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How breastfeeding affects immunity?

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Abstract

Introduction and objective

A person's health is influenced by various factors, one of which is diet, which can be altered to provide many needed ingredients. The early years of life are crucial for building immunity, starting with breast milk as the primary food.

Breastfeeding offers unique benefits, including providing maternal antibodies, immunoglobulins and growth factors that lower the risk of many diseases. In the work presented here, we focus mainly on the components of maternal milk and the benefits of providing them.

Review methods

PubMed/MEDLINE databases were searched using the entry criteria "full text" and the exclusion criteria "systematic reviews," "meta-analyses" and "review articles." The phrases "breastfeeding," "immunity" and "breast milk composition" were included. In the end, 40 publications were left out.

Abbreviated description of the state of knowledge

This study describes the main components of breast milk that build a baby's immunity. The mechanisms of action of these components are key to understanding how food can affect long-term human health and immunity, especially that provided in the first days of life.

Summary

Breastfeeding affects the development and functioning of the baby's operating system. Due to the special composition of breast milk, breastfed children protect against infections and support for additional health. Mechanisms that cause side effects that cause effects not only in the aftermath of life, but also in the aftermath of health in the aftermath of life.

Keywords: breast milk, breastfeeding, immunity, breast milk composition, health

1. Introduction and Objective

Human health is determined by many factors, one of the modifiable ones is food. Along with it, we can provide the body with the necessary ingredients, but also with toxins. Thus, to a large extent, we decide how our health develops.

The first years of life are the period of greatest importance in building immunity. [1] A newborn's diet is most often started with breast milk. It should be provided as the only food within the first hour of life, for a period of 6 months [2] , then the diet should be expanded, but breastfeeding is still best for about 12 months.

Breastfeeding is a natural method of providing needed ingredients to the newborn. [3] However, some women forgo natural feeding and replace it with formula milk.

These mixtures are well suited for feeding in the first days of life and beyond, but there are some benefits that are received only through breastfeeding. According to many studies, breast milk provides ideal nutrition, supplying the young body with components such as maternal antibodies, immunoglobulins, oligosaccharides, growth factors, fatty acids, among others. Breastfeeding during the first period of life reduces the risk of many diseases, affecting many mechanisms in the human body. [4]
In addition, positive effects have been described on the mother, reducing the risk of breast and ovarian cancer. [5] and on the child, among other things, it helps to create and develop a bond between mother and child. [6]

2. Review methods

A PubMed/MEDLINE database was searched for articles meeting specific criteria. The database was searched by entering the phrases “breastfeeding,” “immunity,” and “breast milk composition.” Mainly materials with full access from the last 5 years were included.
The inclusion criteria considered when searching the database were: full-text publications describing the effects of natural feeding on child health and immunity. The exclusion criteria were: systematic reviews, meta-analyses and review articles.
In the end, 40 publications meeting the listed criteria were included. As a result, the most recent data providing information on the described topic were collected.

3. Description of the state of the knowledge – Breast milk composition and its effect on immunity.

3.1. Immunoglobulins:

Newborns can have passive immunity passed on from their mothers through breastfeeding. This is because milk, mainly in the first few days, contains a large amount of immunoglobulins, especially IgA. They form a protective barrier on the mucous membranes of the gastrointestinal and respiratory systems, which are initially immature, preventing pathogens from entering the child's body. This mechanism allows the child to form immunity to pathogens with which its mother has been in contact, and therefore also to those with which it may come into contact in the first days of postnatal life. Breastfeeding is therefore one element in the formation of the infant's initial immune capacity. [7]
The level of immunoglobulins in breast milk was also examined when checking for immunity after vaccination and after COVID- 19. The study reported that mothers vaccinated against SARS-CoV-2 and those infected with the virus passed IgA and IgM to their children through breastfeeding. [8] In addition, the level of IgG tested in milk was higher in women who breastfed for a longer period of time than in those who stopped breastfeeding earlier. Thus, it can be seen that children immediately after birth, despite not having been vaccinated against the virus, can acquire immunity to it precisely by the supply of immunoglobulins in the milk of a mother who has previously been ill or vaccinated. [9]

