

# Infant gut microbiota development is driven by transition to family foods

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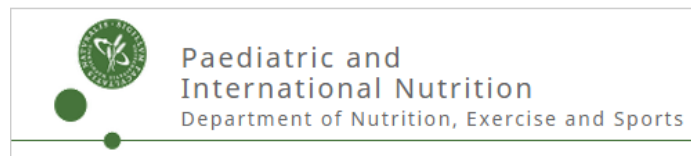
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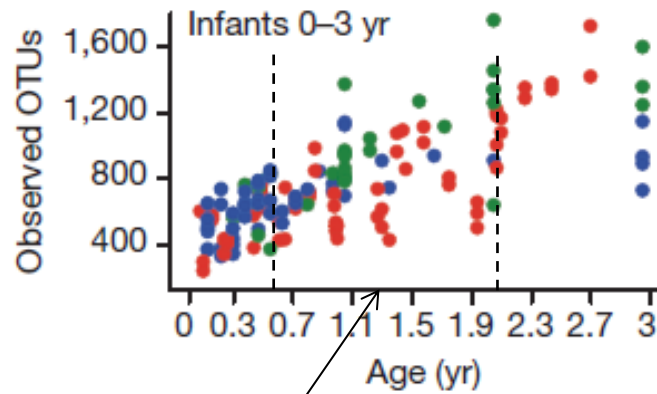
*NuGO week 2016*

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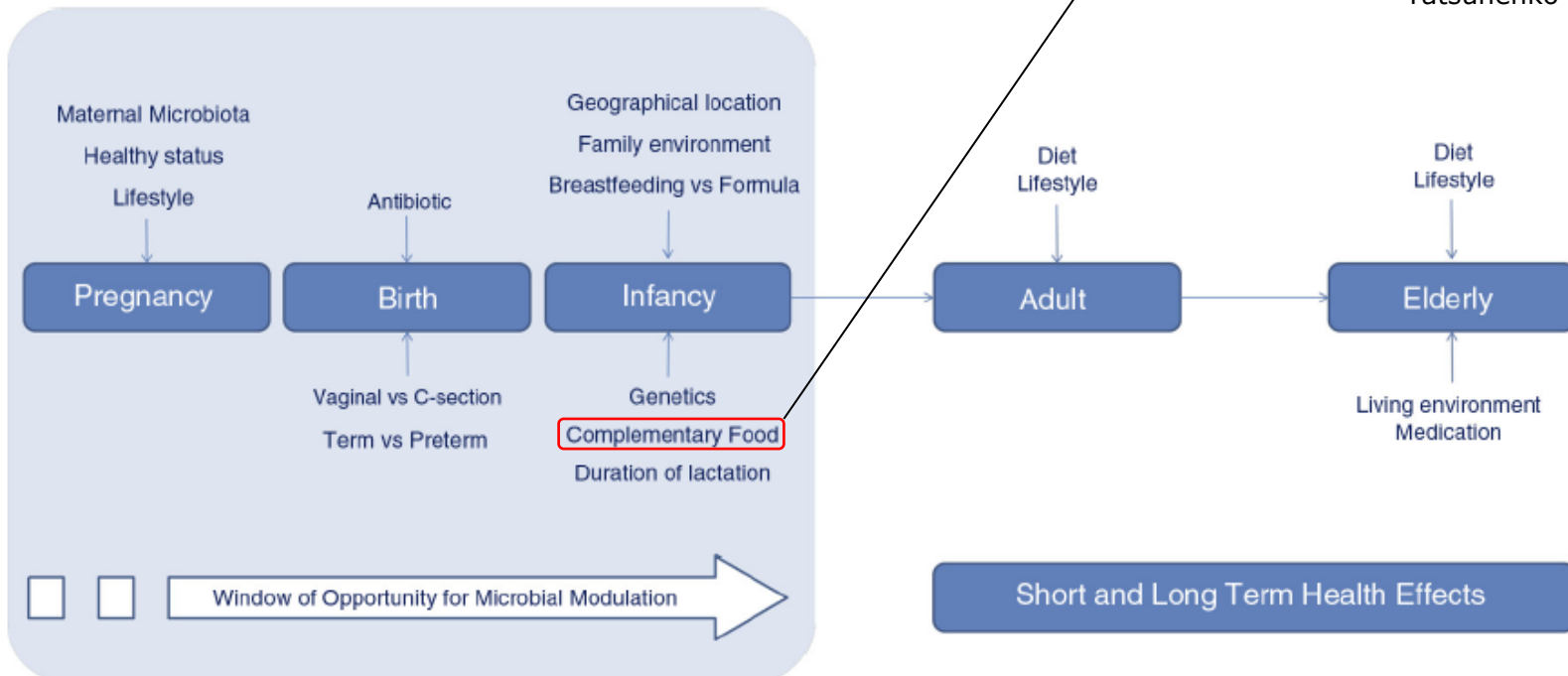
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# Background



Yatsunenkeno *et al*, 2012



Rodriguez *et al*, 2015

## WHO

*"Complementary feeding is defined as the process starting when breast milk alone is no longer sufficient to meet the nutritional requirements of infants, and therefore other foods and liquids are needed, along with breast milk. The transition from exclusive breastfeeding to family foods – referred to as complementary feeding – typically covers the period from **6 - 24 months of age...**"*

