Breastfeeding limits the adverse impact of socioeconomic status on child health by modifying the infant gut microbiome

Darlene L.Y. Dai, Melissa B. Manus, Courtney Hoskinson, Jie Jiang, Hind Sbihi, Kozeta Miliku, Susan C. Campisi,, Daphne J. Korczak, Qingling Duan, Theo J. Moraes, Piushkumar J. Mandhane, B. Brett Finlay, Elinor Simons, Hannah Lishman, David M. Patrick, Padmaja Subbarao, Meghan B. Azad, Bo Chawes, Klaus Bønnelykke, Søren Johannes Sørensen, Jonathan Thorsen, Jakob Stokholm, Charisse Petersen, Stuart E. Turvey

Background

Lower familial socioeconomic status (SES) is linked to increased childhood disease risk. Since SES has no inherent biological basis, identifying how it becomes physiologically embedded is essential for equitable intervention.

Goal

This study aims to evaluate how familial SES associates with perinatal factors and quantify associations between SES, infant microbiota, and subsequent child health outcomes.

Methods

- We harnessed the Canadian CHILD cohort to interrogate associations between familial SES, perinatal factors, and child health outcomes using regression models (Figure 1).
- In a subset, associations between infant microbiota and SES, perinatal factors, and health outcomes were evaluated using longitudinal linear mixed-effects models and structural equation models (SEM).
- Furthermore, key associations were replicated in the independent $COPSAC_{2010}$ cohort from Denmark, reinforcing links among SES, breastfeeding, infant microbiome, and child health.

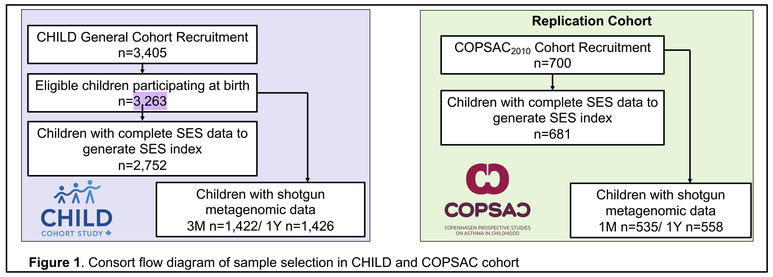

Figure 1. Consort flow diagram of sample selection in CHILD and COPSAC cohort

Results

5 year Health Outcome	N	odds Ratio (95% CI)	P−value
Overweight/obesity	1801 v 450	0.84 (0.72,0.97)	0.017
Asthma	1918 v 143	0.79 (0.62,1.01)	0.059
Atopy	1767 v 421	0.95 (0.81,1.12)	0.56
Emotional/behavioral problems	1915 v 142	0.58 (0.46,0.73)	<0.001

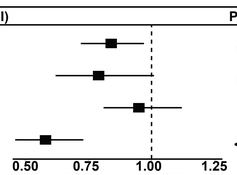

Figure 2. Summarized SES index is associated with childhood NCDs

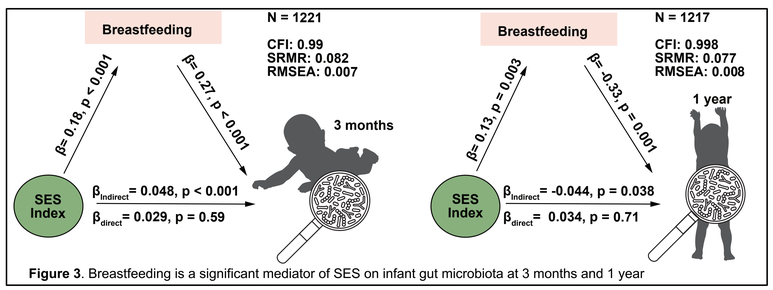

Figure 3. Breastfeeding is a significant mediator of SES on infant gut microbiota at 3 months and 1 year

5 or 6 year Health Outcomes	N	Odds Ratio (95% CI)	P−value
Overweight/obese	536 v 65	0.71 (0.48,1.04)	0.078
Asthma	517 v 135	0.73 (0.55,0.97)	0.03
Atopy	472 v 44	1.1 (0.69,1.75)	0.683
Emotional/behavioral problems	459 v 145	0.45 (0.33,0.6)	<0.001

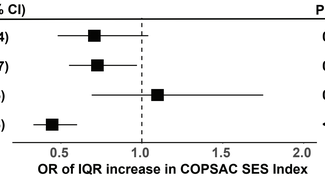

Figure 4. Forest plot of odds ratio (95% CI) of SES and exclusive breastfeeding status (EBF) at 6 months on one or more SES-associated NCDs

