Westfield
Hampden County | Massachusetts

INFORMATION TO PROTECT OUR COMMUNITIES

Per- and Polyfluoroalkyl Substances (PFAS) Exposure Assessment

Appendix A, B, and C

National Center
for Environmental Health
Agency for Toxic Substances
and Disease Registry

11/18/2021

Appendix A: Additional Tables

Table A1. Dust sample results from Westfield EA compared to results from other U.S. studies (nanograms per gram)

PFAS	Westfield EA			Fraser et al. (2013) Household Dust—MA*		Karásková et al. (2016) Household Dust—U.S.†		Wu et al. (2015) Household Dust—CA Homes with Young Children‡		Wu et al. (2015) Household Dust—CA Homes with Older Adults Only‡		Scher et al. (2018) Household Dust—MN§	
	RL	GM	Range	GM	Range	Median	Range	GM	Range	GM	Range	Median	Range
PFBS	0.17–3.3	NA	ND–12.0	NA	4.98–4.98	0.9	<0.73¶–2.6	—	—	—	—	<5	<5–58
PFPeS	0.17–3.3	NA	ND–12.9	—	—	—	—	—	—	—	—	—	—
PFHxS	0.17–3.3	5.3	ND–1,300	NA	6.05–430	8.7	1.4–84.4	3.47	ND**–7,490	3.77	ND**–1,050	18	<5–790
PFHpS	0.17–3.3	NA	ND–3.9	—	—	<0.42¶	<0.42¶–2.9	—	—	—	—	—	—
PFOS	0.17–3.3	12.9	ND–350	26.9	14.1–280	14.1	5.7–239	29.0	ND**–6,670	34.6	ND**–1,040	67	8.4–2,000
PFDS	0.17–8.7	NA	ND–6.1	—	—	2.8	0.5–9.8	—	—	—	—	—	—
PFBA	0.69–13	NA	ND–59.1	13.9	4.89–999	—	—	—	—	—	—	24	<5–200
PFPeA	0.35–6.5	NA	ND–20.6	NA	5.39–249	1.7	<0.76¶–24.8	—	—	—	—	6.2	<5–66
PFHxA	0.17–3.3	8.2	ND–70.8	8.65	4.85–1,380	6.5	2.5–190	—	—	—	—	29	5.4–240
PFHpA	0.21–3.3	5.9	ND–105	12.0	4.93–586	3.6	0.9–86.7	—	—	—	—	23	<5–260
PFOA	0.17–3.3	15.2	ND–424	23.7	5.71–894	9.0	2.9–318	41.4	ND**–2,360	45.0	ND**–728	51	9.9–970
PFNA	0.17–3.3	3.8	ND–30.9	10.9	6.21–1,420	3.9	1.1–62.9	13.3	ND**–1,910	14.7	ND**–883	26	<5–450
PFDA	0.17–3.3	4.3	ND–26.6	NA	6.97–26.8	1.8	0.4–64.0	8.51	ND**–2,520	7.76	ND**–355	13	<5–370
PFUnA	0.17–3.3	2.0	ND–15.4	NA	10.8–39.4	1.2	<1.06¶–13.1	—	—	—	—	7.2	<5–67
PFDoA	0.17–3.3	2.4	ND–18.4	NA	5.09–13.3	0.6	<0.72¶–9.0	—	—	—	—	8.2	<6.5–190
PFTrA	0.17–3.3	NA	ND–8.9	NA	10.3–10.3	ND¶	ND¶–2.1	—	—	—	—	—	—

