Maternal Complex Carbohydrates Diet Enhances Taxonomic Diversity and Metabolic Activities of the Microbiome in Gestational Diabetes and in Their Infants

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Introduction:

•Backgroud:

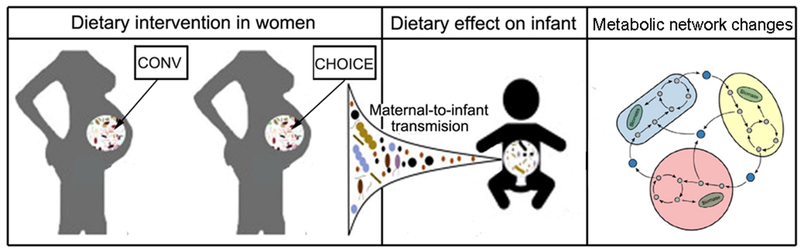
- Gestational diabetes mellitus (GDM) is a common pregnancy complication associated with significant imbalances in the intestinal microbiome, potentially leading to pathological conditions in both mothers and infants.
- Diet is the primary treatment for GDM, yet the impact of maternal diet therapy on the maternal and infant microbiome and the potential long-term consequences are not well-understood.

•Hypothesis:

Dietary interventions in mothers with GDM can significantly alter the taxonomic composition and metabolic capacity of both maternal and infant gut microbiomes, which in turn could influence health outcomes for both mother and infant.

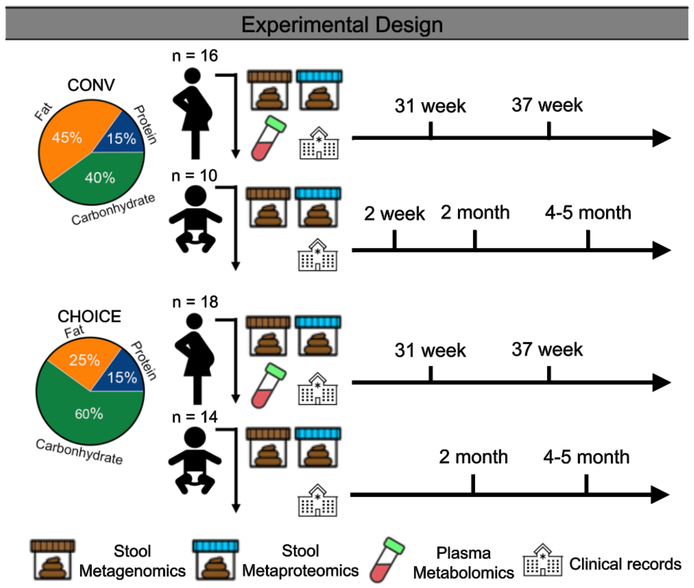
•Proposed Solution:

We conducted a comprehensive evaluation of the taxonomic composition and metabolic capacity of maternal and infant gut microbiomes. This study aims to ascertain the effects of dietary intervention on microbial function and subsequently, maternal and infant health outcomes, providing a clearer understanding of the interplay between diet, microbiome, and gestational diabetes.



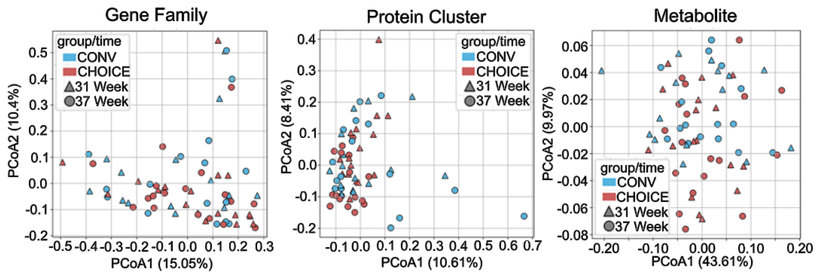
Overview of study design and key hypothesis

Study Design:



Diet and time shift profiles

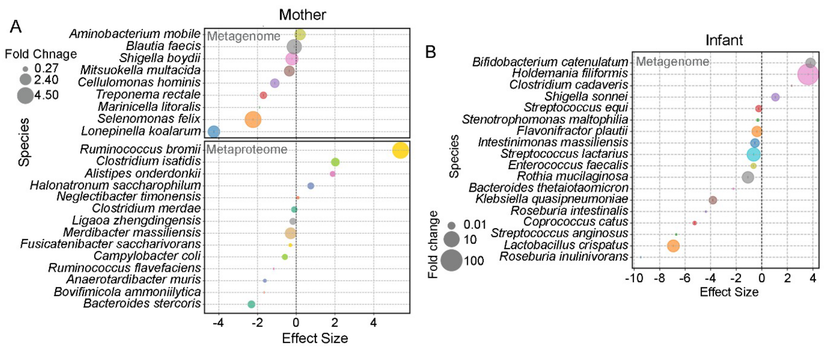
Principal coordinate analyses (PCoA) of gene family, protein cluster, and metabolite profiles reveal distinct clustering patterns between CONV and CHOICE groups, with additional separation over time (31 vs. 37 weeks). These shifts suggest coordinated diet- and age-dependent changes in microbial composition and functional potential, highlighting consistent group-specific divergence across multiple molecular layers.



Principal coordinate analyses (PCoA) of microbiome profiles across omics layers. (A) Gene family composition, (B) protein cluster abundance, and (C) metabolite profiles were analyzed for CONV and CHOICE groups at 31 weeks and 37 weeks.

Species Composition Changes

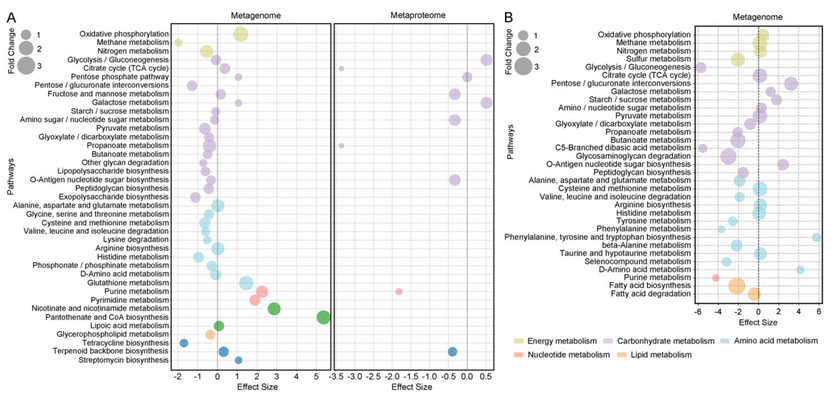
Metagenomic and metaproteomic analyses revealed distinct species-level changes in the microbiomes of mothers and infants. In mothers, both compositional and proteomic shifts were observed, with enrichment of *Aminobacterium mobile*, *Blautia faecis,* and *Ruminococcus bromii*, and depletion of *Shigella boydii* and *Clostridium merdae*. Infant microbiomes showed significant metagenomic changes, including a dramatic increase in *Bifidobacterium catenulatum*, but minimal proteomic alterations, suggesting early microbial colonization occurs ahead of functional maturation..



Species Composition Changes in the Microbiomes of Mother and Infant. (A) the species composition changes in the mother's microbiome at the metagenomic and metaproteomic levels. (B) Species composition changes in the infant's microbiome at the metagenomic level.

Microbial Functional Pathway Shifts

Metagenomic and metaproteomic analyses revealed distinct microbial metabolic shifts in mothers and infants. Mothers showed enrichment of energy, carbohydrate, and amino acid metabolism pathways at both DNA and protein levels, with oxidative phosphorylation notably active. In contrast, infants exhibited significant metagenomic enrichment in similar pathways, but no corresponding metaproteomic changes, indicating functional immaturity and a developmental lag in microbial expression.



Changes in Functional Metabolic Pathways in the Microbiomes of Mother and Infant. (A) Metagenomic and metaproteomic analyses of the mother's microbiome. (B) Metagenomic analysis of the infant's microbiome

Summary

Integrated metagenomic, metaproteomic, and metabolomic analyses reveal distinct microbiome development in mothers and infants: mothers show coordinated shifts in microbial composition and metabolic function, while infants show strong genomic enrichment, particularly in carbohydrate-related pathways and key species like Bifidobacterium, but limited proteomic activity, reflecting early functional maturation.

Acknowledgment:

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Learn more (and download data & code) via:
https://github.com/dywang0323/CHOICE

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