Early-Life Nutrition and Microbiome Development

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Recent reports link clinical conditions, phenotypes alternating from inflammatory bowel disease, obesity, and allergic diseases to neurodevelopmental disorders, to aberrant gut microbiota composition [reviewed in 1]. This has led to a growing interest in host-microbe cross talk, characterizing the healthy microbiome and modifying its deviations at an early age. The rationale arises from the recognition of the intimate interrelationship between diet, immune system and microbiome, and the origins of human disease.

Before satisfactory preventive measures can be put in practice, important questions remain to be solved. First, we need more profound understanding of the complex mechanisms underlying these heterogeneous manifestations of immune-mediated and microbiome-associated chronic conditions. Second, long-term follow-up studies are required to determine whether the changes in the microbiome underlie the pathogenesis of noncommunicable diseases or are merely end results thereof, confronting the question of causality. This uncertainty notwithstanding, the complex and bidirectional interrelationship of the diet and the gut microbiota is becoming evident. Early exposures by the enteral route induce dynamic adaptive modifications in the microbiota composition and activity, which may carry long-term clinical impacts. Microbiota changes, again, control energy acquisition and storage and may contribute to gut immunological milieu; high-energy Western diet alters the microenvironment of the gut leading to propagation of the inflammatory tone and perturbation of gut barrier function and thereby to systemic low-grade inflammation [2, 3].

The cornerstone of prevention of noncommunicable diseases is breastfeeding [4]. Not only does it provide the infant with nutrients, it may also confer immunologic protection at the portal of entry where major load of antigens is encountered, the gut barrier. A delicate balance of stimulatory, even inflammatory, maturational signals, together with a myriad of anti-inflammatory compounds, is transferred from mother to
infant via breastfeeding. Human milk protective compounds also include specific oligosaccharides and fatty acids influencing early microbial colonization and gut barrier adherence of pathogens and other microbes, but also specific microbiota and molecules operating in host-microbe interaction.

Breastfeeding provides several health benefits that are likely to be caused by promotion of age-appropriate and environment-adjusted gut colonization. There is abundant evidence that breast milk complements the microbiota transmission to the infant gut: the mother provides the infant with bifidobacteria, lactic acid bacteria, and other microbiota components in significant quantities during breastfeeding. Several active compounds of breast milk accomplish this progression. However, the microbes and other active compounds in breast milk strongly vary according to the mother’s health and weight gain during pregnancy, and the mode of delivery. In general, the infant’s probability of being colonized by bifidobacteria is lower when the mother has higher BMI, excessive weight gain.

Fig. 1. The progression of gut colonization and the child’s risk of developing noncommunicable diseases. Key risk factors during the perinatal period and infancy include unfavorable nutritional environment during pregnancy, being born preterm or by caesarean section or devoid of important immunomodulatory compounds of breast milk. Resilience to unfavorable changes during this critical period of maturation may be achieved by endorsing breastfeeding and introduction of active protective compounds.
during pregnancy, and the child is delivered via caesarean section, and higher when the mother is of normal weight, has notable bifidobacteria colonization in her own gut and breast milk and is breastfeeding (Fig. 1).

The model of early nutrition for future studies is the healthy breast-fed infant that remains healthy in the long-term. Scientific interest is currently extending from the duration of breastfeeding to the composition of breast milk, and characterization of the key regulatory substances therein. Human milk, rich in bioactive compounds including health-promoting microbes and their optimal growth factors, human milk oligosaccharides, continues to afford tools to study diet-microbiota interactions for research aiming at reducing the risk of noncommunicable diseases.

References