3.2. Oligosaccharides:

Another third largest component of breast milk are oligosaccharides, which are an abundant and diverse group of complex carbohydrates. [10] They are formed by fucose, N-acetyl-neuraminic acid, N-acetyl-glucosamine, glucose and galactose. Human digestive enzymes do not digest HMOs, so they pass into the intestines and can show their positive effects there. [11] HMOs strengthen the gastrointestinal barrier [12], in addition, they have been described to promote resistance to colonization by developing and modulating the gut microbiome and, due to their similarity to mucosal glycogenes, possibly acting as soluble decoy receptors in the gut. [13]

One of their positive actions is to promote the growth of Bifidobacterium - intestinal bacteria that compete with pathogens, thus reducing the development of infections. [14] Roger, L. C et al. described that the number and diversity of beneficial gut bacteria in children fed breast milk was significantly higher than in those fed modified milk. [15]

The greater amount of bifidobacteria in children's feces may be responsible for the greater production of SIgA antibodies in the gut against pathogens after vaccination. [16]

3.3. Immune cells:

Breast milk contains various types of immune cells, including macrophages [17], T cells [18], neutrophils, dendritic cells and natural killer (NK) cells, which help fight infection. These cells work by recognizing and eliminating infected cells. They protect the child's body through various mechanisms, including phagocytosing pathogens and dead cells, cleansing the body, presenting and destroying pathogens. [19]

3.4. Growth factors:

Breast milk also contains growth factors that, among other things, help with tissue regeneration and wound healing, which is important for the baby's overall health. Among these components are epidermal growth factor (EGF); heparin-binding EGF-like growth factor (HB-EGF); insulin-like growth factor (IGF-1 and IGF-2); vascular endothelial growth factor (VEGF); and granulocyte colony-stimulating growth factor (G-CSF). [20]

They perform many important functions for the developing organism:

- accelerate cell proliferation (EGF, HB-EGF, IGF-1, G-CSF)
- enhance regeneration after injury (EGF, HB-EGF)
- act on inflammation (HB-EGF)
- reduce cell apoptosis (HB-EGF, IGF-1, IGF-2)
- reduce the production of oxygen free radicals (HB-EGF) [21].
- regulate fetal growth and organ development (IGF-1, VEGF [22])
- regulate vascular angiogenesis (VEGF).

3.5. Fatty acids:

Breast milk contains 3.5% to 4.5% fatty acids, this depends on the lactation period, as they are the most variable component of milk. 33% of total fatty acids is oleic acid, 26% is palmitic acid, about 10% is linoleic acid and about 9% is lauric acid. [23]

Lipids provide the young body with energy, fat-soluble vitamins and important bioactive components. Polyunsaturated fatty acids promote brain development and have an anti-inflammatory effect, supporting the child's immunity. [24]

4. Additional long-term effects of breastfeeding:

4.1. Health benefits for the child:

Stronger immune system - the components of breast milk described above support the development of a baby's immunity. Acquiring it in the first moments of life is of great importance for the body for the rest of its life. In addition, breastfed babies are more exposed to pathogens, which stimulates their immune system to activate. Natural exposure to microorganisms in the first months of life is crucial for learning the immune system. [25]

Better neurological development: Studies show that breastfed babies have better scores on intelligence tests [26] and show higher cognitive skills later in life [27] [28]. Docosahexaenoic acid (DHA), which is found in breast milk, supports brain development. [29]

Breastfeeding therefore has a positive impact on the child's subsequent intellectual development. [30]

Lower risk of obesity [27] and heart disease: Breastfeeding reduces the risk of obesity [31] in childhood and later life, and protects against cardiovascular disease in adulthood.

