The Association Between Infant Gut Microbiome, Diet, and Mental Health Symptoms in Early Childhood

Tu, E[1,2], Campisi, S.C. [1,3], Dai, D.L.Y.[8], Peterson, C.[8], Simons, E.[4], Mandhane, P.[5,6], Turvey, S. E.[8], Moraes, T.[7], Subbarao, P.J.[7,9], & Korczak, D.J.[1,10]

[1] Department of Psychiatry, Hospital for Sick Children; [2] Department of Psychology, York University; [3] Dalla Lana School of Public Health, University of Toronto; [4] Department of Pediatrics and Child Health, University of Manitoba and Children's Hospital Research Institute of Manitoba; [5] Department of Pediatrics, University of Alberta; [6] Faculty of Medicine, UCSI University; [7] Department of Pediatrics, Hospital for Sick Children; [8] Department of Pediatrics, British Columbia Children's Hospital, [9] Department of Medicine, McMaster University; [10] Department of Psychiatry, Temerty Faculty of Medicine

Background

- The gut microbiome has been implicated in the development of mental health symptoms via the gut-brain axis.[1,2]
- Early childhood is a sensitive period during which diet strongly shapes microbiome development.[3,4]
- Prospective studies using species-level metagenomic sequencing are needed to clarify whether early microbial profiles are associated with later mental health symptoms and whether dietary patterns modify these relationships.

Objectives

1) Examine associations between the infant gut microbiome at 1 year and internalizing/externalizing symptoms at age 5.
2) Explore whether dietary patterns at age 3 modify these associations.

Method

Study Sample

CHILD Cohort (n = 1,182 children, 54.3% male)

- Covariates included child age, sex, race, household income, maternal depressive symptoms, and study site.

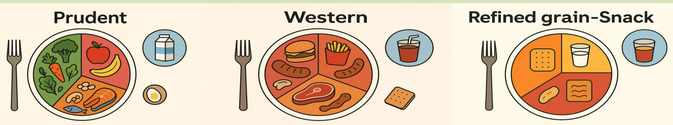
Procedure & Measures

Age 1

Shotgun Metagenomic Sequencing (MetaPhlAn4)

Age 3

Dietary Pattern (from PCA)



Prudent	Western	Refined grain-Snack
High in vegetables, fruits, legumes, eggs, and fish	High in fast foods, meats, and sugar-sweetened beverages	High in refined grains, dairy, and salty snacks

Age 5

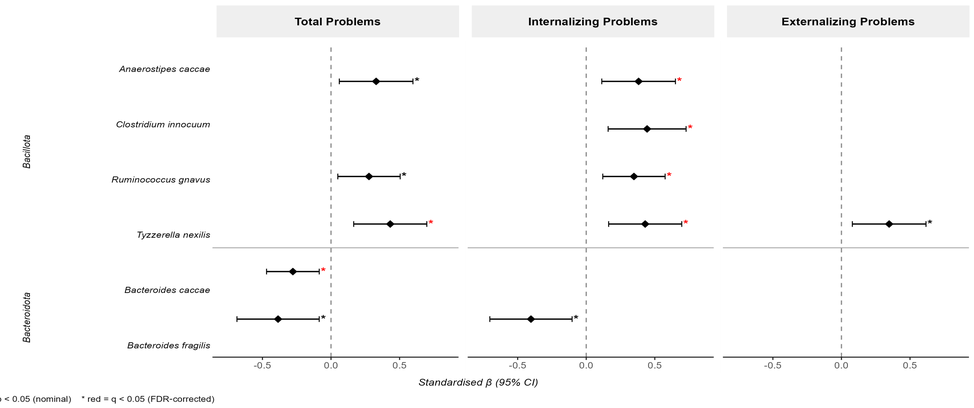
Mental Health Symptoms - Child Behavior Checklist (CBCL)

Total Problems	Internalizing Problems	Externalizing Problems
Overall emotional and behavioural difficulties score.	Anxiety, depression, withdrawal, and somatic subscales.	Aggression, impulsivity, and attention subscales.

