Human Milk Oligosaccharides – The Magic Sugars in Mom's Breastmilk

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Human milk oligosaccharides (HMOs) are complex sugars (carbohydrates) that represent the third most abundant component of human milk after lactose and lipids. More than 150 different and structurally distinct HMOs have been identified so far and accumulating data indicate specific structure-function relationships – in other words: different HMOs have different functions. HMO composition varies between different women and recent research focuses on how fixed and modifiable maternal factors influence HMO variation. Once ingested, HMOs resist degradation and reach the distal parts of the gastrointestinal tract. Here, HMOs serve as natural prebiotics and help shape the infant gut microbiome with immediate and potential long-term consequences for health and development, including infant growth, body composition and potential risk of childhood obesity. However, HMOs are more than just "food for bugs". HMOs serve as antimicrobials and antiadhesives that keep potential pathogens in check. HMOs also have direct effects on epithelial cells as well as on immune cells, both locally in the gastrointestinal tract as well as systemically. Some of the effects of HMOs are highly structure-specific and dose-dependent, suggesting that they interact with specific host and/or microbial receptors. Specific HMOs are required to exert these effects while other, structurally distinct HMOs cannot mimic these effects. Other HMO effects require a particular "mixture" of HMOs with specific ratios of different HMOs to each other. One HMO alone is ineffective; instead a group of different HMOs is required to act together in modulating the composition and activity of microbial communities and/or a complex immune system response. HMOs were first discovered in the mid 1950s and HMO research has come a long way since and has been greatly accelerated over the past few years due to advances in analytical technologies as well as in methods to generate individual HMOs at large scale for research and application. However, we are still at the very beginning of uncovering the complexity of HMOs and understanding their full potential in influencing immediate and long-term infant health and development.