There is also ongoing debate about the impact of breastfeeding in preventing allergies. [32]

4.2. Health benefits for the mother:

Breastfeeding reduces the risk of breast [33] and ovarian [5] cancers. The longer a mother breastfeeds, the lower the risk.

Mental and emotional benefits: Breastfeeding can also have a positive impact on a mother's mental health. It increases a sense of fulfillment, reduces stress and the risk of postpartum depression. [34]

Benefits to the development of the mother-child bond: Breastfeeding supports the development of a strong emotional bond between mother and child, which has long-term effects on the mental health of both parties [35]. Breastfed babies often feel more secure and loved, which can have a positive impact on their emotional and social development.

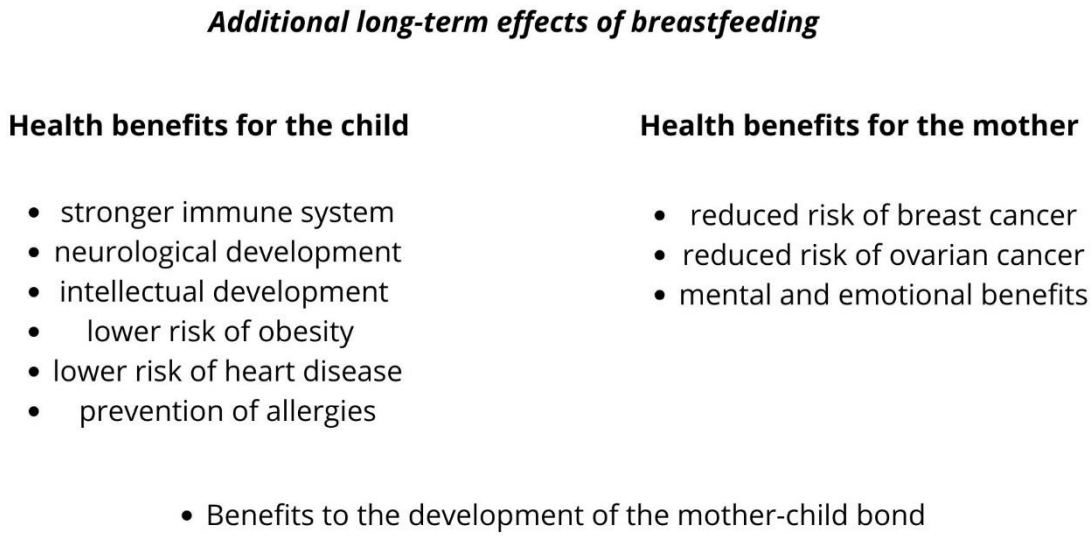

Figure 1. Long-term effects of breastfeeding.

5. Colostrum vs mature milk

The initial nourishment of the baby is colostrum, it is produced after birth in the first 4 days, then there is transitional milk (another 10-15 days). After these 15 days there is a change to mature milk. Milk in these stages differs in composition, color and consistency, colostrum transitioning to mature milk decreases in density and changes in color from slightly yellow. [36] The function of colostrum is not only to provide nutritional value, but primarily to build immunity. Therefore, it contains a lower concentration of lactose [37] and a higher amount of immunoglobulins, growth factors, lipids, proteins, minerals, vitamins [38] and other components that support immune building. [39] Considering these data, it can be seen that the provision of maternal food in these early days is crucial for supporting children's immune defenses.[40]

6. Conclusion

Breastfeeding has a significant impact on the development and functioning of infants' immune systems. Thanks to the unique composition of breast milk, breastfed babies gain natural protection against infections and support for long-term health. The main ingredient in the milk is immunoglobulins, transmitting passive immunity from the mother. Another component is oligosaccharides, whose functions include strengthening the gastrointestinal barrier, supporting the growth of intestinal bacteria and reducing the development of infections. Also included in the milk are immune cells, growth factors, fatty acids and other less significant components for immune development. Other long-term effects of breastfeeding have also been described. It is also worth remembering that the most immune-supporting components for a baby are contained in colostrum, the milk in the first days of breastfeeding. The immune mechanisms associated with breastfeeding underscore its importance not only in the first months of life, but also in terms of health in later life.