Results

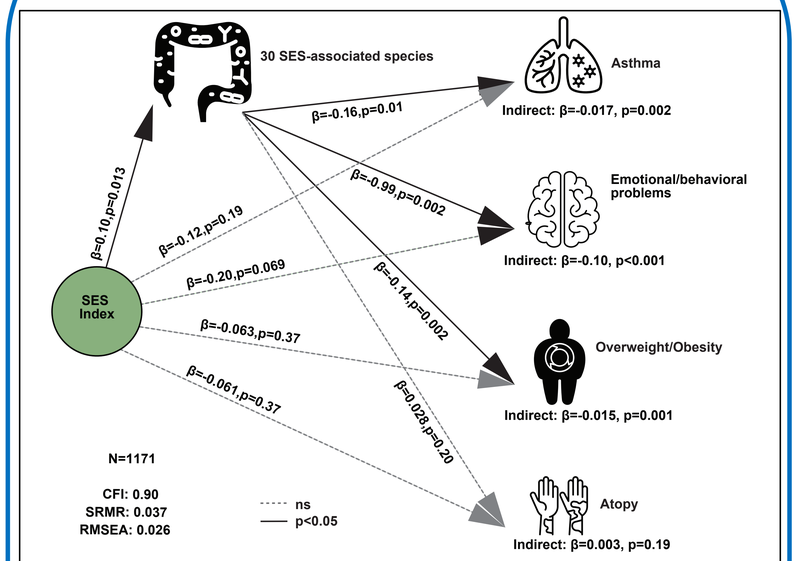

Figure 5. Visualization of SEM testing the mediation effect of SES-associated microbiome on childhood overweight/obesity, asthma, atopy and emotional/behavioral problems at 5 years of age in CHILD cohort

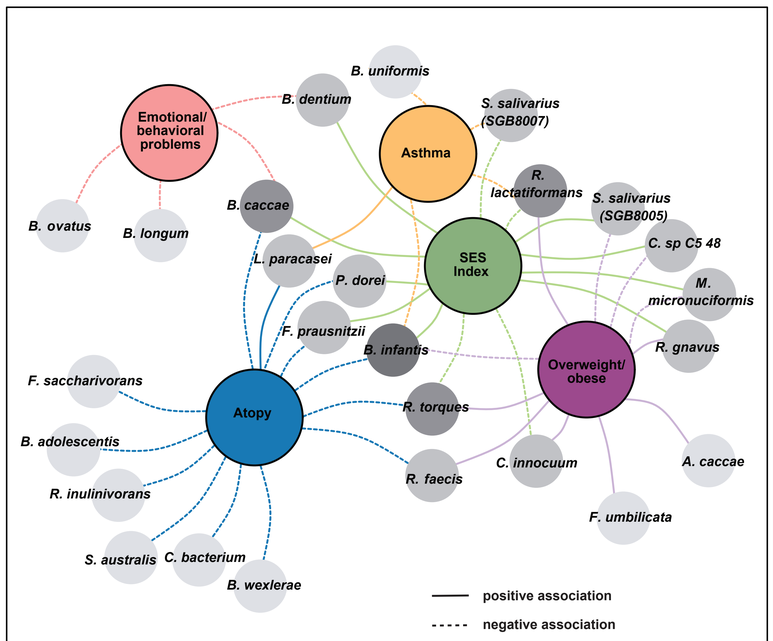

Figure 6. Species associated with any childhood NCDs (FDR < 0.1) at 5 years of age based on MaAslin2 models with or without interaction in CHILD cohort

Results

Replication in $COPSAC_{2010}$

5 or 6 year Health Outcomes	N	Odds Ratio (95% CI)	P−value
Overweight/obese	536 v 65	0.71 (0.48,1.04)	0.078
Asthma	517 v 135	0.73 (0.55,0.97)	0.03
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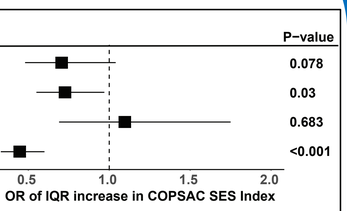

Figure 7. Summarized $COPSAC_{2010}$ SES index is associated with childhood NCDs in $COPSAC_{2010}$ cohort

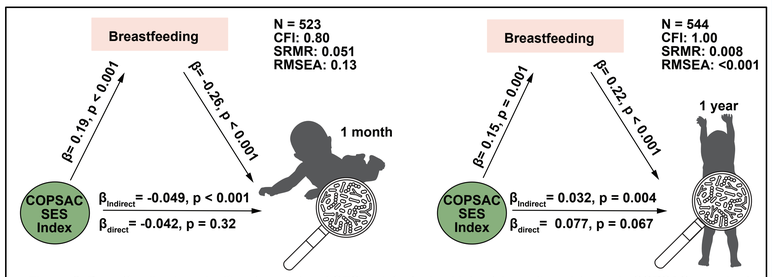

Figure 8. Breastfeeding is a significant mediator of SES on infant microbiota at 1 month and 1 year in $COPSAC_{2010}$ cohort

Group (COPSAC Study Cohort)	N	Odds Ratio (95% CI)	P−value
Low SES w/o EBF (4m)	146	Reference	---
Low SES w/ EBF (4m)	147	0.51 (0.32,0.81)	0.004
High SES w/o EBF (4m)	108	0.56 (0.34,0.93)	0.025
High SES w/ EBF (4m)	190	0.31 (0.2,0.49)	<0.001

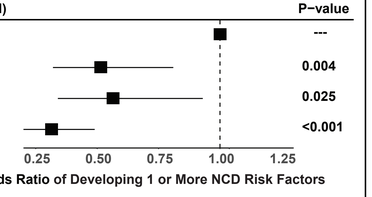

Figure 9. Forest plot of odds ratio (95% CI) of SES and exclusive breastfeeding status (EBF) at 4 months on one or more SES-associated NCDs in $COPSAC_{2010}$ cohort.

Conclusions

- ✓ Familial SES significantly shaped the perinatal environment and subsequently the infant gut microbiota to benefit childhood health outcomes linked to NCD development.
- ✓ This protection was primarily mediated by breastfeeding and the keystone species it fosters (particularly *B. infantis*).
- ✓ Our results highlight the critical role of breastfeeding and beneficial microbes in fostering healthy childhood growth and well-being.

Contact Info:
Darlene Dai Darlene.dai@bcchr.ca