## In Denmark

- Introduce first solids 4-6m of age  
(Kronborg *et al*, 2014 – BMC Pediatrics)
- Capable of eating like the family 12m of age  
(*Nutrition for infants and children*, Danish Health Authorities, 2015)



# Study populations

- **SKOT study:** Dietary habits and well-being of young children

- Overall objective: To investigate interactions between dietary habits, growth and markers of lifestyle-related diseases the first 3 years of life

- SKOT I: 114 children of **normal weight mothers**

- SKOT II: 113 children of **obese mothers (BMI  $\geq$  30)**

**Examined at 9, 18 and 36m**

- Background interview
- Validated dietary questionnaire\*
- Anthropometric measurements
- Blood samples
- Fecal samples
- Urine samples

- **Laursen et al, 2016 – mSphere**

- Fecal samples 9 and 18m → 16s rRNA amplicon seq

- Dietary questionnaire 9m → Detailed composition of complementary diet

\*Gondolf et al, 2012 - EJCN

# Aim


- To elucidate the impact of (i) maternal obesity and (ii) complementary diet on infant gut microbiota development



RESEARCH ARTICLE  
Host-Microbe Biology



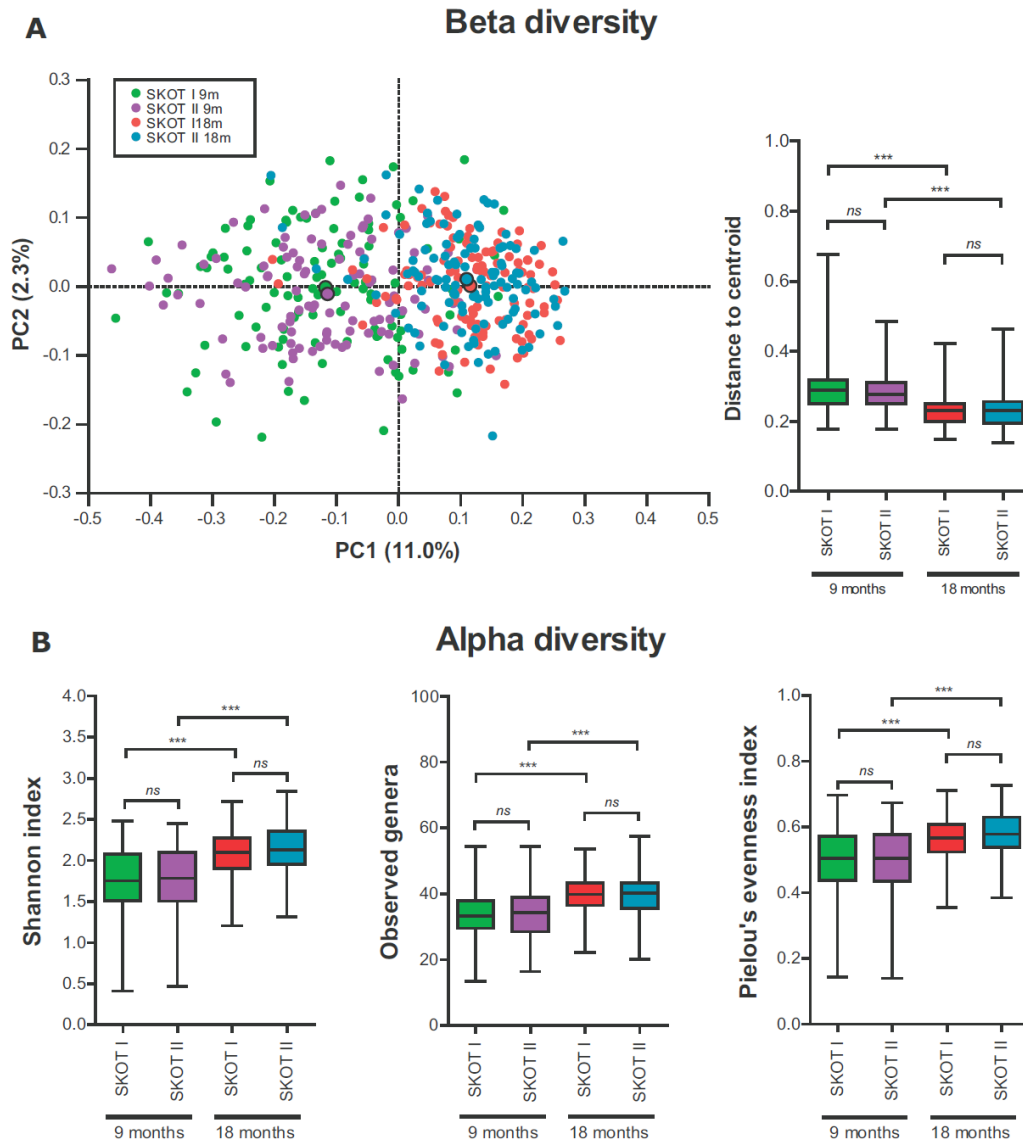
## Infant Gut Microbiota Development Is Driven by Transition to Family Foods Independent of Maternal Obesity

