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Early-life microbiota as a key modulator of immune development: Insights into microbial metabolites, maternal virome, and probiotics

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Background: The early-life gut microbiota is essential for immune system maturation and metabolic stability. While maternal microbial transfer, diet, and environmental factors shape neonatal microbiota composition, emerging evidence highlights novel regulatory mechanisms, including microbial metabolites, maternal virome influences, and multi-strain probiotic interventions. This abstract presents key findings on these factors and their role in immune modulation.

Methods: A structured literature review was conducted, examining recent peer-reviewed studies on microbiota-immune system interactions. The analysis focused on: 1. The immunoregulatory role of microbial metabolites beyond short-chain fatty acids (SCFAs), 2. The impact of maternal gut bacteriophages on neonatal microbial stability, and 3. The effectiveness of multi-strain probiotics in enhancing immune resilience.

Results: 1. Microbial Metabolites as Immune Modulators: a. Beyond SCFAs, tryptophan-derived indole-3-propionic acid (IPA) is produced by Clostridia and Bifidobacterium, playing a critical role in immune homeostasis. b. IPA interacts with the aryl hydrocarbon receptor (AhR), modulating antigen processing and reducing inflammation. 2. Maternal Virome's Role in Neonatal Microbiota Stability: a. Maternal gut bacteriophages regulate neonatal microbiota composition by controlling Proteobacteria overgrowth, reducing inflammatory risk. b. Understanding these virome-host interactions may lead to microbiome-targeted immune interventions. 3. Multi-Strain Probiotics and Immune Optimization: a. Multi-strain probiotics with Faecalibacterium prausnitzii, Bifidobacterium breve, and Akkermansia muciniphila enhance immune tolerance and gut barrier function. b. Combining Akkermansia muciniphila with human milk oligosaccharides (HMOs) presents a promising

Conclusion: These findings highlight emerging microbiota-mediated pathways influencing immune development. Further clinical research is necessary to translate these insights into microbiome-based therapeutic strategies.

Biography

Arzoo Pir Mohammad is a dedicated medical professional with an MD from Kabul University of Medical Sciences. She combines extensive clinical knowledge with a patient-centered approach and is currently preparing for medical board examinations. Passionate about advancing healthcare quality, she aims to contribute meaningfully to global medicine and patient care.

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