

Supporting Information

Predictors of per- and polyfluoroalkyl substance (PFAS) plasma concentrations in 6-10 year old American children

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Table S1. Unadjusted associations from bivariable linear regression models for predictors of PFAS concentrations in Project Viva mid-childhood (age 6-10 years) plasma samples (n=653)

	% Difference in PFAS concentration (95% CI)					
	PFOA	PFOS	PFHxS	PFNA	PFDeA	Me-PFOA-AcOH
Maternal pregnancy concentration of corresponding PFAS (per IQR increase)	12.3 (6.2, 18.9)	14.1 (7.4, 21.1)	21.3 (16.1, 26.7)	3.4 (-3.1, 10.4)	-	15.0 (5.0, 26.0)
Child Characteristics						
Child's age at blood draw (years)	-15.0 (-19.2, -10.7)	-11.5 (-17.0, -5.6)	-12.9 (-20.0, -5.1)	-1.4 (-7.3, 4.9)	-10.2 (-15.5, -4.6)	-18.4 (-26.6, -9.3)
Year of blood draw						
2007	Ref	Ref	Ref	Ref	Ref	Ref
2008	7.2 (-6.8, 23.2)	-4.4 (-20.2, 14.4)	-3.0 (-23.8, 23.5)	39.1 (16.1, 66.5)	11.7 (-6.4, 33.3)	8.9 (-19.4, 47.1)
2009	-21.1 (-31.4, -9.1)	-33.6 (-44.6, -20.3)	-36.1 (-49.9, -18.5)	25.1 (4.3, 50.0)	-6.9 (-22.1, 11.2)	-34.9 (-51.9, -11.7)
2010	-36.3 (-44.9, -26.2)	-43.0 (-52.8, -31.1)	-48.2 (-59.8, -33.3)	28.0 (6.0, 54.0)	-18.2 (-32.0, -1.5)	-49.3 (-63.0, -30.4)
Sex						
Male	Ref	Ref	Ref	Ref	Ref	Ref
Female	-2.0 (-10.0, 6.7)	-4.4 (-14.2, 6.4)	-12.1 (-23.7, 1.4)	-0.3 (-10.1, 10.4)	3.8 (-6.2, 14.9)	-0.4 (-16.5, 18.9)
Race/ethnicity						
White	Ref	Ref	Ref	Ref	Ref	Ref
Black	-34.1 (-40.9, -26.5)	-36.8 (-45.1, -27.3)	-42.2 (-52.1, -30.2)	-3.2 (-15.9, 11.3)	-13.6 (-24.6, -1.0)	-48.7 (-59.5, -35.1)
Other	-24.1 (-32.1, -15.2)	-25.7 (-35.6, -14.3)	-27.8 (-40.3, -12.6)	-7.0 (-19.3, 7.2)	-14.6 (-25.6, -1.9)	-37.3 (-50.7, -20.4)
Breastfeeding duration						
<3 months	Ref	Ref	Ref	Ref	Ref	Ref
3-<6 months	0.8 (-13.3, 17.3)	1.3 (-16.2, 22.4)	0.3 (-22.5, 29.7)	-3.5 (-20.0, 16.3)	2.1 (-14.9, 22.5)	-5.5 (-31.2, 29.8)
≥6 months	16.3 (5.7, 27.9)	25.3 (11.2, 41.1)	27.7 (8.6, 50.2)	-8.9 (-19.0, 2.5)	1.5 (-9.5, 13.9)	28.5 (5.2, 56.8)

