

Breastfeeding for Gut Infant Health

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ABSTRACT

Infants react sensible to dietary changes because the gut physiology and functionality is not fully mature. The first few months of life is the 'window of opportunity' for optimal physical growth and development, cognitive development, and emotional and social development. Exclusive breastfeeding is recommended for the first 6 months of life. Breast milk is important for the maturation of the infant's digestive system. Potentially protective factors are present in higher amounts in feces from breast-fed infant than from formula-fed infants. The amount of intestinal bifidobacteria in breastfed infants is higher than in formula-fed babies. Mother's milk protects against infection because it contains different factors with immunologic properties. The differences in protein fractions between human and cow milk are impressive. The human milk oligosaccharides are the third most important nutritional component are fermented in the colon, making the environment in the colon suitable for the growth of bifidobacteria and lactobacillus.

Keywords: *breastfeeding, breast milk, window of opportunity, gut protection, optimal growth*

ABSTRAK

Bayi bereaksi sensitif terhadap perubahan pola makan karena fisiologi dan fungsi usus yang belum sepenuhnya matang. Beberapa bulan pertama kehidupan adalah 'window of opportunity' untuk pertumbuhan fisik dan perkembangan optimal, perkembangan kognitif, serta perkembangan emosional dan sosial. Pemberian air susu ibu (ASI) eksklusif dianjurkan untuk 6 bulan pertama kehidupan. ASI penting untuk pematangan sistem pencernaan bayi. Faktor yang berpotensi protektif hadir dalam jumlah yang lebih tinggi pada feses bayi yang diberi ASI daripada bayi yang diberi susu formula. Jumlah bifidobakteri usus pada bayi yang diberi ASI lebih tinggi daripada bayi yang diberi susu formula. Air susu ibu melindungi dari infeksi karena mengandung faktor yang berbeda, adanya sifat imologis. Perbedaan fraksi protein antara ASI dan susu sapi sangat mengesankan. Oligosakarida susu manusia adalah komponen nutrisi terpenting ketiga yang difermentasi di usus besar, membuat lingkungan di usus besar cocok untuk pertumbuhan bifidobakteri dan lactobacillus.

Kata kunci: *menyusui, air susu ibu (ASI), window of opportunity, perlindungan usus, pertumbuhan optimal*

INTRODUCTION

Human milk is the first choice infant feeding. The exclusive breastfed infant with a normally diversified maternal dietary intake is the gold standard. Before 2001, the World Health Organization (WHO)

recommended that infants be exclusively breastfed for 4-6 months with the introduction of complementary foods (any fluid or food other than breast milk). Thereafter, in 2001, after a systematic review and expert consultation, this advice was changed and

exclusive breastfeeding is now recommended for the first 6 months of life.¹

Many data showed that formulae feeding increased the incidence of cow's milk protein allergy (CMPA) or atopic manifestation compared to breastfeeding (short-term prevention). The long-term benefit of a reduced incidence of atopic disease, cardio-vascular disease, and other diseases are still on going study.

Window of Opportunity

A window of opportunity is a period of time during which an intervention will result in short and long term benefit, and is thus a critical period. The first few months of life is the 'window of opportunity' for; (1) Optimal physical growth and development (e.g. weight and height gain); (2) Cognitive development (e.g. language, non-verbal learning, attention, problem solving, IQ); (3) Emotional and social development (e.g. emotional control, behavioral adaptation, social interaction).

Infants react sensible to dietary changes because the gut physiology and functionality is not fully mature. The mucosa of the gut is not yet fully closed (relative absence of „tight junctions“); therefore large molecules such as intact proteins, (pathogenic) bacteria pass relatively easy through the small intestinal mucosa into the bloodstream. The immune system is not yet fully developed as well. The first few months of life is a vulnerable period, in which a child's immature immune system is constantly exposed to over one billion of germs.² Children with a poor immune system will be more vulnerable to infection, including respiratory tract infection, otitis media and gastroenteritis. An infant that suffers frequent infections will miss the window of opportunity to develop its full potential.²

Suboptimal Exclusive Breastfeeding

Non-exclusive breastfeeding is associated with an increased risk for many diseases such as necrotizing enterocolitis, otitis media, gastroenteritis, lower respiratory tract infections, atopic dermatitis, sudden infant death syndrome, childhood asthma, leukemia, type 1 diabetes mellitus and childhood obesity.

A socio-economic analysis concluded that the burden of suboptimal breastfeeding is enormous: if 90% of all families could comply with the recommendation to breastfeed exclusively for 6 months in the USA, this would result for the government in savings of 13 billion dollars per year on health care cost and prevent almost a thousand infant deaths.³

Optimal Growth

Exclusive breastfeeding is nutritionally complete for term infants and results in optimal growth. Mother's milk contains nutrients of high biological value, stimulates the development of natural immunity, and is above all practical, economical, convenient, and rewarding because it stimulates the mother to child bonding.

