Stecko Monika Joanna, Korabiusz Katarzyna, Wawryków Agata, Fabian Danielewska Anna, Maciejewska Martyna, Janik Fuks Inga, Wilczyńska Agnieszka, Kordek Agnieszka. Infant microbiome and factors determining colonization of the gastrointestinal tract and subsequent health consequences. Journal of Education, Health and Sport. 2019;9(6):313-318. eISNN 2391-8306. DOI http://dx.doi.org/10.5281/zenodo.3247260
http://ojs.ukw.edu.pl/index.php/johs/article/view/7031

The journal has had 7 points in Ministry of Science and Higher Education parametric evaluation. Part B item 1223 (26/01/2017).
1223 Journal of Education, Health and Sport eISSN 2391-8306 7

The authors declare that there is no conflict of interests regarding the publication of this paper.

Received: 05.05.2019. Revised: 25.05.2019. Accepted: 17.06.2019.

Infant microbiome and factors determining colonization of the gastrointestinal tract and subsequent health consequences

Name	Monika Joanna Stecko
ORCID iD	http://orcid.org/0000-0003-2685-359X
URL	https://orcid.org/0000-0003-2685-359X
Affiliation	Pomeranian Medical University in Szczecin, Doctoral Study of the Faculty of Health Sciences, Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Principal contact for editorial correspondence.

Name	Katarzyna Korabiusz
ORCID iD	http://orcid.org/0000-0003-4512-7550
URL	https://orcid.org/0000-0003-4512-7550
Affiliation	Pomeranian Medical University in Szczecin, Doctoral Study of the Faculty of Health Sciences, Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Name	Agata Wawryków
ORCID iD	http://orcid.org/0000-0003-0517-5857
URL	https://orcid.org/0000-0003-0517-5857
Affiliation	Pomeranian Medical University in Szczecin, Doctoral Study of the Faculty of Health Sciences, Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Name	Anna Fabian Danielewska
ORCID iD	http://orcid.org/0000-0003-1290-4608
URL	https://orcid.org/0000-0003-1290-4608
Affiliation	Pomeranian University of Medical Science, Doctoral Study of the Faculty of Medicine, ul. Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Name	Martyna Maciejewska
ORCID iD	http://orcid.org/0000-0002-2017-5196
URL	https://orcid.org/0000-0002-2017-5196
Affiliation	Pomeranian Medical University in Szczecin, Doctoral Study of the Faculty of Health Sciences, Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Name	Inga Janik Fuks
ORCID iD	http://orcid.org/0000-0002-4238-0465
URL	https://orcid.org/0000-0002-4238-0465
Affiliation	Pomeranian Medical University in Szczecin, Doctoral Study of the Faculty of Health Sciences, Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Name	Agnieszka Wilczyńska
ORCID iD	http://orcid.org/0000-0002-1042-2376
URL	https://orcid.org/0000-0002-1042-2376
Affiliation	Pomeranian Medical University in Szczecin, Doctoral Study of the Faculty of Health Sciences, Żołnierska 54, 71-210 Szczecin
Country	Poland
Bio Statement	—

Name	Agnieszka Kordek
ORCID iD	http://orcid.org/0000-0002-2881-9769
URL	http://orcid.org/0000-0002-2881-9769
Affiliation	Pomeranian University of Medical Science Neonatal Patology Clinic, Aleja Powstańców Wielkopolskich 72, 70-111 Szczecin
Country	Poland
Bio Statement	—

ABSTRACT

Microbiome is a key element in maintaining health, forming all saprophytic, commensal and parasitic microorganisms that invade the human body [1]. The development of microbiota begins already in the prenatal period, providing the way for further studies on the influence of the course and duration of pregnancy, delivery mode, feeding, exposure to environmental factors and gestational age [1,2]. Colonization of the gastrointestinal tract of infants is an important aspect of later health [1]. Probiotics and prebiotics can regulate the composition of bacterial flora of the gastrointestinal tract and thus influence the homeostasis of human body [1].

