronic databases and searches of reference lists, finally, 34 articles were selected for this review (**Table 1**).

Authors	Title	Year	Design	Conclusions
Pathak DR, Osuch JR, He J.	Breast carcinoma etiology: current knowledge and new insights into the effects of reproductive and hormonal risk factors in black and white populations.	2000	Literature review	To promote public health in diverse populations, and to provide further insight into breast carcinoma etiology, research needs to focus on multicultural differences and similarities in the relation of hormonal risk factors and breast carcinoma.
González-Jiménez E, García PA, Aguilar MJ, Padilla CA, Álvarez J.	Breastfeeding and the prevention of breast cancer: a retrospective review of clinical histories.	2014	Retrospective study of the clinical histories	Breastfeeding for over six months not only provides children with numerous health benefits, but also protects mothers from breast cancer

Authors	Title	Year	Design	Conclusions
				when the mothers are nonsmokers.
Clemon M, Goss P.	Estrogen and the risk of breast cancer.	2001	Literature review	Although a relation between exposure to estrogen and the risk of breast cancer has been identified in specific groups of women, we cannot accurately predict the risk in an individual woman. Clinical markers of exposure to estrogen, such as serum estrogen concentrations, breast density on mammography, and bone mineral density, may prove to be useful tools for assessing a woman's risk of breast cancer.
Chlebowski RT, Hendrix SL, Langer RD, Stefanick ML, Gass M, Lane D, et al.	Influence of estrogen plus progestin on breast cancer and mammography in healthy postmenopausal women: the Women's Health Initiative Randomized Trial.	2003	Randomized clinical trial	Relatively short-term combined estrogen plus progestin use may stimulate breast cancer growth and hinder breast cancer diagnosis.
Vyas U.	Risk of breast Cancer due to hyperprolactinemia caused by antipsychotics (Neuroleptics).	2012	Literature review	Some reports suggest that neuroleptics and other dopamine antagonists increase the risk of breast cancer due to hyperprolactinemia. There are other reports which suggest that they may decrease the risk of cancer especially rectum, colon and prostate.
Halbreich U, Kinon BJ, Gilmore JA, Kahn LS.	Elevated prolactin levels in patients with schizophrenia: mechanisms and related adverse effects.	2003	Literature review	Elevated prolactin levels may play important roles, both direct and indirect, in various pathologic states, including breast cancer.
Levine RS, Dolin P.	Pregnancy and breast cancer: a possible explanation for the negative association.	1992	Literature review	Larger studies are needed to demonstrate the preventive effect of pregnancy against the development of breast cancer.
Albrektsen G, Heuch I, Kvåle G.	Multiple births, sex of children and subsequent breast-cancer risk for the mothers: a prospective study in Norway.	1995	Prospective study	There was a slightly lower risk of breast cancer among women ever having had a multiple birth than among women with singletons only.
Håkansson A, Zhivotovsky B, Orrenius S, Sabharwal H, Svanborg C.	Apoptosis induced by a human milk protein	1995	Experimental study	A component of milk in a particular physical state–multimeric alpha-lact-albumin–is a potent Ca(2+)-elevating and apoptosis-inducing agent with broad, yet selective, cytotoxic activity.