The digestive system of a newborn is immature. Infants may lose up to 10% of their birth weight in the first days of his life, as they adjust using their own digestive system. The optimal infant feeding need to contain a large amount of calories in a relatively small volume of food. Breast milk, with a high fat content, is the most efficient way for infants to meet their caloric needs.⁴

During the first 4-6 months of life, the digestive system undergoes enormous changes as it develops the ability to produce enzymes to digest food, to develop tolerance and antibodies offering protection. During first months of life, infants can not handle solid food or large feedings, because their intestinal tract is not sufficiently developed and mature. Breast milk is a food designed especially for infants to allow adapted maturation of the gastrointestinal tract.

Lipase and bile salts, which aid in fat digestion, do not reach full levels until the age of 6 months. Human milk is rich in lipids (98% triglyceride), but contains bile salt-stimulated lipase which is an enzyme similar to pancreatic lipase.^{4,5} Proteins and amino acids are needed by infants in relatively important quantities to support their rapid growth rate. Protein requirements are met by adequate intake of breast milk. Breast milk contains a variety of proteases, including trypsin, elastase, plasmin, etc that start digesting proteins as soon as they are secreted. Breast milk also contains antiproteases that serve to protect milk proteins from degradation. The process of protein secretion and digestion in the mammary glands, depends on the balance of proteases and antiprotease.⁶ Unmodified cow's milk is not suitable to feed an infant because it is nutritionally unbalanced, has a high renal solute load (three times as much protein as human milk, an excess of sodium), too low in iron, and fat that is difficult to be digested by the infant's gastrointestinal system.

Gut Protection

Breast milk is important for the maturation of the infant's digestive system. Colonies of beneficial

bacteria will develop in the intestine as a consequence of the presence of human milk oligosaccharides and intestinal growth factors in mother's milk. These beneficial bacteria help prevent an invasion by pathogens and contribute to a healthy maturation process. The protective mucosal barrier in infant is immature and puts infant at risk for infection. Antibodies in breast milk help protect infants until the digestive mucosa matures and increases the ability to produce its own antibodies around the age of 4-6 months.

Secretory Immunoglobulin A (sIgA) constitutes the first line of defense, protecting the intestinal epithelium from enteric toxins and pathogenic microorganisms. sIgA promotes the clearance of antigens from the gut by blocking their access to epithelial receptors, entrapping in mucus, and facilitating their removal by peristaltic and mucociliary activities.⁷ sIgA in breast milk is capable of binding commensal bacteria and may be involved in the progressive and controlled establishment microbiota of the newborn. The microbiota stimulates the maturation of the gut-associated-lymphoid-tissue (GALT), resulting in the production of IgA with both a limited affinity and repertoire to redundant epitopes on gut microorganisms.⁸

Potentially protective factors are present in higher amounts in feces from breast-fed infant than from formula-fed infants. The sIgA level in breastmilk is high (1-2g /L in colostrum and 0.5-1 g/L in mature breastmilk). The sIgA levels in the feces of breastfed infants (0.11 ± 0.07 mg/mL) was higher than in the feces of standard formula-fed infants (0.03 ± 0.01 mg/mL) at the age of one month of life.⁹

Gut bacteria modulate the immune response. The amount of intestinal bifidobacteria in breastfed infants is higher than in formula-fed babies. Mother's milk influences the species and amount of gut bacteria through multiple factors, such as human milk oligosaccharides, immunology active components, nutrient content (e.g low protein and low phosphate), etc. This microbiota will stimulate the reproduction of sIgA against some gastrointestinal pathogens such as *E. coli*, *V. cholerae*, *C. difficile*, *Salmonella*, *Rotavirus*, *C. albicans*.¹⁰

Good Reason for Breastfeeding

Casein is a milk protein with diverse biologic consequences. What is good for the goose may be good for the gander, but what is good for the cow could be harmful to the human infant. The differences in protein fractions between human and cow milk are impressive.

First, cow's milk contains three times more protein than human milk. Breast milk contains 60% whey and 40% casein while cow's milk contains 20% whey and 80% casein. Whey breast milk contains mostly lactoferrin, alpha lactalbumin and immunoglobulin, whereas whey cow's milk contains mostly Beta-lactoglobulin.¹¹ A randomized clinical trial showed low protein in infant formula is associated with lower weight up to age 2 year, more similar to the weight gain in breastfed infants.^{12,13} There is no convincing scientific evidence that avoidance or delayed introduction of potentially allergenic foods, such as fish and eggs would reduce allergies, either in infants considered at increased risk for the development of allergy or in those not considered to be at increased risk.¹⁴ If the incidence of allergic manifestations is higher in formula than in breastfed infants, is still a matter of debated. This is mainly due to the fact that breastfeeding cannot be randomized, and that the most allergic families breastfeed more frequently and longer.