PFAS	Westfield EA			Fraser et al. (2013) Household Dust—MA*		Karásková et al. (2016) Household Dust—U.S.†		Wu et al. (2015) Household Dust—CA Homes with Young Children‡		Wu et al. (2015) Household Dust—CA Homes with Older Adults Only‡		Scher et al. (2018) Household Dust—MN§	
	RL	GM	Range	GM	Range	Median	Range	GM	Range	GM	Range	Median	Range
PFTA	0.17–3.3	NA	ND–13.4	NA	11.2–11.2	0.8	<1.15¶–3.0	—	—	—	—	—	—
PFOSA	0.17–3.3	NA	ND–4.5	—	—	—	—	—	—	—	—	—	—
N-MeFOSA	0.2–3.7	NA	ND–4.8	—	—	0.6	0.6–0.6	—	—	—	—	—	—
MeFOSAA	0.17–3.3	NA	ND–800	—	—	—	—	—	—	—	—	—	—
N-MeFOSE	1.7–32.5	NA	ND–1,050	NA	18–488	1.0	<0.57¶–9.9	—	—	—	—	—	—
N-EtFOSA	0.43–8.1	NA	ND–7.9	—	—	5.9	5.9–5.9	—	—	—	—	—	—
EtFOSAA	0.17–3.3	6.8	ND–83.2	—	—	—	—	—	—	—	—	—	—
N-EtFOSE	1.3–24.4	NA	ND–492	NA	12.2-3,280	<0.34¶–	<0.34¶–93.9	—	—	—	—	—	—
FtS 6:2	0.62–11.7	NA	ND–104	—	—	—	—	—	—	—	—	—	—
FtS 8:2	0.69–13	NA	ND–47.0	—	—	—	—	—	—	—	—	—	—

RL = reporting limit, GM = geometric mean, ng/g = nanograms per gram, NA = not applicable (i.e., too few detected results to calculate a GM), ND = not detected, — = PFAS was not measured as part of the study

* This study evaluated dust samples collected from homes, offices, and vehicles in the greater Boston, Massachusetts, area between January and March of 2009. This table presents results for dust samples collected in the main living areas of 30 homes.

† This study evaluated dust samples collected from living rooms and bedrooms from homes in Canada, the Czech Republic, and the United States during the spring and summer of 2013. The results presented in this table are from the 14 homes in the United States.

‡ As part of this study, dust samples were collected between 2007 and 2009 from carpet or area rugs in the main living areas of homes in California with and without young children residing in the home. This table presents results separately for dust samples collected in the 82 homes with young children and the 42 homes with older adults only.

§ As part of this study, dust samples were collected between July and September 2010 from 19 homes located in cities with PFAS-contaminated drinking water in Minnesota. Samples were collected at each home from an entryway to the yard as well as in an interior living space (e.g., family room, living room). The results presented in this table are for dust samples collected in interior living spaces only.

¶ Value was less than author-specified method detection limit. For this study, method detection limits varied because they were defined as mean concentration of procedural blanks plus three times the standard deviation of blank response. Values included in this table represent the upper bound of the method detection limit for a given PFAS, unless noted by "ND" (i.e., for PFTrA). For PFTrA, the upper bound method detection limit was greater than the maximum detected value. For PFTrA, the method detection limits ranged from 0.48 to 2.32 ng/g.** Reporting limits for dust not specified in Wu et al. (2015).

Table A2. Comparison values for PFAS measured in blood from other exposure assessments