KEYWORDS: microbiome, intestinal microbiota, gastrointestinal colonization

INFANT MICROBIOME

Microbiome represents a collection of all microorganisms living in a specific environment (human organism, host), i.e. bacteria, fungi, viruses and archaea, while the term "microbiome" indicates a collection of their genomes [1,2]. The development of microbiota begins already in the prenatal period, providing the way for further studies on the influence of the course and duration of pregnancy, delivery mode, feeding and exposure to environmental factors [3].

Until recently, it was believed that the gastrointestinal tract of a healthy infant is sterile [4]. However, there are reports that the intrauterine environment is not sterile – bacteria were found in the amniotic fluid, fetal membranes and placenta [5, 6]. Jimenez et al. confirmed the presence of marked DNA of bacteria previously administered to the mother in the neonates of mouse meconium [7].

Therefore, already intrauterine the man has to deal with stimulation of the immune system with antigens from the bacteria originating from the mother [4].

KEY ELEMENTS IN THE DEVELOPMENT OF MICROFLORA IN INFANTS

One of the key factors influencing colonization is the birth type, feeding method, use of drugs, especially antibiotics. [8,9] . After childbirth, the immune system of infants and newborns has to face pathogenic pathogens and gain tolerance to food [4]. This is a crucial time for the proper colonization of microorganisms in the intestine and translates into many aspects, including the development of immune tolerance, angiogenesis and stress response [10,11,12,13]. The delivery method affects the type and number of bacteria acquired by a newborn baby. During natural childbirth a newborn baby comes into contact with the bacterial flora of the vagina and gastrointestinal tract of the mother, the dominant flora are: *Lactobacillus, Prevotella, Escherichia, Enterococcus, Bacteroides* and *Bifidobacterium* [4, 10 , 14, 15, 16].

Neonates born by cesarean section are colonized by fewer bacteria [4]. The sterile environment of the operating room, which the child encounters during childbirth by cesarean section, deprives the child of contact with the mother's natural microflora [4]. This causes colonization with bacteria from the hospital environment and from the mother's skin [4, 17]. Gastrointestinal microflora resembles the ecosystem of bacteria on the skin, it contains mainly bacteria of genera: *Staphylococcus, Corynebacterium, Propionibacterium* and *Clostridium* [4]. The basic intestinal flora in infants born by caesarean section may be disturbed for up to 6 months after birth [4,17]. Another equally important factor influencing microorganisms colonizing the gastrointestinal tract of infants is the feeding method [4,17]. The best food for a newborn baby is breast milk, which can be described as a natural synbiotic [4,17].

It contains a number of natural oligosaccharides (prebiotics) that stimulate the growth of healthy lactic acid bacteria in the baby's intestine [8]. Apart from prebiotics, there are also strains of *Bifidobacterium* and *Lactobacillus* (probiotics), which colonize the gastrointestinal tract of infants and have a beneficial effect on their health [18]. In breastfed children, the number of Bifidobacterium increases rapidly, which become the dominant flora and may constitute up to 60-90% of the bacteria in stool [4]. Fermentation products of these bacteria protect the digestive tract against pathogenic strains of E. coli and C. perfringens [9, 19, 20]. It should also be noted that the use of antibiotics has a catastrophic effect on intestinal microbiota [4]. Treatment with broad spectrum antibiotics contributes to a significant decrease in the number of Bifidobacterium and Bacteroides with simultaneous competitive Firmicutes increase

[4,17]. The reconstruction of bacterial flora of the gastrointestinal tract after antibiotic treatment may take up to 6-10 months [18].

MICROBIOTA AND THE IMMUNE RESPONSE OF THE ORGANISM

Intestinal microbiota has a significant role in the development and efficient functioning of the immune response of the organism and the nervous system, as well as in the regulation of metabolic
and digestive system functions [19/20]. The proper composition of bacterial flora determines the proper functioning of the whole organism. The intestinal microbiota of a healthy child is formed up to the age of 3 years, in the literature the key role of the first 1000 days of a child's life is emphasized [3].