Mother's milk protects against infection because it contains different factors with immunologic properties. Therefore, mother's milk influences the longterm immune response and risk for the development of auto-immune disease. sIgA, lactoferrin, lysozym, lactoperoxidase, oligosaccharides, bifidus factor, etc act as anti-microbial agents; cytokines (IL-10 and TGF β) and anti-idiotypic antibodies play an important role in the development of tolerance and priming; macrophages, neutrophils, lymphocytes, cytokines, growth factors, hormones, nucleotides, milk peptide, adhesion molecules influence the immune development, and TNF alpha and IL-6 receptors CD4, cytokines, adhesion molecules, LC-PUFA, IL-1 receptor antagonist, lactoferrin, hormone and growth factors, etc. have anti-inflammatory properties.¹⁵

Lactoferrin is an iron binding protein, facilitating iron uptake, and is resistant to trypsin digestion. Lactoferrin has a bacteriostatic effect since it has a high iron affinity and competition for iron with iron-dependant microbes. Lactoferrin has a strong bactericidal effect (independent from iron saturation), at least partly due to lactoferricin (bactericidal peptide formed during digestion). Lactoferrin also decreases the intestinal cell attachment of Enteropathogenic *E. coli* (EPEC). In vitro, lactoferricin is active against HIV and *C. albicans*.¹⁶

Essential fatty acids (e.g. linoleic acid, alpha linolenic acid) can not be synthesized by the body, must therefore be supplied in adequate amounts by feeding. Essential fatty acids are precursors of a number of

long-chain poly-unsaturated fatty acids (LCPUFAs). The long-chain poly-unsaturated fatty acids consist of arachidonic acid (ARA) and Docosohexanoic acid (DHA). Arachidonic acid acts in all cell membranes as a modulator of cell immunity, and is pro-inflammatory. Docosohexanoic acid is present mainly in neuronal tissue (brain, retina) and has also an important role on the development of immune function, and has anti-inflammatory properties. The levels of DHA in human milk lipids reflect the dietary intake of the mother. World-wide, the mean ratio of ARA and DHA in human milk is 1:1, what ensures an adequate ARA status even in presence of DHA. Excessive LC-PUFA supplementation may induce a risk for metabolic oxidation. ARA is efficiently metabolised from linoleic acid. Excesses of ARA may lead to undesirable inflammatory processes. Essential fatty acids may possibly enhance the beneficial actions of probiotics since LC-PUFAs promote the adhesion of probiotics to mucosal surfaces which increases their health-promoting.¹⁷ Some studies showed abnormal fatty acids composition in umbilical cord blood in infants at high risk of atopic diseases. Breast milk from mothers of children with newly developed atopic eczema has low levels of LC-PUFA.^{18,19}

The human milk oligosaccharides are the third most important nutritional component after fat and lactose in human milk. Human milk oligosaccharides act as receptor analogues for glycoconjugates on epithelial and endothelial cells. Glycolipids and glycoproteins mediate cell to cell interaction, bind humoral mediators, and modulate signal transfer. Human milk oligosaccharides decrease the adhesion of invasive *C. jejuni* and the toxicity of heat stable *E.coli* enterotoxin.²⁰ Human milk oligosaccharides are fermented in the colon, found in stools. The *bifidobacteria* and *lactobacilli* present in the colon will ferment oligosaccharides into energy and short chain fatty acids (acetate, propionate, butyrate), making the environment in the colon suitable for the growth of these bacteria. Lactic acid increases the motility and blood flow of the colon, stimulating the absorption of minerals. Butyric acid increases the proliferation of colonic epithelial cells and fluid absorption, and stimulates mucus production in the intestinal epithelium, while propionic acid decreases the inflammatory mediators.²¹

Nucleotides are conditionally essential nutrients for infants with beneficial effects on the immune system, lymphocyte maturation, antibody response to vaccines, increase of sIgA, and decrease the incidence of various

infections, especially infections of gastrointestinal and upper respiratory tract.²² Nucleotides also respond better to diphtheria, polio and influenza immunization.²³

CONCLUSION

Human milk is the best, complete nutrition for infants. It has anti-infective and anti-inflammatory effects by modulating the development of the immune response. Numerous human milk components and their interaction are involved in this complex process. Research is needed to better understand the short and long-term effects of these specific nutrients and breastfeeding as a whole. Opportunities for innovations in infant formula exist since many outcomes in formula-fed infants differ from those in breastfed populations. The development of these innovations with relevant outcome effects is complex, costly and time consuming.

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