Authors	Title	Year	Design	Conclusions
Bernstein L.	Epidemiology of endocrine-related risk factors for breast cancer.	2002	Literature review	The main risk factors for breast cancer identified by observing patterns of risk among various population groups are age, race/ethnicity, reproductive factors (menarche, menopause, and pregnancy and lactation history), and obesity.
González-Jiménez E, Garcia-Lopez PA, Schmidt-Rio-Valle J, Valenza C.	Influence of nutritional status, hormones serum levels, and family history on breast cancer development	2012	Retrospective study of the clinical histories	Extreme serum levels of estrogen, progesterone and prolactin appear to be related to the early development of breast cancer, which in turn is influenced by the existence of a family history of cancer among those women with normal or average hormone levels.
Løland BF, Baerug AB, Nylander G.	Human milk, immune responses and health effects	2007	Literature review	Human milk may confer long-term benefits such as lower risk of certain malignancies. A reduced incidence of breast cancer is best documented.
Aguilar Cordero MJ, González Jiménez E, Alvarez Ferre J, Padilla Lopez CA, Mur Villar N, Garcia Lopez PA, et al.	Breast feeding: an effective method to prevent breast cancer	2010	Retrospective study of the clinical histories	Breastfeeding for periods of longer than six months, not only provides children with many health benefits, but may also protect the mother from serious diseases, such as breast cancer.
Lee SY, Kim MT, Kim SW, Song MS, et al.	Effect of lifetime lactation on breast cancer risk: a Korean women's cohort study.	2003	Prospective study	This prospective study of a large Korean cohort provides strong empirical evidence that lactation decreases the risk of breast cancer among premenopausal women.
Chang-Claude J, Eby N, Kiechle M, Bastert G, et al.	Breastfeeding and breast cancer risk by age 50 among women in Germany.	2000	Case–control study	The reduction in risk associated with duration of breastfeeding was not primarily due to breastfeeding the firstborn and more evident in women who were older (> 25 years) when they first breastfed and among women who experienced a recent full-term pregnancy.
Dumitrescu RG, Cotarla I.	Understanding breast cancer risk–where do we stand in 2005?	2005	Literature review	Risk factors that modulate the development of breast cancer are: age, geographic location (country of origin) and socioeconomic status, reproductive events, exogenous hormones, lifestyle risk factors (alcohol, diet, obesity and

Authors	Title	Year	Design	Conclusions
				physical activity), familial history of breast cancer, mammographic density, history of benign breast disease, ionizing radiation, bone density, height, IGF-1 and prolactin levels, chemopreventive agents. Additionally, we summarized breast cancer risk associated with the following genetic factors: breast cancer susceptibility high-penetrance genes (BRCA1, BRCA2, p53, PTEN, ATM, NBS1 or LKB1) and low-penetrance genes such as cytochrome P450 genes (CYP1A1, CYP2D6, CYP19), glutathione S-transferase family (GSTM1, GSTP1), alcohol and one-carbon metabolism genes (ADH1C and MTHFR), DNA repair genes (XRCC1, XRCC3, ERCC4/XPF) and genes encoding cell signaling molecules (PR, ER, TNFα or HSP70).
Freudenheim JL, Marshall JR, Vena JE, Moysich KB, et al.	Lactation history and breast cancer risk	1997	Case–control study	Breast cancer risk was very weakly associated with long duration of lactation among premenopausal women. Among postmenopausal women, the protective effect of lactation was restricted to women with first lactation before age 25 years.
Stuver SO, Hsieh CC, Bertone E, Trichopoulos D.	The association between lactation and breast cancer in an international case–control study: a re–analysis by menopausal status	1997	Case–control study	This study did not suggest a protective effect of lactation among the pre-menopausal women. Although the 95% confidence intervals around the estimates generated do not exclude the possibility of a reduced risk of breast cancer associated with breast-feeding, no consistent dose–response with increasing total duration was evident.
Lipworth L, Bailey LR, Trichopoulos D.	History of breast-feeding in relation to breast cancer risk: a review of the epidemiologic literature	2000	Literature review	The evidence with respect to "ever" breast-feeding remains inconclusive, with results indicating either no association or a rather weak protective effect against breast cancer. It