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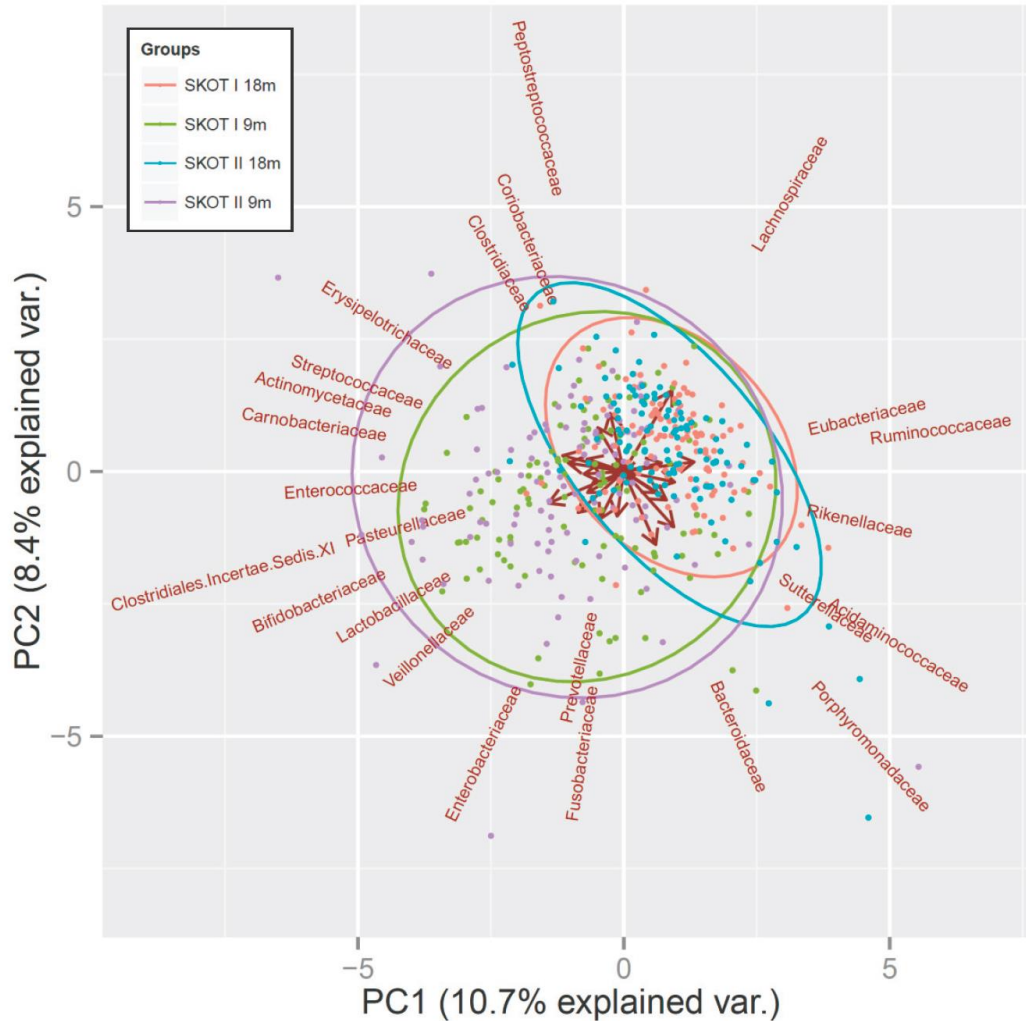
Laursen *et al*, 2016 - mSphere

