Maternal microbial inheritance—benefits of breastfeeding

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UNICEF social media materials for World Breastfeeding Week 2016. Credit: UNICEF/UN026414/

The theme of World Breastfeeding Week 2016 is Breastfeeding: A key to sustainable development. The core message of this year's World Breastfeeding Week is to "learn to value our wellbeing from the beginning of life, and to respect and care for each other in our shared world," consistent with the rhetoric of the United Nations Global Goals. In addition to sharing the world with other humans, we also have mutually beneficial relationships with our microbiota. This human-

microbiota relationship is connected to breastfeeding and the wellbeing of children. In this post, I will review how breastfeeding influences gut microbial ecology and healthy development of infants.

Even though we now hear that breast milk is best for infants, breastfeeding was considered a lower class and uncultured practice in many societies through ancient and modern times. In early history, wet nursing, in which one woman fed another woman's child, was a common practice of infant feeding. Anthropological studies show that many cultures hid or obscured their infant feeding methods. In the early nineteenth century, breastfeeding was viewed negatively by Western cultures, especially in Canada and the United States. Multiple factors have decreased the frequency of breastfeeding, including the invention of feeding bottles, the availability of animal milk, and development of formulas similar to human milk. Today, both breastfeeding and formula feeding are widely practiced throughout the world. Although synthetic formulas are nutritionally similar to breast milk, there are many hidden microbial treasures inside breast milk that are not present in formula.

Transmission of microbial inheritance through breastfeeding

The collection of all the microorganisms living in association with the human body is called the human microbiome, which is acquired both during and after birth. Inside the womb, an infant's gut is almost sterile. Before birth, their gut gradually incorporates different species of bacteria, and trillions of bacteria transfer from mother to child through birth and breastfeeding. In total, the adult human gut harbors up to 100 trillion bacteria belonging to over one thousand species. This huge microbial population inside the human gut maintains a mutualistic relationship with their host throughout their lifespan.

Painting of a woman breastfeeding at home, Netherlands. Credit: Wikimedia Commons

In a *PLOS Biology* essay, Funkhouser and Bordenstein stated that maternal microbial transmission is an important mechanism for genetic and functional change in human evolution. They describe how maternal microbial populations are transmitted from mothers to infants through internal and external processes such as breastfeeding (see figure below.) Previously, milk was considered sterile, and although the origin of milk microbes is still a mystery, the advent of high throughput sequencing technology has enabled scientists to identify a diverse microbial population in breast milk. For example, Hunt et al. published a *PLOS ONE* study describing the bacterial community diversity in human milk. They identified an incredible 100-600 bacterial species in breast milk from 16 healthy women. Interestingly, the bacterial population in breast milk is not constant; rather, it changes over the lactation period.

Health benefits

It is now evident that the human microbiome is passed from one generation to another and contributes to human health. In particular, the breast milk microbiome improves infants' immune system development, prevents the development of allergies and asthma in childhood, provides resistance against infection, helps prevent autoimmune diseases like celiac disease, and reduces one's risk of inflammatory bowel diseases, cardiovascular diseases, obesity, and Type 2 Diabetes in later life. A recent study on metagenomics and host gene expression data set revealed co-expression of more genes associated with immunological, metabolic, and biosynthetic activities in the guts of breastfed infants compared to those who were formula fed. Several scientific studies have demonstrated that the gut microbiota differ significantly between breastfed and formula fed babies, and that formula fed babies are more prone to general infection compared to breastfed infants.

Conclusion

As a method for microbial inheritance, breastfeeding helps to establish a healthy microbial community in an infant's gut. The complex symbiosis between humans and microbes is important for human health, and breastfeeding benefits the health and wellbeing of infants. While breast milk is beneficial to child's health in many ways, it's important to note that formula feeding is not harmful to infants. In many circumstances, formula feeding may be only option for newborn babies. My intention in writing this blog is to explain the benefits of breastfeeding from the perspective of breast milk microbiome, an exciting new area of research.

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