BMI in mid-childhood (percentile)						
Underweight/normal (<85th)	Ref	Ref	Ref	Ref	Ref	Ref
Overweight (85- <95th)	-10.1 (-20.8, 2.0)	-10.0 (-23.4, 5.7)	-15.5 (-31.7, 4.6)	0.1 (-14.3, 16.9)	-5.5 (-18.8, 9.9)	-8.8 (-30.1, 19.0)
Obese (≥95th)	-22.6 (-31.4, -12.7)	-24.8 (-35.5, -12.4)	-28.2 (-41.4, -12.1)	5.8 (-8.7, 22.6)	-18.4 (-29.3, -5.8)	-23.0 (-40.2, -0.9)
Fast food consumption						
<1 per month	Ref	Ref	Ref	Ref	Ref	Ref
1-3 times per month	1.0 (-10.2, 13.7)	-4.7 (-18.0, 10.9)	0.3 (-17.8, 22.3)	10.3 (-4.4, 27.3)	5.5 (-8.4, 21.5)	-4.4 (-25.3, 22.4)
Once per week	-3.4 (-15.0, 9.9)	-10.3 (-23.8, 5.7)	-3.3 (-22.0, 20.0)	3.3 (-11.6, 20.6)	-0.2 (-14.4, 16.3)	-10.2 (-31.3, 17.4)
≥2 times per week	16.0 (-3.9, 39.9)	5.9 (-16.6, 34.6)	-4.0 (-29.9, 31.6)	22.5 (-2.4, 53.7)	12.3 (-10.2, 40.4)	37.8 (-6.9, 104.0)
Time spent outdoors (in summer)						
Low	Ref	Ref	Ref	Ref	Ref	Ref
Medium	21.3 (7.6, 36.8)	27.3 (9.3, 48.4)	18.7 (-3.0, 45.4)	18.2 (2.2, 36.7)	17.4 (1.8, 35.4)	5.3 (-18.2, 35.6)
High	25.3 (10.3, 42.4)	24.7 (6.0, 46.8)	16.0 (-6.4, 43.8)	21.5 (4.1, 41.8)	25.8 (8.1, 46.5)	16.8 (-10.7, 52.8)
Time spent outdoors (in winter)						
Low	Ref	Ref	Ref	Ref	Ref	Ref
Medium	4.9 (-4.9, 15.7)	5.4 (-6.9, 19.5)	-7.2 (-21.2, 9.3)	6.4 (-5.4, 19.8)	-0.2 (-11.2, 12.1)	0.7 (-18.0, 23.6)
High	2.4 (-11.2, 18.1)	-2.3 (-18.4, 17.2)	16.7 (-7.9, 48.0)	8.1 (-8.9, 28.4)	2.7 (-13.3, 21.6)	-4.8 (-29.3, 28.2)
Parental characteristics						
Maternal age at enrollment (per 5 years)	10.0 (6.0, 14.1)	13.0 (7.8, 18.4)	15.3 (8.3, 22.7)	1.3 (-3.2, 6.0)	3.5 (-1.0, 8.3)	23.6 (14.4, 33.5)
Maternal race/ethnicity						
White	Ref	Ref	Ref	Ref	Ref	Ref
Black	-35.8 (-42.0, -29.0)	-37.6 (-45.2, -28.9)	-44.1 (-53.0, -33.6)	-2.3 (-14.2, 11.2)	-16.4 (-26.4, -5.1)	-47.6 (-57.9, -34.9)
Other	-28.4 (-35.8, -20.1)	-28.9 (-38.3, -18.2)	-43.9 (-53.4, -32.4)	-3.6 (-16.2, 11.0)	-10.8 (-22.3, 2.4)	-40.3 (-52.8, -24.5)