# Gut microbial beta and alpha diversity is independent of maternal obesity but change over time

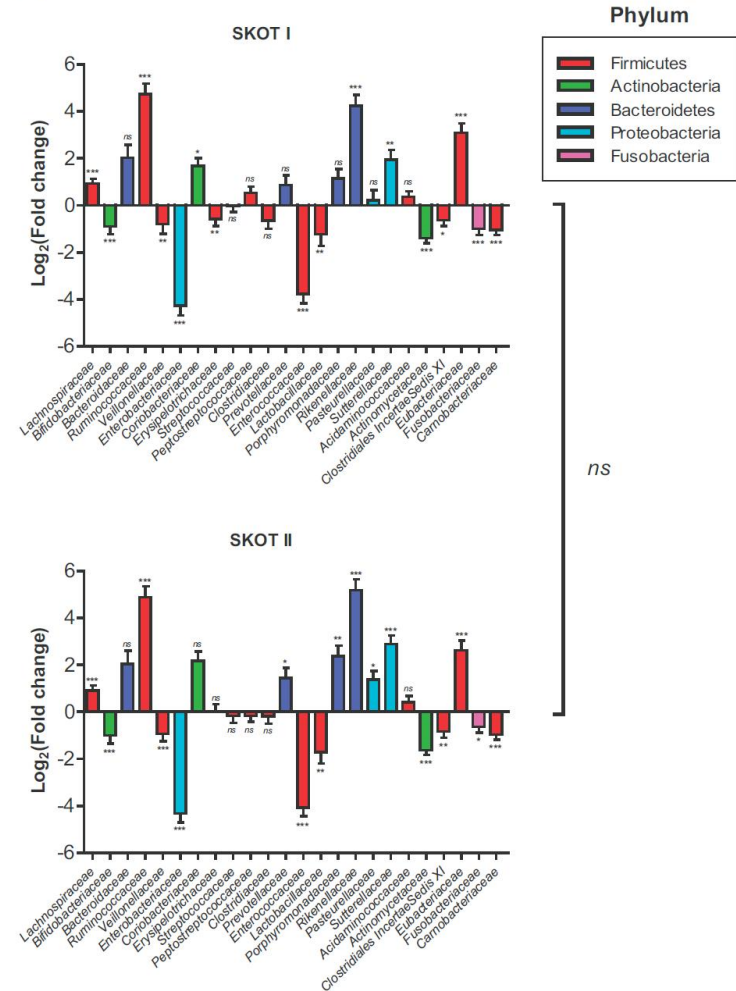


# Gut microbiota composition is independent of maternal obesity but changes over time

**A**

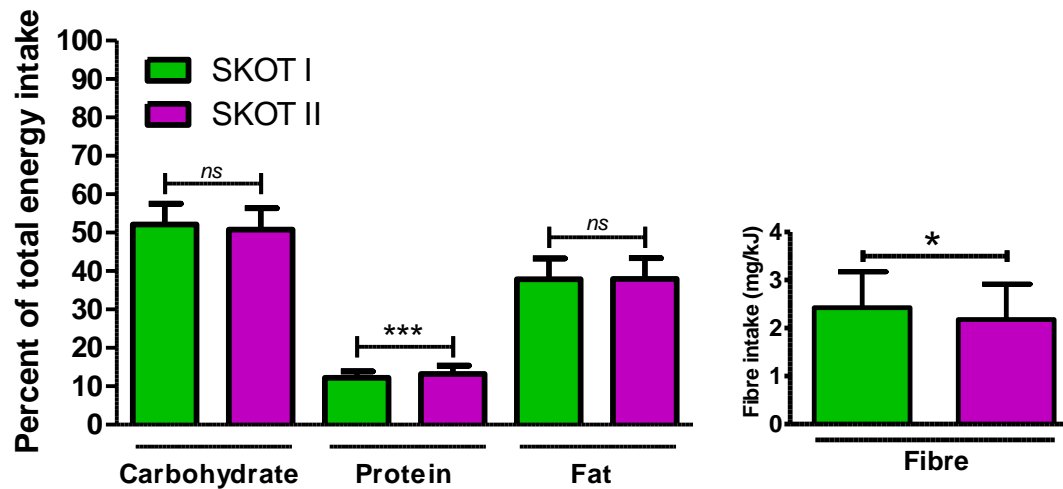


**B**

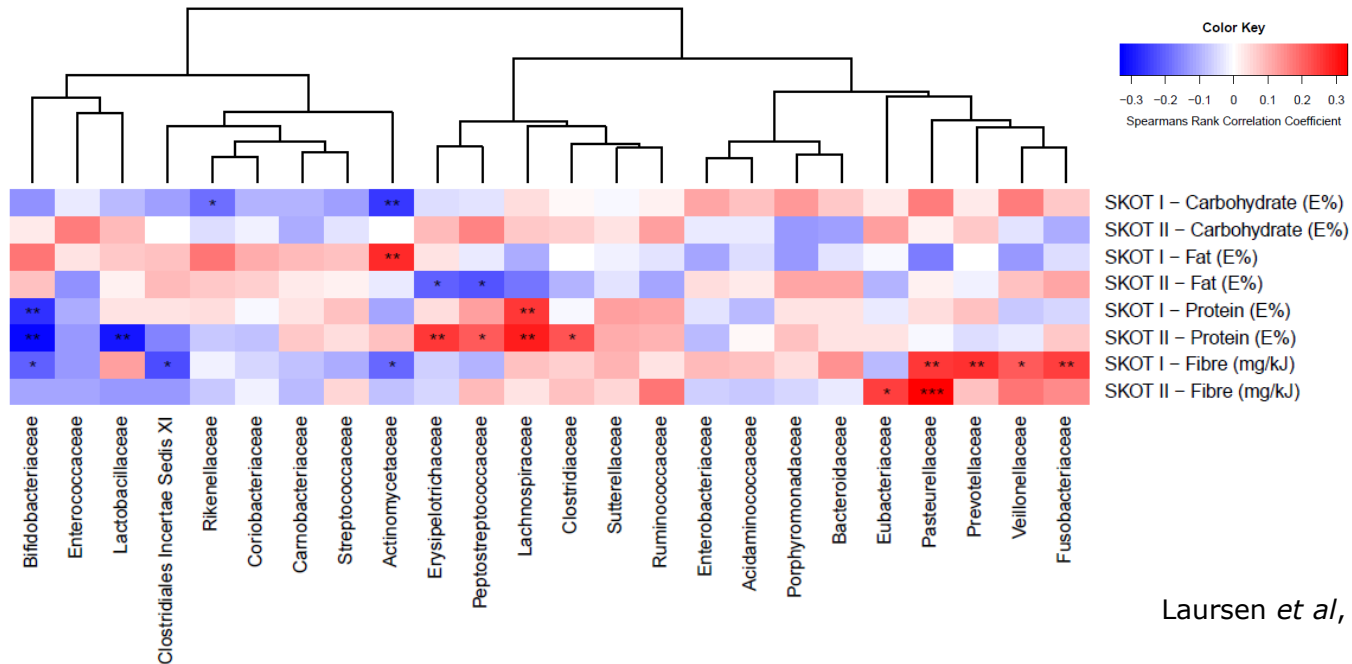


# Macronutrient intake correlate with gut microbes

**A**



**B**





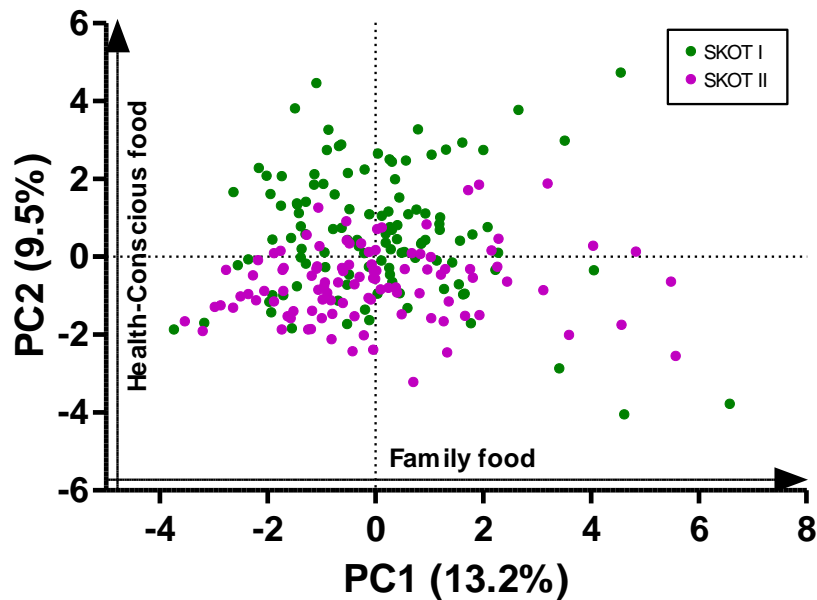
**TABLE 2** Food group definitions, average intake, and correlation to gut microbial alpha diversity at 9 months of age in SKOT I and SKOT II<sup>a</sup>

Food group	Definition	Avg intake (g/day/kg body wt)		
		SKOT I (n = 114)	SKOT II (n = 103)	SKOT I + SKOT II (n = 217)
Porridge	Cereal gruel and porridge (homemade or already prepared)	18.21	15.03	16.70
Breakfast cereals	Oatmeal, muesli, Cornflakes, sugar puffs, and sugary cereals	0.13	0.17	0.15
Wheat bread, whole grain	Grainy bread and crisp bread	1.05	1.73	1.38
Wheat bread, no whole grain	White bread and biscuits	0.57	0.89	0.72
Rye bread	Rye bread with and without seeds	1.28	1.40	1.34
Pasta/rice	Pasta and rice	0.90	0.97	0.93
Potato	Potatoes that were boiled, baked, mashed, or prepared in potato salad	4.48	1.51	3.07
Fruit	Fresh fruit, fresh berries, and fruit porridge, soup, or compote (homemade or already prepared)	12.47	8.23	10.46
Vegetable	All vegetables eaten raw, cooked, or mashed alone or in a dish	6.84	3.26	5.14