Authors' contributions:
All authors contributed to the article: conceptualization: KZ, methodology: AS, DP, EH software: WS, PP, MZ, KZ , check: AS, DP, formal analysis: DP, EH, investigation: KZ, WS, MZ resources: PP, MZ, data curation: WS, PP, writing - rough preparation: KZ, WS, writing - review and editing: PP, MZ, DP, EH visualization: KZ. supervision: WS ; project administration: MZ. All authors have read and agreed with the published version of the manuscript.

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References:

1. Brink, L. R., Mercer, K. E., Piccolo, B. D., i wsp. (2020). Neonatal diet alters fecal microbiota and metabolome profiles at different ages in infants fed breast milk or formula. *The American journal of clinical nutrition*, *111*(6), 1190–1202. https://doi.org/10.1093/ajcn/nqaa076
2. https://www.who.int/health-topics/breastfeeding#tab=tab_2
3. Pillay, J., & Davis, T. J. (2023). Physiology, Lactation. In *StatPearls*. StatPearls Publishing.
4. Shah, R., Sabir, S., & Alhawaj, A. F. (2022). Physiology, Breast Milk. In *StatPearls*. StatPearls Publishing.
5. Jans, S., Westra, X., Crone, M., i wsp. (2023). Long-term cost savings with Centering-based group antenatal care. *Midwifery*, *126*, 103829. https://doi.org/10.1016/j.midw.2023.103829
6. Del Ciampo, L. A., & Del Ciampo, I. R. L. (2018). Breastfeeding and the Benefits of Lactation for Women's Health. Aleitamento materno e seus benefícios para a saúde da mulher. *Revista brasileira de ginecologia e obstetricia : revista da Federacao Brasileira das Sociedades de Ginecologia e Obstetricia*, *40*(6), 354–359. https://doi.org/10.1055/s-0038-1657766
7. Hurley, W. L., & Theil, P. K. (2011). Perspectives on immunoglobulins in colostrum and milk. *Nutrients*, *3*(4), 442–474. https://doi.org/10.3390/nu3040442