Authors	Title	Year	Design	Conclusions
				appears that the protective effect, if any, of long-term breast-feeding is stronger among, or confined to, premenopausal women.
Collaborative Group on Hormonal Factors in Breast Cancer.	Breast cancer and breastfeeding: collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50,302 women with breast cancer and 96,973 women without the disease.	2002	Systematic review and Meta-analysis	The longer women breast feed the more they are protected against breast cancer. The lack of or short lifetime duration of breastfeeding typical of women in developed countries makes a major contribution to the high incidence of breast cancer in these countries.
Chowdhury R, Sinha B, Sankar MJ, Taneja S, et al.	Breastfeeding and maternal health outcomes: a systematic review and meta-analysis.	2015	Systematic review and Meta-analysis	Breastfeeding is protective against breast and ovarian carcinoma, and exclusive breastfeeding and predominant breastfeeding increase the duration of lactational amenorrhoea.
Islam T, Matsuo K, Ito H, Hosono S, et al.	Reproductive and hormonal risk factors for luminal, HER2-overexpressing, and triple negative breast cancer in Japanese women.	2012	Case–control study	Reproductive events in adolescence have differential impact on the risk of breast cancer molecular subtypes in Japanese.
Lipworth L, Bailey LR, Trichopoulos D.	History of breast-feeding in relation to breast cancer risk: a review of the epidemiologic literature.	2000	Literature review	The evidence with respect to "ever" breast-feeding remains inconclusive, with results indicating either no association or a rather weak protective effect against breast cancer.
Yoo KY, Tajima K, Kuroishi T, Hirose K, et al.	Independent protective effect of lactation against breast cancer: a case control study in Japan.	1992	Case–control study	Lactation has an independent protective effect against breast cancer in Japanese women.
Wang QS, Ross RK, Yu MC, Ning JP, et al.	A case–control study of breast cancer in Tianjin, China.	1992	Case–control study	The results strongly suggest that both parity and lactation independently contribute to breast cancer risk.
Michels KB, Willett WC, Rosner BA, Manson JE, et al.	Prospective assessment of breastfeeding and breast cancer incidence among 89,887 women	1996	Prospective study	The results suggest that there is no important overall association between breast-feeding and the occurrence of breast cancer.
Zheng T, Duan L, Liu Y, Zhang B, et al.	Lactation reduces breast cancer risk in Shandong Province, China.	2000	Case–control study	These results suggest that prolonged lactation reduces breast cancer risk.
Hajian-Tilaki KO, Kaveh-Ahangar T.	Reproductive factors associated with breast cancer risk in northern Iran	2011	Case–control study	The duration of breast feeding was inversely associated with breast cancer risk. Nulliparity,

Authors	Title	Year	Design	Conclusions
				late age at first birth and abortion were the most important reproductive factors associated with breast cancer risk.
Awatef M, Olfa G, Imed H, Kacem M, et al.	Breastfeeding reduces breast cancer risk: a case–control study in Tunisia	2010	Case–control study	The results support an inverse association between breastfeeding and breast cancer risk.
Nagata C, Mizoue T, Tanaka K, Tsuji I, et al.	Breastfeeding and breast cancer risk: an evaluation based on a systematic review of epidemiologic evidence among the Japanese population.	2012	Systematic review	The results suggest that breastfeeding possibly decreases the risk of breast cancer among Japanese women
Galukande M, Wabinga H, Mirembe F, Karamagi C, et al.	Breast cancer risk factors among Ugandan women at a tertiary hospital: A case–control study.	2016	Case–control study	Breastfeeding seems to be associated with reduced odds of breast cancer.

Table 1. Summary table of selected studies.

3. Pregnancy

Early pregnancy has a protective effect against breast cancer [10]. Some of the mechanisms explaining the protective effect of pregnancy have been explored in animal models of breast cancer. Both early age (less than 20 years versus more than 30 years) at first full-term pregnancy and higher parity decrease breast cancer risk to half of the risk of nulliparous women [10]. Although the mechanisms are not entirely elucidated, pregnancy has been hypothesized to reduce the risk of breast cancer primarily through two mechanisms: firstly estrogen-induced mitosis may be suppressed by estriol, the main estrogen produced during pregnancy. Secondly, estrogen-induced mitosis may be suppressed by the hormone prolactin, whose levels are increased during pregnancy [11]. Then, high levels of estriol may protect women against the development of breast cancer [12, 13]. However, there is somewhat less agreement concerning the role of prolactin in the disease. Different studies show a relationship between hyperprolactinemia and an increased risk of breast cancer in women [14, 15]. The mechanisms potentially involved are: increased synthesis and expression of prolactin receptors in malignant breast tissue and a prolactin-induced increase in DNA synthesis in breast cancer cell *in vivo* [14]. Secondly, and according to Levine and Dolin [16], pregnancy reduces the risk of breast cancer because of the excretion of lipophilic carcinogens by the mother through the fetal fat and vernix caseosa. Other studies have yielded conflicting results. According to Alberktsen et al. [17] in their study with 802,457 Norwegian women (20–56 years old), an increase in the diagnosis of breast cancer after full-term pregnancy was observed, particularly between 3 and 4 years after the delivery. Hakansson et al. [18] and, more recently, Rough et al. [19] reported that human milk causes the vitro apoptosis or the programmed cell death of several varieties of cancer cells. On the other hand, the decrease of breast cancer risk due to prolonged lactation may be explained in part by the reduction of total number of ovulatory menstrual cycles and consequently cumulative ovarian hormone exposure [20]. Despite the scientific evidence available, there is an important controversy about the effect of hormones on the development of breast cancer. This is a complex task when we consider the complex etiopathogenic nature of breast tumors. Consequently, further studies are necessary in order to analyze this relationship [21].