The most important functions of intestinal microorganisms include: stimulation of the immune system development, modulation of genes expression responsible for strengthening the intestinal barrier and angiogenesis, as well as postnatal development and maturation of the gastrointestinal tract [21/22]. The intestinal microflora fulfils many metabolic tasks; it is responsible for the production of vitamins and digestion of carbohydrates, which are not assimilable to humans, to simple sugars and short-chain fatty acids, which are an additional source of energy for the host cells [4]. It is a source of countless antigens constantly stimulating the intestinal immune system, thus supporting the normal development of the intestinal lymphatic system, development and differentiation of NK cells and plasma cells [4]. Plasma cells, located in the lamina propria of intestinal wall, under the influence of the intestinal flora, produce secretory class A immunoglobulin [3/4]. It is a key element of the humoral immunity of gastrointestinal tract and defends the intestinal mucosa against the intrusion of bacteria from the environment [23]. The maintenance of a balance between the intestinal microbiota and the host is of fundamental importance in order to maintain health [4].

Quantitative and qualitative disturbances in the intestinal microflora composition – intestinal dysbiosis – may increase the risk of many diseases, including hospital infections, necrotizing enterocolitis in premature infants, obesity and autoimmune diseases [4]. They are also associated with more frequent occurrence of inflammatory bowel disease, coeliac disease, depression, cancer and others [24, 25, 26, 27].

Colonization of the gastrointestinal tract by non-physiological microorganisms disturbs and delays the maturation of the immune system and causes imbalance between TH1 and TH2 lymphocytes, which is associated with more frequent occurrence of atopic diseases, including atopic dermatitis and asthma [28, 29].

CONCLUSIONS

Intestinal microbiota affects many aspects of human physiology and the incidence of many diseases, not only in the gastrointestinal tract, but also in the systemic system [4]. Bacterial imbalance of the gastrointestinal tract of infants has long-term health effects, because intestinal microflora has a significant role in the development and maturation of the child's immune system [2,4]. Exposure to microorganisms in the earliest period of life is very important in human immunological programming [2,4,17]. Appropriate microbiota is the basis for proper functioning of the organism.