Maternal education						
<College	Ref	Ref	Ref	Ref	Ref	Ref
College	28.0 (16.1, 41.1)	33.8 (18.3, 51.3)	48.1 (25.7, 74.4)	7.2 (-5.0, 21.0)	12.7 (0.1, 27.0)	48.9 (21.2, 82.9)
>College	41.3 (27.4, 56.7)	53.2 (34.4, 74.7)	73.8 (45.9, 106.9)	0.0 (-12.1, 13.8)	18.8 (4.7, 34.8)	67.5 (34.6, 108.5)
Paternal education						
<College	Ref	Ref	Ref	Ref	Ref	Ref
College	37.1 (23.4, 52.3)	44.6 (26.4, 65.4)	72.8 (44.6, 106.5)	7.2 (-5.8, 21.9)	22.1 (7.3, 39.0)	61.4 (29.1, 101.8)
>College	34.3 (20.3, 50.0)	36.6 (18.6, 57.2)	43.8 (19.3, 73.3)	-1.2 (-13.7, 13.0)	22.2 (6.7, 40.0)	36.2 (7.8, 72.0)
Mother married or cohabitating						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	40.8 (23.1, 60.9)	38.4 (16.7, 64.1)	49.1 (18.8, 87.1)	-7.2 (-21.3, 9.3)	17.3 (-0.2, 37.8)	54.4 (16.5, 104.7)
Maternal parity						
0	Ref	Ref	Ref	Ref	Ref	Ref
≥1	5.3 (-3.4, 14.7)	1.4 (-9.0, 13.1)	0.2 (-13.3, 15.7)	1.6 (-8.4, 12.7)	1.0 (-8.8, 11.9)	12.2 (-6.1, 34.2)
<i>Household Characteristics</i>						
Annual household income						
≤\$40K	Ref	Ref	Ref	Ref	Ref	Ref
\$>40–≤70K	8.8 (-6.2, 26.2)	30.6 (7.7, 58.5)	36.5 (5.1, 77.1)	-4.1 (-20.7, 15.9)	7.6 (-10.9, 29.8)	62.8 (17.4, 125.8)
\$>70–≤150K	29.3 (14.4, 46.2)	34.1 (14.2, 57.4)	34.6 (8.4, 67)	1.2 (-13.5, 18.5)	9.6 (-6.2, 28.1)	64.4 (25.4, 115.5)
>\$150K	42.4 (24.4, 63.0)	51.2 (26.8, 80.3)	50.0 (18.3, 90.3)	3.1 (-13.3, 22.5)	21.9 (2.7, 44.6)	106.3 (53.2, 177.9)
Carpeting or a rug in room where child sleeps						
No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	22.5 (11.7, 34.2)	32.8 (18.2, 49.2)	38.9 (19.0, 62.1)	0.7 (-10.0, 12.7)	11.5 (-0.1, 24.3)	49.8 (23.7, 81.4)

Carpeting or a rug in
room where child
spends most awake time

No	Ref	Ref	Ref	Ref	Ref	Ref
Yes	21.3 (10.5, 33.1)	30.5 (16.0, 46.9)	43.0 (22.3, 67.2)	-3.1 (-13.4, 8.5)	0.8 (-9.8, 12.5)	37.7 (13.3, 67.4)

***Neighborhood
Characteristics***

Census tract median household income (per \$10,000 increase)	5.7 (3.9, 7.6)	6.9 (4.5, 9.3)	6.5 (3.4, 9.8)	0.4 (-1.8, 2.6)	5.0 (2.8, 7.2)	9.8 (5.8, 13.9)
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Table S2. Predictors of linear and branched PFOS isomer (n-PFOS and sm-PFOS) concentrations in Project Viva mid-childhood (age 6-10 years) plasma samples (n=653)