Fish	All fish and fish products eaten as a sandwich spread or in a dish	0.81	0.71	0.76
Meat	All meat and meat products eaten as a sandwich spread or in a dish, except poultry and fish	1.63	1.74	1.68
Poultry	All poultry and poultry products eaten as a sandwich spread or in a dish	0.43	0.35	0.39
Egg	All egg and egg products eaten as a sandwich spread or in a dish	0.16	0.14	0.15
Fats (animal)	Butter, spreadable butter, and sauce made from butter	0.98	1.01	1.00
Fats (vegetable)	Oil, margarine, mayonnaise, remoulade, ketchup, and low-fat sauce	0.56	0.38	0.47
Cheese	All cheese and cheese products eaten as a sandwich spread or in a dish	0.55	0.65	0.59
Milk	All milk and milk products eaten alone or in a dish, except human milk or infant formula	12.95	17.90	15.30
Formula	Infant formula and follow-up formula	32.71	27.77	30.37
Breast milk	Human milk from the mother	11.62	8.06	9.93
Fruit/nut/snack	Cereal bar, nuts, almonds, dried fruit, fruit spread, jam, honey, peanut butter, and seeds	0.31	0.16	0.24
Sweets/cake	Ice cream, chocolate, licorice, soufflé, croissant, Danish pastry, cookies, cream cake, pancake, and cream puff (mix of light/not light versions)	0.21	0.16	0.19
Sugary drink	Soda, juice, lemonade, chocolate milk, milk shake, and yogurt drink (mix of light/not light versions)	1.12	0.39	0.78
Fast food	Fried potatoes, French fries, hot dogs, pizza, burgers, spring rolls, and chips	0.59	0.50	0.55

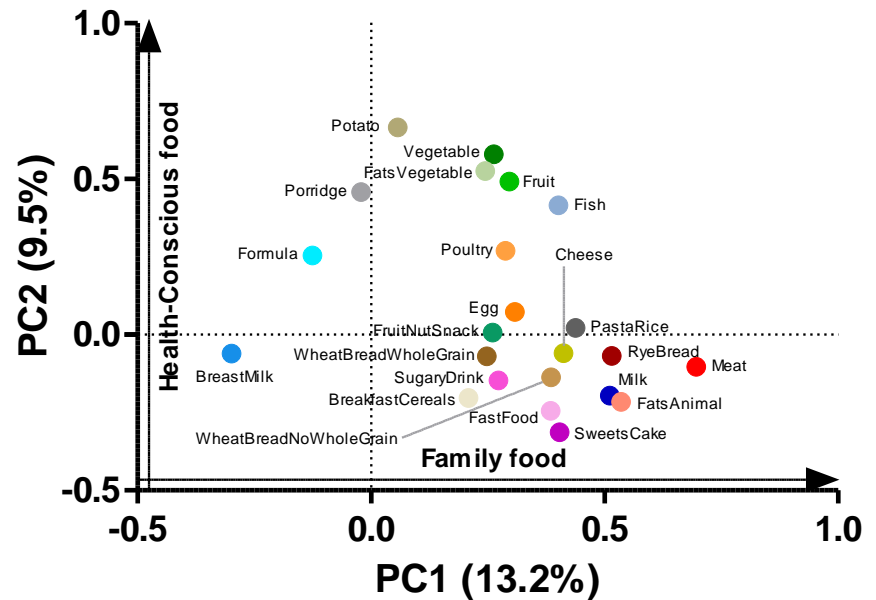
## Complementary diet divided into 23 food groups