8. Drugs and Lactation Database (LactMed®) [Internet]. Bethesda (MD): National Institute of Child Health and Human Development; 2006-. Szczepionki przeciwko COVID-19. [Aktualizacja 2024 15 grudnia]. https://www.ncbi.nlm.nih.gov/books/NBK565969/
9. van Keulen, B. J., Romijn, M., Bondt, A., i wsp. (2021). Human Milk from Previously COVID-19-Infected Mothers: The Effect of Pasteurization on Specific Antibodies and Neutralization Capacity. *Nutrients*, *13*(5), 1645. https://doi.org/10.3390/nu13051645
10. Boulangé, C. L., Pedersen, H. K., Martin, F. P., i wsp. (2023). An Extensively Hydrolyzed Formula Supplemented with Two Human Milk Oligosaccharides Modifies the Fecal Microbiome and Metabolome in Infants with Cow's Milk Protein Allergy. *International journal of molecular sciences*, *24*(14), 11422. https://doi.org/10.3390/ijms241411422
11. Henrick, B. M., Rodriguez, L., Lakshmikanth, T., i wsp. (2021). Bifidobacteria-mediated immune system imprinting early in life. *Cell*, *184*(15), 3884–3898.e11. https://doi.org/10.1016/j.cell.2021.05.030
12. Parschat, K., Melsaether, C., Jäpelt, K. R., i wsp. (2021). Clinical Evaluation of 16-Week Supplementation with 5HMO-Mix in Healthy-Term Human Infants to Determine Tolerability, Safety, and Effect on Growth. *Nutrients*, *13*(8), 2871. https://doi.org/10.3390/nu13082871
13. Berger, B., Porta, N., Foata, F., i wsp. (2020). Linking Human Milk Oligosaccharides, Infant Fecal Community Types, and Later Risk To Require Antibiotics. *mBio*, *11*(2), e03196-19. https://doi.org/10.1128/mBio.03196-19
14. Newburg, D. S., Ruiz-Palacios, G. M., & Morrow, A. L. (2005). Human milk glycans protect infants against enteric pathogens. *Annual review of nutrition*, *25*, 37–58. https://doi.org/10.1146/annurev.nutr.25.050304.092553
15. Roger, L. C., Costabile, A., Holland, D. T., i wsp. (2010). Examination of faecal Bifidobacterium populations in breast- and formula-fed infants during the first 18 months of life. *Microbiology (Reading, England)*, *156*(Pt 11), 3329–3341. https://doi.org/10.1099/mic.0.043224-0
16. Béghin, L., Tims, S., Roelofs, M., i wsp. (2021). Fermented infant formula (with Bifidobacterium breve C50 and Streptococcus thermophilus O65) with prebiotic oligosaccharides is safe and modulates the gut microbiota towards a microbiota closer to that of breastfed infants. *Clinical nutrition (Edinburgh, Scotland)*, *40*(3), 778–787. https://doi.org/10.1016/j.clnu.2020.07.024
17. Ichikawa, M., Sugita, M., Takahashi, M., i wsp. (2003). Breast milk macrophages spontaneously produce granulocyte-macrophage colony-stimulating factor and differentiate into dendritic cells in the presence of exogenous interleukin-4 alone. *Immunology*, *108*(2), 189–195. https://doi.org/10.1046/j.1365-2567.2003.01572.x
18. Ahlberg, E., Martí, M., Govindaraj, D., i wsp. (2023). Immune-related microRNAs in breast milk and their relation to regulatory T cells in breastfed children. *Pediatric allergy and immunology : official publication of the European Society of Pediatric Allergy and Immunology*, *34*(4), e13952. https://doi.org/10.1111/pai.13952
19. Andersson, Y., Hammarstrom, M. L., Lonnerdal, B., i wsp. (2009). Formula feeding skews immune cell composition toward adaptive immunity compared to breastfeeding. The Journal of Immunology, 183(7), 4322-4328.