4. Breast milk

Breastfeeding is still another research focus. An increasing number of studies have indicated that breastfeeding offers protection against breast cancer [22, 23]. In the long term, the protection offered by breastfeeding is greater for premenopausal women, but also persists for postmenopausal women even after 50 years since the first lactation [24]. These protective effects of breastfeeding appear to be stronger the longer a woman breastfeeds her first child, as well as cumulative, such that increased lifetime duration of lactation over multiple children confers greater protection against breast cancer [25]. From a biological perspective, there are various explanations why breastfeeding seems to prevent breast cancer and why it appears to significantly benefit female health. One mechanism may involve a markedly reduced susceptibility of the fully differentiated mammary gland to carcinogens due to, at least in part, a decrease in proliferative activity of parous epithelium [26]. Other important changes are estrogen reduction and elimination through mammary fluid and the excretion of carcinogenic agents through the breast tissue during the breastfeeding process [27–29].

According to a study carried out by Cancer Research UK, the short duration of breastfeeding typical of women in developed countries makes a major contribution to the high incidence of breast cancer in these countries. The results obtained showed that the relative risk of breast cancer decreased by 7.0% for each birth in addition to a decrease of 4.3% for every 12 months of breastfeeding [30]. Despite such studies, many researchers are still skeptical as to the protection against breast cancer potentially afforded by breastfeeding. They claim that the data obtained until now are both insufficient and in many cases, inconsistent. Therefore, the influence of each birth should be considered when the relationship between breastfeeding and breast cancer is studied. Likewise, the reported breastfeeding duration is not very trusty, with values generally rounded to multiples of 6 or 12 months, particularly among women who had breastfed for long periods of time [31].

Nevertheless, a slightly lower rate of breast cancer was observed in women who breastfed their children for periods of over 12 months [32]. Of the women who had given birth, those who were cancer-free were more likely to have breastfed than those who subsequently developed breast cancer (79% as compared to 71%) [33]. However, a history of ever breast-feeding may be too crude an indicator, and it may be more important to demonstrate a dose–response association with increasing duration of breast-feeding in making causal inferences [34]. These results suggest an inverse relationship between breastfeeding duration and risk of developing breast cancer.

The decrease of relative risk´ rate of developing breast cancer associated with breastfeeding did not change significantly for women in developed and developing countries, and did not change according to the age and ethnicity [31]. Other studies have analyzed breast cancer risk factors, including breastfeeding duration, in Asian and African populations. The results obtained about breastfeeding duration and risk of developing breast cancer between these populations are limited [35, 36].

Additionally Michels et al. [37], in the Nurse's Health Study, in a retrospective review of breastfeeding duration in nearly 90,000 women, reported that, in comparison to never breastfeeding, the RR was 0.86 for fewer than 3 months of breastfeeding, 0.95 for 7–11 months, 0.86 for 12–23 months, and 1.11 for 24 months or longer. These results show the importance of the breastfeeding duration in reducing the risk of breast cancer.

Moreover, Zheng et al. [38], in the period 1997–1999 in Shandong, China, studied breast cancer risk in 404 women and in a control group. Their results show that for those women who breastfed their children for more than 24 months, the odds ratio was 0.46 (95% CI, 0.27–0.78) when compared with those women who breastfed their child for 1–6 months. These data suggest that prolonged lactation reduces breast cancer risk. Similar results were found by Hajian-Tilaki et al. [39], in their study with 100 women diagnosed of breast cancer and 200 controls. The authors conclude that duration of breast feeding was inversely associated with breast cancer risk. In another case–control study in Tunisia between 2006 and 2009, involving 400 breast cancer cases and 400 controls, the authors likewise observed an inverse association between breastfeeding duration and breast cancer risk [40].