# PCA of complementary diet → Food patterns\*

## Scores



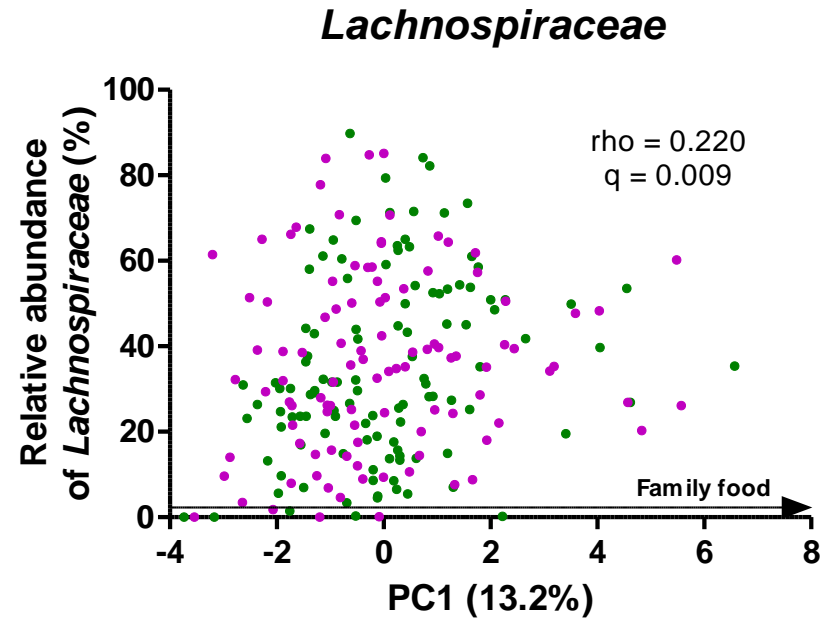
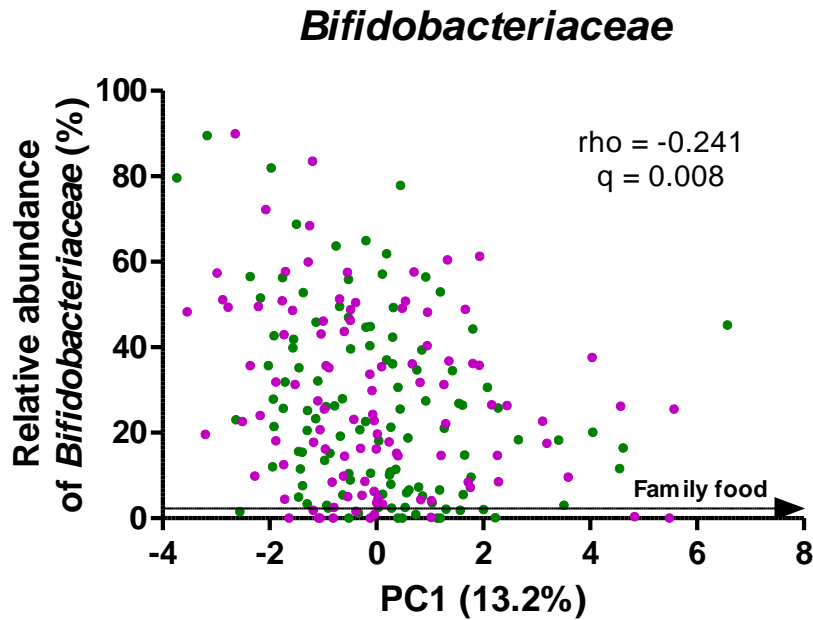
## Loadings