References

1. Bartnicka A., Gałęcka M., Mazela J.: *Influence of prenatal and postnatal factors on intestinal microbiota of infants*. Medical Standards/Pediatrics 2016, 13: 165-172
2. Gregorczyk-Maślanka K., Kurzawa R.: *Microbiota of human organism and its influence on immunological homeostasis – part I.* Allergy Asthma Immunology 2016, 21 (3): 146-150
3. Rakowska M., Lichosik M., Kacik J., Kalicki B.: *Influence of microbiota on human health*. Pediatr. Med. Rodz. 2016, 12 (4): 404-412.
4. Jańczewska I., Domżalska-Popadiuk I.: *Colonization of the gastrointestinal tract of infants and the influence of factors modifying intestinal microbiota on health*. Infection Forum 2016, 7(6): 443-448
5. Jiménez E, Fernández L, Marín ML et al. *Isolation of commensal bacteria from umbilical cord blood of healthy neonates born by cesarean section*. Curr Microbiol 2005;51(4): 270-274.
6. Aagaard K, Ma J, Antony KM, Ganu R, Petrosino J, Versalovic J. *The placenta harbors a unique microbiome*. Sci Transl Med 2014;6(237):237-265.
7. Jiménez E, Marín ML, Martín R et al. *Is meconium from healthy newborns actually sterile?* Res Microbiol 2008;159(3):187-193.
8. Gałęcka M., Bartnicka A., Szewc M., Mazela J.: *Development of intestinal microbiota in infants as a condition of maintaining health*. Medical Standards/Pediatrics 2016;13: 359-367.
9. Penders J, Thijs C, Vink C, Stelma FF, Snijders B, Kummeling I, van den Brandt PA, Stobberingh EE. *Factors influencing the composition of the intestinal microbiota in early infancy*. Pediatrics. 2006;118,2:511-521.
10. Sudo N, Sawamura S, Tanaka K et *al. The requirement of intestinal bacterial flora for the development of an IgE production system fully susceptible to oral tolerance induction*. J Immunol 1997;159:1739-1745.
11. Mazmanian SK, Liu CH, Tzianabos AO et al. *An immunomodulatory molecule of symbiotic bacteria directs maturation of the host immune system*. Cell 2005;15:107-118
12. Stappenbeck TS, Hooper LV, Gordon JI. *Developmental regulation of intestinal angiogenesis by indigenous microbes via Paneth cells*. Proc Natl Acad Sci USA 2002;99:15451-15455.
13. Sudo N, Chida Y, Aiba Y et al. *Postnatal microbial colonization programs the hypothalamic-pituitary-adrenal system for stress response in mice*. J Physiol 2004;558:263-275.
14. Romero R, Hassan SS, Gajer P et al. *The composition and stability of the vaginal microbiota of normal pregnant women is different from that of non-pregnant women*. Microbiome 2014;2(1):4.
15. Aagaard K, Riehle K, Ma J et al. *A metagenomic approach to characterization of the vaginal microbiome signature in pregnancy*. PLoS One 2012;7(6):e36466.
16. Dominguez-Bello MG, Costello EK, Contreras M. *Delivery mode shapes the acquisition and structure of the initial microbiota across multiple body habitats in newborns*. Proc Natl Acad Sci USA 2010;107(26):11971–11975.
17. Witkowska-Wirstlein R., Jurczyk M.: F*actors determining the colonization of gastrointestinal tract of infants*. Polish Review of Health Sciences 2016, 3 (48) : 285-289.
18. Jańczewska I, Domżalska-Popadiuk I. *The importance of bacterial colonization of the gastrointestinal tract of infants born by caesarean section*. Ann Acad Med Gedan 2014;44:99-104.
19. Weng M, Walker WA. *The role of gut microbiota in programming the immune phenotype*. J Dev Orig Health Dis 2013;4(3):203–214.

20. Guaraldi F, Salvatori G. *Effect of breast and formula feeding on gut microbiota shaping in newborns*. Front Cell Infect Microbiol 2012;2:94.
21. Buccigrossi V, Nicastro E, Guarino A. *Functions of intestinal microflora in children*. Curr Opin Gastroenterol 2013;1:31-38.
22. Goulet O. *Potential role of the intestinal microbiota in programming health and disease*. Nutr Rev 2015;73 (Suppl. 1):S32–S40.
23. Forchielli ML, Walker WA. *The role of gut-associated lymphoid tissues and mucosal defence*. Br J Nutr 2005;93 (Suppl. 1):S41–S48.
24. Elgin TG, Kern SL, McElroy SJ. *Development of the neonatal intestinal microbiome and its association with necrotizing enterocolitis*. Clin Ther 2016;38(4):706– 715.
25. Jacob JA. *In infants with necrotizing enterocolitis, gut dysbiosis precedes disease*. JAMA 2016;315(21):2264–2265.
26. Luoto R, Collado MC, Salminen S, Isolauri E. *Reshaping the gut microbiota at an early age: functional impact on obesity risk*. Ann Nutr Metab 2013;63 (Suppl. 2):S17-S26.
27. Houghteling PD, Walker WA. *From birth to "immune health", allergies and enterocolitis*. J Clin Gastroenterol 2015;49 (Suppl. 1):S7-S12.
28. Kero J, Gissler M, Grönlund MM et al. *Mode of delivery and asthma: is there a connection*. Pediatr. Res. 2002; 52(1):6–11.
29. Biasucci G, Rubini M, Riboni S, Morelli L, Bessi E, Retetangos C. *Mode of delivery affects the bacterial community in the newborn gut*. Early Human Dev 2010;86 (Suppl. 1):S13-S15.