	Unadjusted associations from bivariable linear regression models		Adjusted associations from multivariable linear regression	
	n-PFOS	sm-PFOS	n-PFOS	sm-PFOS
<i>Child Characteristics</i>				
Child's age at blood draw (years)	-10.6 (-16.1, -4.7)	-14.2 (-19.5, -8.7)	7.9 (-1.5, 18.3)	9.6 (0.6, 19.4)
Year of blood draw				
2007	Ref	Ref	Ref	Ref
2008	-5.1 (-20.6, 13.5)	-5.8 (-20.9, 12.3)	-4.1 (-19.9, 14.8)	-6.1 (-20.7, 11.2)
2009	-33.4 (-44.3, -20.2)	-35.5 (-46.0, -23.1)	-28.5 (-40.3, -14.2)	-31.4 (-42.1, -18.7)
2010	-42.0 (-51.9, -30.1)	-47.0 (-55.9, -36.3)	-37.8 (-50.5, -21.7)	-40.5 (-52.0, -26.2)
Sex				
Male	Ref	Ref	Ref	Ref
Female	-4.1 (-13.8, 6.6)	-5.7 (-15.2, 4.8)	-2.4 (-12.3, 8.7)	-4.6 (-13.7, 5.6)
Race/ethnicity				
White	Ref	Ref		
Black	-33.5 (-42.2, -23.5)	-44.7 (-51.5, -36.8)		
Other	-23.1 (-33.2, -11.3)	-31.3 (-39.9, -21.5)		
Breastfeeding duration				
<3 months	Ref	Ref	Ref	Ref
3-<6 months	-0.5 (-17.5, 20.0)	6.0 (-11.8, 27.3)	-7.6 (-23.3, 11.3)	0.7 (-15.4, 20.0)
≥6 months	22.2 (8.6, 37.5)	36.0 (21.2, 52.6)	6.6 (-5.9, 20.7)	14.7 (2.0, 28.9)
BMI in mid-childhood (percentile)				
Underweight/normal (<85th)	Ref	Ref	Ref	Ref
Overweight (85-<95th)	-8.9 (-22.3, 6.8)	-11.9 (-24.7, 3.1)	-7.8 (-21.3, 8)	-12.2 (-24.3, 1.8)
Obese (≥95th)	-22.7 (-33.5, -10.0)	-30.8 (-40.4, -19.7)	-6.6 (-20.6, 9.9)	-9.8 (-22.5, 5.1)
Fast food consumption				
<1 per month	Ref	Ref	Ref	Ref
1-3 times per month	-4.5 (-17.8, 10.8)	-5.7 (-18.7, 9.3)	-3.7 (-16.4, 10.9)	-2.4 (-14.5, 11.5)
Once per week	-9.6 (-23.1, 6.3)	-12.3 (-25.3, 2.9)	-8.9 (-22.1, 6.6)	-9.9 (-22.2, 4.5)
≥2 times per week	5.5 (-16.7, 33.7)	5.7 (-16.4, 33.7)	3.0 (-17.9, 29.2)	5.6 (-14.6, 30.6)

Time spent outdoors (in summer)

Low	Ref	Ref	Ref	Ref
Medium	24.8 (7.3, 45.2)	29.3 (11.3, 50.2)	15.9 (-1.1, 35.7)	19.1 (2.7, 38.2)
High	21.6 (3.5, 42.8)	29.8 (10.7, 52.2)	15.3 (-3.2, 37.4)	21.3 (2.9, 42.9)

Time spent outdoors (in winter)

Low	Ref	Ref	Ref	Ref
Medium	5.2 (-7.0, 19.0)	5.6 (-6.6, 19.4)	-4.0 (-15.5, 9.1)	-6.3 (-16.8, 5.6)
High	-2.5 (-18.5, 16.6)	-0.5 (-16.7, 18.9)	-19.8 (-33.3, -3.5)	-20.9 (-33.5, -5.9)

Parental characteristics

Maternal age at enrollment (per 5 years)	11.8 (6.7, 17.1)	16.0 (10.8, 21.4)	-0.9 (-6.9, 5.4)	-0.6 (-6.2, 5.4)
Maternal race/ethnicity				
White	Ref	Ref	Ref	Ref
Black	-34.4 (-42.3, -25.3)	-45.1 (-51.5, -37.8)	-25.7 (-36.9, -12.6)	-31.4 (-41.1, -20)
Other	-25.5 (-35.3, -14.3)	-36.5 (-44.5, -27.3)	-8.8 (-22.8, 7.7)	-18.7 (-30.4, -4.9)
Maternal education				
<College	Ref	Ref	Ref	Ref
College	29.6 (14.7, 46.4)	44.0 (27.8, 62.3)	12.3 (-3.3, 30.5)	11.7 (-3.0, 28.6)
>College	47.6 (29.7, 68.1)	65.6 (45.9, 88.1)	20.4 (1.9, 42.3)	18.1 (1.0, 38.1)
Paternal education				
<College	Ref	Ref		
College	40.1 (22.6, 60.2)	53.9 (35.3, 75.1)		
>College	32.2 (15.0, 52.1)	47.8 (29.2, 69.2)		
Mother married or cohabitating				
No	Ref	Ref	Ref	Ref
Yes	32.9 (12.3, 57.3)	56.1 (32.2, 84.4)	1.0 (-18.1, 24.5)	7.6 (-11.6, 31.0)
Maternal parity				
0	Ref	Ref	Ref	Ref
≥1	0.6 (-9.6, 12.0)	4.1 (-6.5, 15.9)	1.2 (-9.8, 13.6)	3.4 (-7.2, 15.2)