20. York, D. J., Smazal, A. L., Robinson, D. T., i wsp. (2021). Human Milk Growth Factors and Their Role in NEC Prevention: A Narrative Review. *Nutrients*, *13*(11), 3751. https://doi.org/10.3390/nu13113751
21. Kuhn, M. A., Xia, G., Mehta, V. B., i wsp. (2002). Heparin-binding EGF-like growth factor (HB-EGF) decreases oxygen free radical production in vitro and in vivo. *Antioxidants & redox signaling*, *4*(4), 639–646. https://doi.org/10.1089/15230860260220148
22. Conbercept. (2021). In *Drugs and Lactation Database (LactMed®)*. National Institute of Child Health and Human Development.
23. Khor, G. L., Tan, S. S., Stoutjesdijk, E., i wsp. (2020). Temporal Changes in Breast Milk Fatty Acids Contents: A Case Study of Malay Breastfeeding Women. *Nutrients*, *13*(1), 101. https://doi.org/10.3390/nu13010101
24. German, J. B., & Dillard, C. J. (2010). Saturated fats: a perspective from lactation and milk composition. *Lipids*, *45*(10), 915–923. https://doi.org/10.1007/s11745-010-3445-9
25. Martín-Álvarez, E., Diaz-Castro, J., Peña-Caballero, M., i wsp. (2020). Oropharyngeal Colostrum Positively Modulates the Inflammatory Response in Preterm Neonates. *Nutrients*, *12*(2), 413. https://doi.org/10.3390/nu12020413
26. Plunkett, B. A., Mele, L., Casey, B. M., i wsp. (2021). Association of Breastfeeding and Child IQ Score at Age 5 Years. *Obstetrics and gynecology*, *137*(4), 561–570. https://doi.org/10.1097/AOG.0000000000004314
27. Lin, Y. H., Hsu, Y. C., Lin, M. C., i wsp. (2020). The association of macronutrients in human milk with the growth of preterm infants. *PloS one*, *15*(3), e0230800. https://doi.org/10.1371/journal.pone.0230800
28. Nieto-Ruiz, A., Diéguez, E., Sepúlveda-Valbuena, N., i wsp. (2020). Wpływ funkcjonalnej mieszanki dla niemowląt wzbogaconej w składniki odżywcze na rozwój języka u zdrowych dzieci w wieku czterech lat. *Składniki odżywcze* , *12* (2), 535. https://doi.org/10.3390/nu12020535
29. Basak, S., Mallick, R., & Duttaroy, A. K. (2020). Maternal Docosahexaenoic Acid Status during Pregnancy and Its Impact on Infant Neurodevelopment. *Nutrients*, *12*(12), 3615. https://doi.org/10.3390/nu12123615
30. Onyango, S., Kimani-Murage, E., Kitsao-Wekulo, P., i wsp. (2022). Associations between exclusive breastfeeding duration and children's developmental outcomes: Evidence from Siaya county, Kenya. *PloS one*, *17*(3), e0265366. https://doi.org/10.1371/journal.pone.0265366
31. Chatmethakul, T., Schmelzel, M. L., Johnson, K. J., i wsp. (2022). Postnatal Leptin Levels Correlate with Breast Milk Leptin Content in Infants Born before 32 Weeks Gestation. *Nutrients*, *14*(24), 5224. https://doi.org/10.3390/nu14245224
32. Mennini, M., Arasi, S., & Fiocchi, AG (2021). Zapobieganie alergii poprzez karmienie piersią. *Aktualna opinia w dziedzinie alergii i immunologii klinicznej* , *21* (2), 216–221. https://doi.org/10.1097/ACI.0000000000000718
33. National Guideline Alliance (UK). (2021). *Tools for predicting breastfeeding difficulties: Postnatal care*. National Institute for Health and Care Excellence (NICE).

34. Franco-Antonio, C., Santano-Mogena, E., Chimento-Díaz, S., i wsp. (2022). A randomised controlled trial evaluating the effect of a brief motivational intervention to promote breastfeeding in postpartum depression. *Scientific reports*, *12*(1), 373. https://doi.org/10.1038/s41598-021-04338-w
35. Kalarikkal, S. M., & Pfleghaar, J. L. (2023). Breastfeeding. In *StatPearls*. StatPearls Publishing.
36. Yimer, NB i Liben, ML (2018). Wpływ dostawy do domu na praktyki unikania siary w strefie North Wollo, środowisku miejskim, Etiopia: badanie przekrojowe. *Journal of health, population, and nutrition* , *37* (1), 4. https://doi.org/10.1186/s41043-018-0134-4
37. Kulski, JK, & Hartmann, PE (1981). Zmiany składu mleka ludzkiego w trakcie inicjacji laktacji. *The Australian journal of experimental biology and medical science* , *59* (1), 101–114. https://doi.org/10.1038/icb.1981.6
38. Duman, H., & Karav, S. (2023). Bovine colostrum and its potential contributions for treatment and prevention of COVID-19. *Frontiers in immunology*, *14*, 1214514. https://doi.org/10.3389/fimmu.2023.1214514
39. Durkalec-Michalski, K., Główka, N., Podgórski, T., i wsp. (2024). Does *Colostrum Bovinum* Supplementation Affect Swimming Performance in Endurance-Trained Males? A Randomized Placebo-Controlled Crossover Study. *Nutrients*, *16*(18), 3204. https://doi.org/10.3390/nu16183204
40. Playford, RJ i Weiser, MJ (2021). Siara bydlęca: jej składniki i zastosowania. *Składniki odżywcze* , *13* (1), 265. https://doi.org/10.3390/nu13010265