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Children who adhered to a dietary pattern of primarily packaged foods and fish had higher plasma concentrations of select PFAS, reflective of food intake and/or correlated lifestyle factors

Background

- Per-and polyfluoroalkyl substances (PFAS) are a group of environmentally persistent and ubiquitous synthetic endocrine-disrupting chemicals.[1]
- PFAS are grease-repellant and can be incorporated into food packaging[2]
- Children are particularly vulnerable to PFAS,[1] but data on food sources of PFAS exposure in children are limited[2, 3]

Methods

Study Population: Children born to Boston-area women enrolled into the prospective Project Viva pre-birth cohort, 1999-2002

2128 mother-infant pairs enrolled in early pregnancy

↓

1271 children with dietary data in early childhood (median age 3.1y)

↓

559 children with plasma PFAS measured in mid-childhood (median age 7.7y)

Dietary assessment in early childhood

- Parent-reported diet in early childhood using a validated, 89-item Harvard Service Food Frequency Questionnaire (FFQ)[4]

PFAS plasma concentrations in mid-childhood

- Measured in plasma in mid-childhood by CDC staff using on-line solid-phase extraction with isotope dilution high performance liquid chromatography mass spectrometry
- Perfluorooctanoate **(PFOA)**, perfluorooctane sulfonate **(PFOS)**, perfluoro-decanoate **(PFDA)**, perfluorohexane sulfonate **(PFHxS)**, 2-(N-methyl-per-fluorooctane sulfonamido) acetate **(MeFOSAA)**, perfluorononanoate **(PFNA)**

Statistical analyses

- We performed **linear regression** to examine associations between each food item and each PFAS, accounting for multiple comparisons using Benjamini-Hochberg false discovery rate (FDR) correction at a level of 0.1 within each set of 89 tests for each PFAS
- We used **reduced rank regression (RRR)** to estimate overall percent variation in PFAS explained by diet and to identify dietary patterns most correlated with plasma concentrations of all PFAS included in the study
- In all models, we adjusted for race/ethnicity, maternal education, and household income and used ln-transformed PFAS plasma concentrations

Results

Table 1. Overall participant characteristics (N = 548)

Characteristic	N (%) or median (IQR)
Age at dietary assessment, years	3.1 (0.2)
Female	258 (47%)
Race/Ethnicity:	
White	349 (64%)
Black	99 (18%)
Hispanic	22 (4%)
Asian	12 (2%)
Other	66 (12%)
Maternal age at enrollment, years	32.8 (6.7)
College graduate	378 (69%)
Household income	
<$40,000/year	87 (16%)
$40,000 - $70,000/year	117 (21%)
>$70,000/year	344 (63%)

Table 2. PFAS plasma concentration distributions and correlations

	PFOA	PFOS	PFDA	MeFOSAA	PFHxS	PFNA
	PFAS plasma concentrations (ng/mL)					
Median (IQR)	4.5 (3.0)	6.6 (5.9)	0.4 (0.2)	0.3 (0.5)	2.0 (2.3)	1.5 (1.2)
5th percentile	2.0	2.4	< LOD	< LOD	0.7	0.7
95th percentile	9.8	19.0	0.7	1.9	15.9	5.3
Detection frequency (%)	99.5	99.5	89.6	66.8	99.5	99.5
	Spearman correlation coefficients					
PFOA	1.00					
PFOS	0.71	1.00				
PFDA	0.65	0.48	1.00			
MeFOSAA	0.49	0.58	0.24	1.00		
PFHxS	0.32	0.44	0.11	0.12	1.00	
PFNA	0.22	0.22	0.25	0.09	0.004	1.00

Limit of detection (LOD) = 0.1 ng/mL for all PFAS; Abbreviation: IQR – Interquartile range

Strengths

- First U.S. study in children to comprehensively evaluate multiple food items as well as dietary patterns associated with PFAS plasma concentrations
- Analysis accounts for socioeconomic status measures that are tightly linked to both diet and PFAS plasma concentrations

Limitations

- The FFQ does not capture information on food packaging which may have limited the variability in PFAS explained by diet in the RRR
- Dietary data are from early childhood FFQ and PFAS from mid-childhood, but this reflects the 3-7y half-life of some of the evaluated PFAS
- Project Viva is largely white and higher SES, thus limiting generalizability

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Linear regression analyses

Greater intake of ice cream and soda ⟶ higher plasma concentrations of MeFOSAA

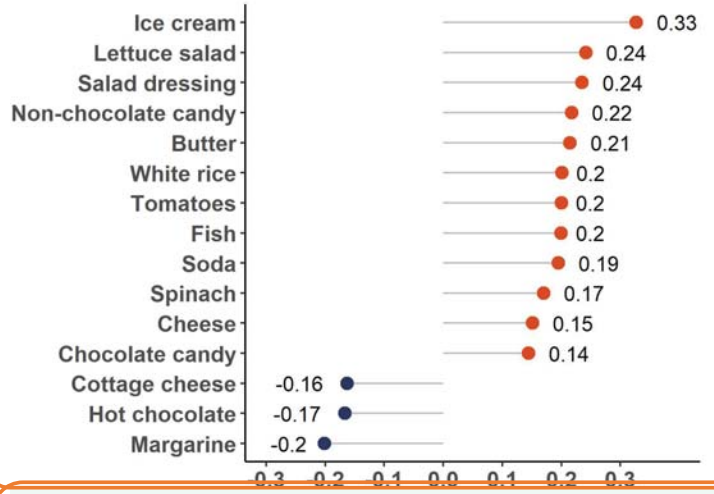
- 17.8% (95% CI: 7.2, 29.5) higher MeFOSAA per SD increment in ice cream intake
- 17.0% (95% CI: 6.4, 28.7) higher MeFOSAA per SD increment in soda intake

Other food items were not associated with MeFOSAA or other PFAS plasma concentrations

RRR analysis

6 dietary patterns explained 18% variability in PFAS plasma concentrations

Figure 1. The dietary pattern that explained the most variability (9%) in PFAS plasma concentrations was a diet of frequently packaged foods and fish



Children who adhered to this dietary pattern had higher concentrations of each PFAS, especially:

- MeFOSAA: 36% (95%CI: 24, 49) higher per SD in dietary pattern score
- PFOS: 29% (95%CI: 22, 36) higher per SD in dietary pattern score

Association of diet with MeFOSAA, found primarily in carpeting and textiles, may additionally reflect correlated lifestyle factors