Laursen *et al*, 2016 - mSphere

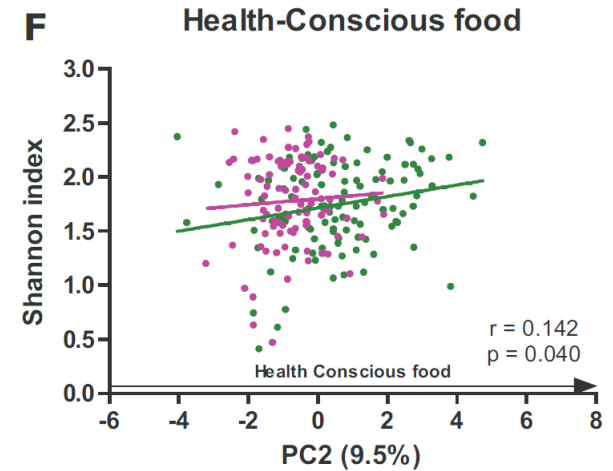
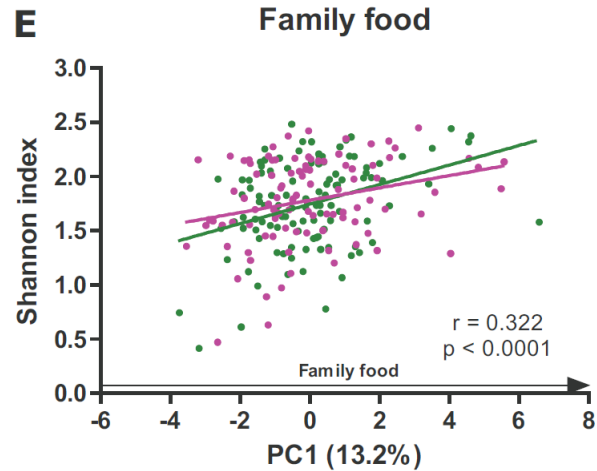
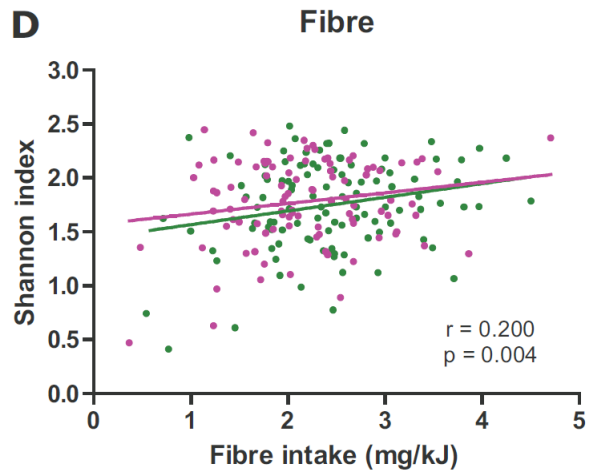
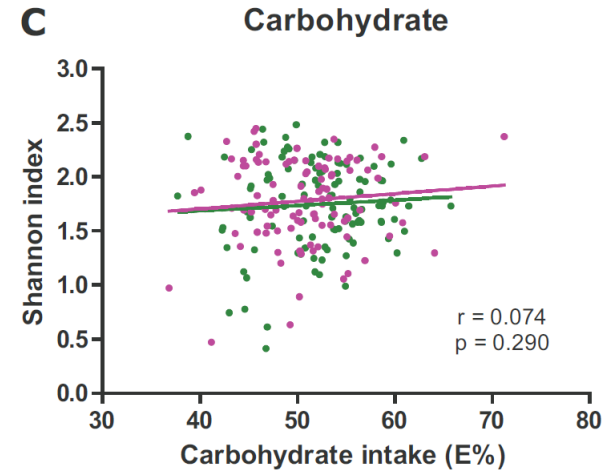
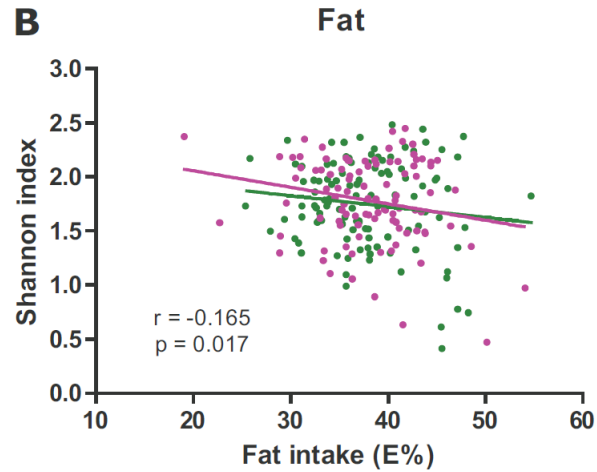
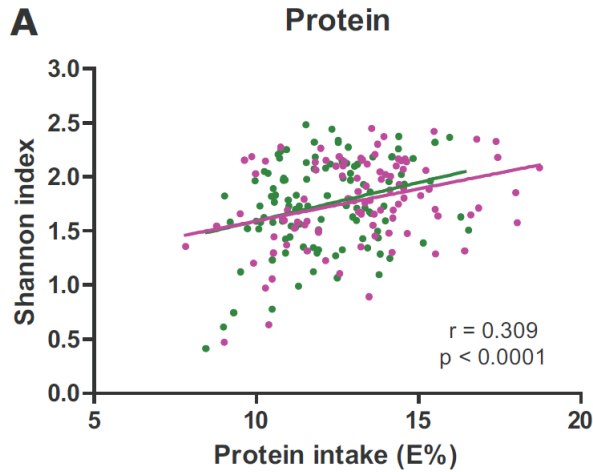
\*Andersen *et al*, 2015 - EJCN

