Early Pregnancy Plasma Per- and Polyfluoroalkyl Substances (PFAS) and Postpartum Long-term Maternal Weight Trajectory

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Background

Exposure to per- and polyfluoroalkyl substances (PFAS) is associated with faster weight gain.[1] Prior studies did not assess parameters of weight trajectories postpartum, which are likely linked to development of cardiometabolic disease.[2]

Hypothesis

Higher PFAS exposures measured in early pregnancy are associated with **higher** and **faster** maternal weight trajectories spanning 17 years post index pregnancy.

Methods

Participants: 1106 pregnant individuals enrolled in *Project Viva* between 1999 and 2002 (Table 1).

Exposures: Plasma PFAS concentrations in pregnancy (mean 10 weeks gestation; Table 2): perfluorooctane sulfonate (**PFOS**), perfluorooctanoic acid (**PFOA**), perfluorononanoate (**PFNA**), perfluorohexane sulfonate (**PFHxS**), 2-[N-methyl-perfluorooctane sulfonamido] acetate (**MeFOSAA**), 2-[N-ethyl-perfluorooctane sulfonamido] acetate (**EtFOSAA**)

Covariates: age at enrollment, age at menarche, race/ethnicity, pre-pregnancy body mass index (BMI), parity, marital status, smoking status, seafood intake.

Outcome: Weight trajectory parameters estimated with both research-assistant-measured and self-reported weights measured from 6-months to 17-years post index pregnancy.

Statistical Analysis:

- Modelled weight trajectories via Super Imposition by Translation and Rotation model (Figure 1).
- Examined $\log_2$-transformed PFAS exposures with parameters of weight trajectory via linear regression (Figure 2) & Bayesian Kernel Machine Regression (BKMR; Figure 3).

Results

Table 1. Participant characteristics (N = 1106).

	Mean (SD) or %
Age at enrollment, years	32.4 (5.0)
Age at menarche, years	12.8 (1.6)
Race/ethnicity, % white	24.9 (5.4)
Parity, % nulliparous	55.7
Martial status, % married	92.3
Smoking status, % never smoked	69.1
Seafood intake, servings/week	0.2 (0.2)

Table 2. Distributions of PFAS (ng/mL).

	Min	Q1	Median	Q3	Max
PFOS	1.4	18.3	24.8	34.0	185.0
PFOA	0.3	4.0	5.7	7.7	36.7
PFNA	0.1	0.5	0.7	0.9	6.0
PFHxS	0.1	1.6	2.4	3.7	46.4
MeFOSAA	0.1	1.2	1.9	3.0	29.7
EtFOSAA	0.1	0.7	1.1	1.8	33.6

Figure 1. Average weight trajectory.

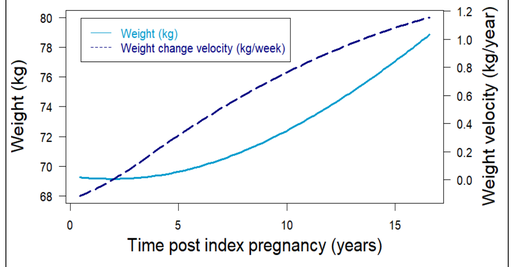


Figure 2. Associations of PFAS and parameters of the weight trajectory, estimated via linear regression.

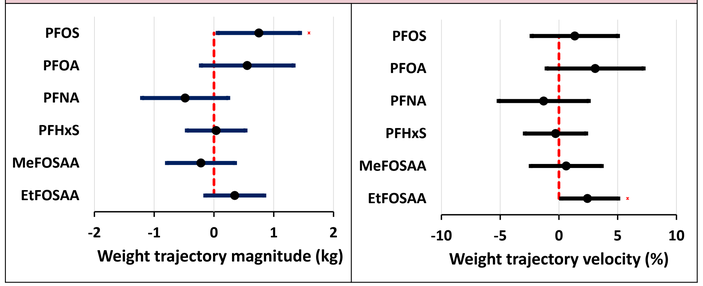
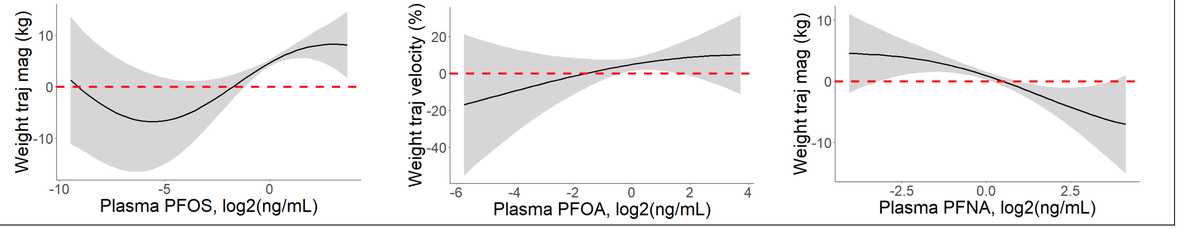


Figure 3. Key associations of select individual PFAS and parameters of the weight trajectory, estimated via BKMR. Other PFAS in the mixture are fixed at their 50th percentile.



Summary

Weight trajectory:

- Weight remained steady from about 6 months to 3 years post index pregnancy.
- Weight steadily ↑ by 9.7 kg from 3 years to 17 years post index pregnancy.

PFAS and weight trajectory parameters:

- PFOS was associated with ↑ weight trajectory magnitude (i.e., upward shift of the trajectory)
- EtFOSAA and PFOA were associated with ↑ weight trajectory velocity (i.e., steeper slope of the trajectory).
- PFNA was associated with ↓ weight trajectory magnitude (i.e., downward shift of the trajectory).

Limitations: 1) limited generalizability due to mostly non-Hispanic White study population; 2) assessed exposures from 1999-2002, when PFOS and PFOA concentrations were higher.

Conclusion

- ↑ **PFOS** in early pregnancy was associated with ↑ **weight trajectory** and ↑ **EtFOSAA and PFOA** were associated with ↑ **velocity**.
- ↑ parameters of midlife weight trajectory are associated with ↑ risk of coronary heart disease, diabetes, obesity-related cancer.[2]

References

1. N. Ding, C. A. Karvonen-Gutierrez, W. H. Herman, A. M. Calafat, B. Mukherjee, and S. K. Park, "Perfluoroalkyl and polyfluoroalkyl substances and body size and composition trajectories in midlife women: the study of women's health across the nation 1999–2018," *International Journal of Obesity 2021 45:9*, vol. 45, no. 9, pp. 1937–1948, May 2021, doi: 10.1038/s41366-021-00848-9.
2. Y. Zheng et al., "Associations of Weight Gain From Early to Middle Adulthood With Major Health Outcomes Later in Life," *JAMA*, vol. 318, no. 3, pp. 255–269, Jul. 2017, doi: 10.1001/JAMA.2017.7092