Other review study developed by Nagata et al. [41], in which they identified three cohort studies and five case–control studies show similar results as described above. There was no significant association between the risk of breast cancer and breastfeeding according cohort studies analyzed. Nevertheless, in most case–control studies observed a statistically significant reduction in risk for women who ever had breastfed or for women with longer breastfeeding duration. These results again suggest that breastfeeding decreases the risk of breast cancer among Japanese women.

Despite the extensive scientific evidence available, there is still controversy about the effect of breastfeeding on the prevention of breast cancer. Consequently, more studies in different parts of the world are needed to analyze this relationship [42].

5. Conclusions

Breastfeeding for periods of over 6 months results in statistically significant reductions in the risk of developing breast cancer, the most common gynecological tumor in young women. However, it remains to be studied further whether the observed risk reduction applies to women with inherited susceptibility to develop breast cancer. Further studies must be conducted to focus on populations in which breastfeeding was common for relatively long durations, and should attempt to collect information on the errors in the reporting of lifetime duration of breastfeeding and other forms of complementary feeding. Meanwhile, this potential beneficial effect of breastfeeding for the mother should lead health professionals to encourage prolonged breastfeeding in their clinical practice.

Author details

Emilio González-Jiménez

Address all correspondence to: emigoji@ugr.es

Department of Nursing, Faculty of Health Science, University of Granada, Spain

References

[1] Hery C, Ferlay J, Boniol M, Autier P. Changes in breast cancer incidence and mortality in middle–aged and elderly women in 28 countries with Caucasian majority populations. Annals of Oncology. 2008;**19**:1009-1018

[2] Amaral P, Miguel R, Mehdad A, Cruz C, Monteiro Grillo I, Camilo M, Ravasco P. Body fat and poor diet in breast cancer women. Nutrición Hospitalaria. 2010;**25**:456-461

[3] Jemal A, Bray F, Center MM, Ferlay J, Ward E, Forman D. Global cancer statistics. CA: A Cancer Journal for Clinicians. 2011;**61**(2):69-90

[4] do Carmo França-Botelho A, Ferreira MC, França JL, França EL, Honório-França AC. Breastfeeding and its relationship with reduction of breast cancer: A review. Asian Pacific Journal of Cancer Prevention. 2012;**13**(11):5327-5332

[5] Ghoncheh M, Momenimovahed Z, Salehiniya H. Epidemiology, incidence and mortality of breast cancer in Asia. Asian Pacific Journal of Cancer Prevention. 2016;**17**:47-52

[6] Golubnitschaja O, Debald M, Yeghiazaryan K, Kuhn W, Pešta M, Costigliola V, Grech G. Breast cancer epidemic in the early twenty-first century: Evaluation of risk factors, cumulative questionnaires and recommendations for preventive measures. Tumour Biology. 2016;**37**(10):12941-12957. [Epub ahead of print]

[7] Tryggvadottir L, Tulinius H, Eyfjord JE, Sigurvinsson T. Breastfeeding and reduced risk of breast cancer in an Icelandic cohort study. American Journal of Epidemiology. 2001;**154**:37-42

[8] Vieira FGK, Di Pietro PF, Boaventura BCB, Ambrosi C, Rockenbach G, Fausto MA, Crippa CG, Da Silva EL. Factors associated with oxidative stress in women with breast cancer. Nutrición Hospitalaria. 2011;**26**:528-536

[9] Manrique Tejedor J, Figuerol Calderó MI, Cuéllar De Frutos A. Breastfeeding as a method of breast cancer prevention. Revista de Enfermería. 2015;**38**(12):32-38

[10] Pathak DR, Osuch JR, He J. Breast carcinoma etiology: Current knowledge and new insights into the effects of reproductive and hormonal risk factors in black and white populations. Cancer. 2000;**88**:1230-1238