# Transition to family foods affect gut microbial composition



# Transition to family foods increase gut microbial diversity

● SKOT I  
● SKOT II



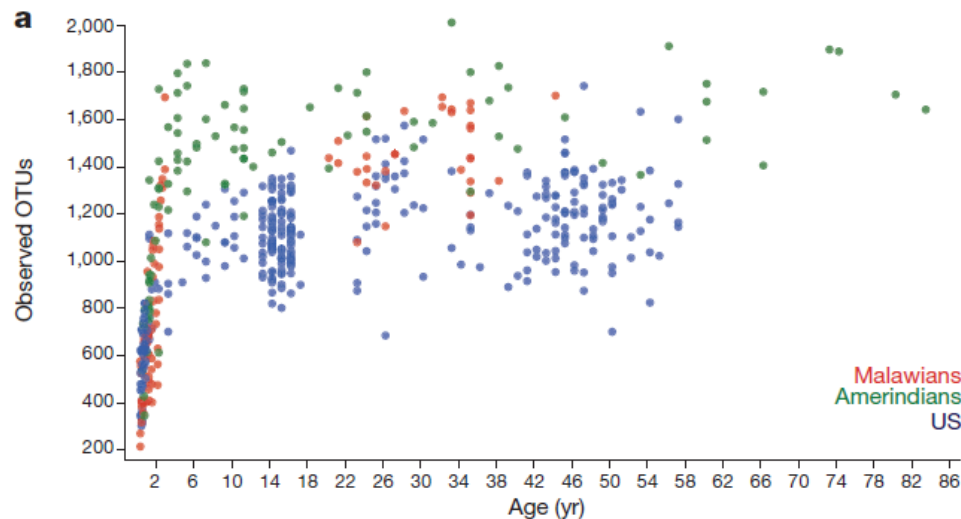
**TABLE 2** Food group definitions, average intake, and correlation to gut microbial alpha diversity at 9 months of age in SKOT I and SKOT II<sup>a</sup>

Food group	Definition	Avg intake (g/day/kg body wt)			Spearman correlation to Shannon diversity (SKOT I + SKOT II)		
		SKOT I (n = 114)	SKOT II (n = 103)	SKOT I + SKOT II (n = 217)	rho	P value	q value
Porridge	Cereal gruel and porridge (homemade or already prepared)	18.21	15.03	16.70	0.143	<b>0.039</b>	0.149
Breakfast cereals	Oatmeal, muesli, Cornflakes, sugar puffs, and sugary cereals	0.13	0.17	0.15	-0.044	0.525	0.636
Wheat bread, whole grain	Grainy bread and crisp bread	1.05	1.73	1.38	-0.032	0.644	0.705
Wheat bread, no whole grain	White bread and biscuits	0.57	0.89	0.72	0.072	0.299	0.416
Rye bread	Rye bread with and without seeds	1.28	1.40	1.34	0.235	<b>&lt;0.001</b>	<b>0.004</b>
Pasta/rice	Pasta and rice	0.90	0.97	0.93	0.120	0.083	0.192
Potato	Potatoes that were boiled, baked, mashed, or prepared in potato salad	4.48	1.51	3.07	0.073	0.294	0.416
Fruit	Fresh fruit, fresh berries, and fruit porridge, soup, or compote (homemade or already prepared)	12.47	8.23	10.46	0.111	0.110	0.231
Vegetable	All vegetables eaten raw, cooked, or mashed alone or in a dish	6.84	3.26	5.14	0.134	0.053	0.153
Fish	All fish and fish products eaten as a sandwich spread or in a dish	0.81	0.71	0.76	0.122	0.080	0.192
Meat	All meat and meat products eaten as a sandwich spread or in a dish, except poultry and fish	1.63	1.74	1.68	0.274	<b>&lt;0.0001</b>	<b>&lt;0.001</b>
Poultry	All poultry and poultry products eaten as a sandwich spread or in a dish	0.43	0.35	0.39	0.039	0.578	0.664
Egg	All egg and egg products eaten as a sandwich spread or in a dish	0.16	0.14	0.15	0.003	0.968	0.968
Fats (animal)	Butter, spreadable butter, and sauce made from butter	0.98	1.01	1.00	0.078	0.264	0.416
Fats (vegetable)	Oil, margarine, mayonnaise, remoulade, ketchup, and low-fat sauce	0.56	0.38	0.47	0.138	<b>0.046</b>	0.153
Cheese	All cheese and cheese products eaten as a sandwich spread or in a dish	0.55	0.65	0.59	0.296	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
Milk	All milk and milk products eaten alone or in a dish, except human milk or infant formula	12.95	17.90	15.30	0.156	<b>0.024</b>	0.111
Formula	Infant formula and follow-up formula	32.71	27.77	30.37	0.071	0.308	0.416
Breast milk	Human milk from the mother	11.62	8.06	9.93	-0.366	<b>&lt;0.0001</b>	<b>&lt;0.0001</b>
Fruit/nut/snack	Cereal bar, nuts, almonds, dried fruit, fruit spread, jam, honey, peanut butter, and seeds	0.31	0.16	0.24	0.051	0.468	0.597
Sweets/cake	Ice cream, chocolate, licorice, soufflé, croissant, Danish pastry, cookies, cream cake, pancake, and cream puff (mix of light/not light versions)	0.21	0.16	0.19	0.086	0.218	0.412
Sugary drink	Soda, juice, lemonade, chocolate milk, milk shake, and yogurt drink (mix of light/not light versions)	1.12	0.39	0.78	-0.015	0.826	0.863
Fast food	Fried potatoes, French fries, hot dogs, pizza, burgers, spring rolls, and chips	0.59	0.50	0.55	0.083	0.233	0.412

<sup>a</sup>The food group definitions are from reference 25. Gut microbial alpha diversity is the Shannon index. Significant P and q values are highlighted in bold. Data from 10 individuals from SKOT II were missing.

# Conclusions

- Maternal obesity *per se* does not impact gut microbial changes during late infancy and early childhood
- Transition from early infant feeding to family foods is a major determinant for gut microbiota development
- Fiber and protein intake is associated with increased microbial diversity



Yatsunenکو *et al*, 2012

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Children and parents