Species-level differences in infant gut microbiome were associated with later **emotional and behavioural symptoms**; one association may be shaped by a **prudent diet in early childhood**.

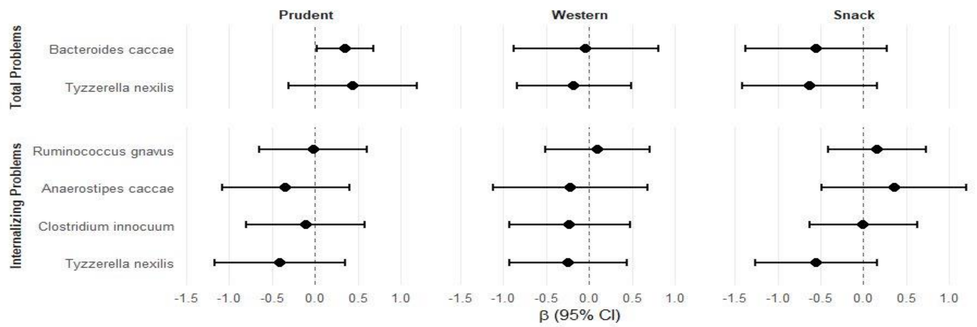
Results

Figure 1.
Forest plots display associations between Gut Microbial Taxa and Total, Internalizing and Externalizing Symptoms.



* p < 0.05 (nominal) * red = q < 0.05 (FDR-corrected)

Figure 2. Forest plots display associations between Gut Microbial Taxa and Total and Internalizing Problems moderated by Prudent, Western and Snack Dietary Patterns.

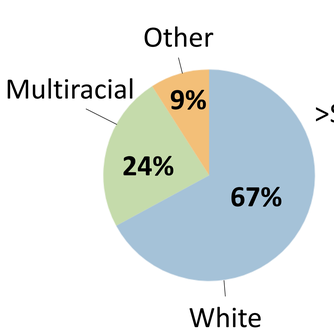


Participant Characteristics

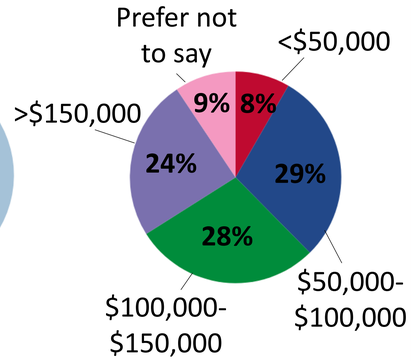
Table 1.
Mean and Standard Deviations of Mental Health Outcomes

Variable	*M*	*SD*	*R*
Mental Health Symptoms at 5 Years			
CBCL, Total Problems Score	41.1	8.9	[29, 77]
CBCL, Internalizing Problems Score	44.3	9.0	[33, 74]
CBCL, Externalizing Problems Score	39.6	9.4	[28, 79]

Child Ethnicity



Household Income (CAD)



Conclusions

- Species-level microbiome composition may be more relevant to early MH symptom expression than overall microbial diversity.
- A prudent diet modified the association between specific microbiota in infancy and overall emotional/behavioural symptoms at age 5 years.
- Future research examining the gut-brain axis in older children and clinical samples is needed.

Acknowledgements

We are grateful to all the families who took part in this study and the interviewers, nurses, computer and laboratory technicians, clerical workers, research scientists, volunteers, managers, and receptionists of the CHILD team.

References

1. Marx W, Lane M, Hockey M, et al. Diet and depression: exploring the biological mechanisms of action. Mol Psychiatry 2021;26:134-150.
2. Srivastava R, Gupta MK. Gut bacteria-derived metabolites and their implications in mental health and neurological diseases. World J Microbiol Biotechnol 2025;41:423
3. Stewart CJ, Ajami NJ, O'Brien JL, et al. Temporal development of the gut microbiome in early childhood from the TEDDY study. Nature 2018;562:583-588 .
4. Ross FC, Patangia D, Grimaud G, et al. The interplay between diet and the gut microbiome: implications for health and disease. Nature Reviews Microbiology 2024;22:671-686.