[11] González-Jiménez E, García PA, Aguilar MJ, Padilla CA, Álvarez J. Breastfeeding and the prevention of breast cancer: A retrospective review of clinical histories. Journal of Clinical Nursing. 2014;**23**(17–18):2397-2403

[12] Clemon M, Goss P. Estrogen and the risk of breast cancer. The New England Journal of Medicine. 2001;**344**:276-285

[13] Chlebowski RT, Hendrix SL, Langer RD, Stefanick ML, Gass M, Lane D, Rodabough RJ, Gilligan MA, Cyr MG, Thomson CA, Khandekar J, Petrovitch H, McTiernan A, Investigators WHI. Influence of estrogen plus progestin on breast cancer and mammography in healthy postmenopausal women: The women's health initiative randomized trial. Journal of the American Medical Association. 2003;**289**:3243-3253

[14] Umesh V. Risk of breast cancer due to hyperprolactinemia caused by antipsychotics (neuroleptics). British Journal of Medical Practitioners. 2012;**5**(4):a534

[15] Halbreich U, Kinon BJ, Gilmore JA, Kahn LS. Elevated prolactin levels in patients with schizophrenia: Mechanisms and related adverse effects. Psychoneuroendocrinology. 2003; **28**(Suppl 1):53-67

[16] Levine RS, Dolin P. Pregnancy and breast cancer: A possible explanation for the negative association. Medical Hypotheses. 1992;**38**:278-283

[17] Alberktsen G, Heuch I, Kvale G. Multiple births, sex of children and subsequent breast cancer risk for the mothers: A prospective study in Norway. International Journal of Cancer. 1995;**60**(3):341-344

[18] Hakansson A, Zhivotovsky B, Orrenius S, Sabharwal H, Svanborg C. Apoptosis induced by a human milk protein. Proceedings of the National Academy of Sciences. 1995;**92**:8064-8068

[19] Rough SM, Sakamoto P, Fee CH, Hollenbeck CB. Qualitative analysis of cancer patients' experiences using donated human milk. Journal of Human Lactation. 2009;**25**:211-219

[20] Bernstein L. Epidemiology of endocrine-related risk factors for breast cancer. Journal of Mammary Gland Biology and Neoplasia. 2002;**7**:3-15

[21] González-Jiménez E, Garcia-Lopez PA, Schmidt-Rio-Valle J, Valenza C. Influencia del estado nutricional, niveles hormonales e historia familiar de cancer en el desarrollo del cancer de mama. Revista Médica de Chile. 2012;**140**:1263-1267

[22] Løland BF, Baerug AB, Nylander G. Human milk, immune responses and health effects. Tidsskrift for den Norske Lægeforening. 2007;**127**:2395-2398

[23] Aguilar Cordero MJ, González Jiménez E, Alvarez Ferre J, Padilla Lopez CA, Mur Villar N, Garcia Lopez PA, Valenza Peñna MC. Breast feeding: An effective method to prevent breast cancer. Nutrición Hospitalaria. 2010;**25**:954-958

[24] Lee SY, Kim MT, Kim SW, Song MS, Yoon SJ. Effect of lifetime lactation on breast cancer risk: A Korean women's cohort study. International Journal of Cancer. 2003;**105**(3): 390-393

[25] Chang-Claude J, Eby N, Kiechle M, Bastert G, Becher H. Breastfeeding and breast cancer risk by age 50 among women in Germany. Cancer Causes & Control. 2000;**11**(8):687-695

[26] Dumitrescu RG, Cotarla I. Understanding breast cancer risk–Where do we stand in 2005? Journal of Cellular and Molecular Medicine. 2005;**9**(1):208-221

[27] Freudenheim JL, Marshall JR, Vena JE, Moysich KB, Muti P, Laughlin R, Nemoto T, Graham S. Lactation history and breast cancer risk. American Journal of Epidemiology. 1997;**146**:932-938

[28] Stuver SO, Hsieh CC, Bertone E, Trichopoulos D. The association between lactation and breast cancer in an international case–control study: A re–analysis by menopausal status. International Journal of Cancer. 1997;**71**:166-169

[29] Loren L, Renee B, Dimitrios T. History of breast–feeding in relation to breast cancer risk: A review of the epidemiologic literature. Journal of the National Cancer Institute. 2000;**92**: 302-312