Household Characteristics

Annual household income				
≤\$40K	Ref	Ref	Ref	Ref

\$>40–≤70K	29.7 (7.0, 57.3)	39.4 (15.4, 68.4)	6.7 (-13.9, 32.3)	4.7 (-14.4, 28.1)
\$>70–≤150K	28.0 (9.1, 50.1)	52.8 (30.6, 78.7)	-12.1 (-28.5, 8.0)	-7.3 (-23.6, 12.6)
>\$150K	43.4 (20.3, 70.9)	75.4 (47.6, 108.4)	-15.0 (-32.8, 7.4)	-10.4 (-28.1, 11.6)
Carpeting or a rug in room where child sleeps				
No	Ref	Ref	Ref	Ref
Yes	30.4 (16.2, 46.3)	35.8 (21.2, 52.1)	18.3 (4.5, 33.8)	17.0 (4.2, 31.4)
Carpeting or a rug in room where child spends most awake time				
No	Ref	Ref	Ref	Ref
Yes	27.4 (13.4, 43.2)	35.2 (20.5, 51.7)	-1.9 (-13.7, 11.4)	-0.8 (-12, 11.8)
Census tract median household income (per \$10,000 increase)	6.1 (3.8, 8.5)	8.7 (6.4, 11.1)	2.7 (0.0, 5.4)	3.3 (0.8, 5.9)

Table S3. Summary statistics for PFAS concentrations measured in maternal plasma samples from early pregnancy (median=9.7 weeks gestation) in Project Viva, in subset of population with mid-childhood PFAS measurements (n=440)

PFAS analyte (ng/mL)	N (%) detect	LOD	Geometric Mean	Median	Minimum	Maximum
PFOS	440 (100)	0.2	24.21	21.1	4.6	115.0
PFOA	440 (100)	0.1	5.33	5.4	0.90	20.5
PFHxS	438 (99.5)	0.1	2.53	2.5	<LOD	43.2
PFNA	434 (98.6)	0.1	0.61	0.6	<LOD	3.4
Me-PFOA-AcOH	440 (100)	0.1	2.02	2.0	0.1	29.7
PFDeA	242 (55.0)	0.1	0.11	<LOD	<LOD	1.0

Table S4. PFAS plasma geometric means by year of collection for Project Viva mid-childhood (age 6-10 years) samples, and PFAS serum geometric means for NHANES participants aged 12-19 in 2007-8 and 2009-10 cycles

PFAS analyte (ng/mL)	Project Viva mid-childhood geometric mean (6-10 years)				NHANES geometric mean (12-19 years)	
	2007 (n=68)	2008 (n=223)	2009 (n=207)	2010 (n=155)	2007-8	2009-10
PFOS	8.17	7.81	5.43	4.66	11.30	6.84
PFOA	4.96	5.31	3.91	3.16	3.91	2.74
PFHxS	2.95	2.87	1.89	1.53	2.40	2.03
PFNA	1.30	1.81	1.62	1.66	1.16	1.10
Me-PFOSA-AcOH	0.34	0.37	0.22	0.17	0.34	0.24
PFDeA	0.32	0.36	0.29	0.26	0.23	0.22