[30] Woodman I. Breast–feeding reduced risk of breast cancer, says study. BMJ. 2002;**27**:184

[31] Collaborative Group on Hormonal Factors in Breast Cancer. Breast cancer and breastfeeding: Collaborative reanalysis of individual data from 47 epidemiological studies in 30 countries, including 50302 women with breast cancer and 96973 women without the disease. Lancet. 2002;**360**(9328):187-195

[32] Chowdhury R, Sinha B, Sankar MJ, Taneja S, Bhandari N, Rollins N, Bahl R, Martines J. Breastfeeding and maternal health outcomes: A systematic review and meta-analysis. Acta Paediatrica. 2015;**104**(467):96-113

[33] Islam T, Matsuo K, Ito H, Hosono S, Watanabe M, Iwata H, Tajima K, Tanaka H. Reproductive and hormonal risk factors for luminal, HER2-overexpressing, and triplenegative breast cancer in Japanese women. Annals of Oncology. 2012;**23**:2435-2441

[34] Lipworth L, Bailey LR, Trichopoulos D. History of breast-feeding in relation to breast cancer risk: A review of the epidemiologic literature. Journal of the National Cancer Institute. 2000;**92**(4):302-312

[35] Yoo KY, Tajima K, Kuroishi T, Hirose K, Yoshida M, Miura S, et al. Independent protective effect of lactation against breast cancer: A case control study in Japan. American Journal of Epidemiology. 1992;**135**:726-733

http://dx.doi.org/10.5772/intechopen.72688

[36] Wang QS, Ross RK, MC Y, Ning JP, Henderson BE, Kimm HT. A case-control study of breast cancer in Tianjin, China. Cancer Epidemiology, Biomarkers & Prevention. 1992;**1**:435-439

[37] Michels KB, Willett WC, Rosner BA, Manson JE, Hunter DJ, Colditz GA, et al. Prospective assessment of breast-feeding and breast cancer incidence among 89,887 women. Lancet. 1996;**347**:431-436

[38] Zheng T, Duan L, Liu Y, Zhang B, Wang Y, Chen Y, Zhang Y, Owens PH. Lactation reduces breast cancer risk in Shandong Province, China. American Journal of Epidemiology. 2000;**152**:1129-1135

[39] Hajian-Tilaki KO, Kaveh-Ahangar T. Reproductive factors associated with breast cancer risk in northern Iran. Medical Oncology. 2011;**28**(2):441-446

[40] Awatef M, Olfa G, Imed H, Kacem M, Imen C, Rim C, Mohamed B, Slim BA. Breastfeeding reduces breast cancer risk: A case-control study in Tunisia. Cancer Causes & Control. 2010;**21**(3):393-397

[41] Nagata C, Mizoue T, Tanaka K, Tsuji I, Tamakoshi A, Wakai K, Matsuo K, Ito H, Sasazuki S, Inoue M, Tsugane S; Research Group for the Development and Evaluation of Cancer Prevention Strategies in Japan. Breastfeeding and breast cancer risk: An evaluation based on a systematic review of epidemiologic evidence among the Japanese population. Japanese Journal of Clinical Oncology 2012;**42**(2):124-130

[42] Galukande M, Wabinga H, Mirembe F, Karamagi C, Asea A. Breast cancer risk factors among Ugandan women at a tertiary hospital: A case-control study. Oncology. 2016;**90**(6): 356-362

Edited by R. Mauricio Barría P.

Breastfeeding is a cornerstone of child nutrition and the growth and development of children. In addition, it generates other multiple benefits for both child and mother. Consequently, it has been recognized as a strategy of promotion and protection of the main health for different countries across the world. However, despite the strong evidence of its benefits and the public health policies being implemented to promote breastfeeding, the prevalence of exclusive breastfeeding at the sixth month does not reach the recommendations of many countries. This book intends to provide the reader with an overview of selected topics on current state-of-the-art breastfeeding in different situations and conditions. Specialists in the field of breastfeeding from different countries have developed these chapters and through them they share part of their experience.

Published in London, UK

IntechOpen

ISBN 978-1-83881-325-3