PFAS/Population	Reference	Geometric Mean for Blood (µg/L)
PFHxS		
Manufacturing workers, Decatur, AL	Olsen et al. 2003	180.0
Montgomery and Bucks Counties, PA	PA DOH 2019	6.6
Decatur, AL	ATSDR 2013	6.4
Little Hocking Water Association, OH	Frisbee et al. 2009	5.7*
Westfield EA[†]	This EA	4.7
Portsmouth, NH	NH DPHS 2016	4.1
Westhampton Beach/Quogue Area, NY	NYDOH 2019	3.0
General U.S. population (NHANES 1999/2000)	CDC 2019	2.1
General U.S. population (NHANES 2015/2016)	CDC 2019	1.2
PFOS		
Manufacturing workers, Decatur, AL	Olsen et al. 2003	941.0
Decatur, AL	ATSDR 2013	39.8
General U.S. population (NHANES 1999/2000)	CDC 2019	30.4
Little Hocking Water Association, OH	Frisbee et al. 2009	23.5*
Montgomery and Bucks Counties, PA	PA DOH 2019	10.2
Portsmouth, NH	NH DPHS 2016	8.6
Westhampton Beach/Quogue Area, NY	NYDOH 2019	6.6
Westfield EA[†]	This EA	5.9
General U.S. population (NHANES 2015/2016)	CDC 2019	4.7
PFOA		
Manufacturing workers, Decatur, AL	Olsen et al. 2003	899.0
Little Hocking Water Association, OH	Frisbee et al. 2009	227.6*
Decatur, AL	ATSDR 2013	16.3
General U.S. population (NHANES 1999/2000)	CDC 2019	5.2
Montgomery and Bucks Counties, PA	PA DOH 2019	3.1
Portsmouth, NH	NH DPHS 2016	3.1
Westfield EA[†]	This EA	1.9
General U.S. population (NHANES 2015/2016)	CDC 2019	1.6
Westhampton Beach/Quogue Area, NY	NYDOH 2019	1.5

µg/L = micrograms per liter

* The study reported medians instead of geometric means.

[†] Unadjusted geometric means from the Westfield EA are included in this table for comparison.

Appendix B: Additional Background Statistics

As described in the main body of this report, all statistical analyses (e.g., correlations, geometric means, univariate linear regression models, multivariate linear regression models) were completed in SAS version 9.4 (SAS Institute, Cary, NC) following the methods outlined in the study protocol. Several key details on these methods are provided below.

- Consistent with NHANES methodology and per the EA protocol, all non-detect observations were substituted with a value equal to the LOD divided by the square root of 2. Geometric means were not reported for PFAS with 40% or more non-detect observations. Additional information on the effect of this substitution method is provided below.
- Geometric means, 95% confidence intervals around geometric means, and percentiles were calculated with the SURVEYMEANS procedure in SAS. In this procedure, percentiles are based on the population cumulative distribution function.
- Univariate and multivariate regression analyses were conducted with the SURVEYREG procedure in SAS. Multivariate regressions were conducted using a backwards stepwise approach. "Interactions" were only considered when there was a suspected relationship between two variables. Due to the skewed distribution of PFAS blood levels, log transformed (log_{10}) values were used as dependent variables in all linear regression analyses.
- For this EA, all eligible residents within the randomly selected households were invited to participate. This means a single household may have multiple participants. To account for the one-stage cluster sampling design used for this EA, household IDs were assigned to each participant. All statistics were calculated while accounting for clustering at the household level by including this household ID variable in a CLUSTER statement in SAS survey procedures. Additional information on the effect of clustering is provided below.
- A finite population correction was applied by including the total number of households in the sampling frame in a TOTAL statement in the SAS survey procedures. For this EA, a total of 4,776 households were identified within the sampling frame. A finite population correction corrects the standard errors when sampling without replacement from a finite population and is recommended when sample size is greater than 5% of the population being sampled.
- A p-value of less than 0.05 was used to identify statistically significant associations in regression models and 95% confidence limits were provided for all estimated geometric means.
- Age-adjusted statistics were calculated using the POSTSTRATA statement in the PROC SURVEYREG procedure in SAS. For age adjustments to the sampling frame population, the number of people in the sampling frame for each 5-year age interval (5–9 years, 10–15 years, etc.) was calculated from census block data from 2010 and was used as poststratum totals (_PSTOTAL_). Similarly, for age-adjustments to the NHANES population, estimates of the U.S. population in each age category starting from 12-14 years and increasing by 5-year age intervals (15-20 years, 25-30 years etc.) were calculated.

Additional details on non-detect observations

As noted, all results reported below the LOD were substituted with a value equal to the LOD divided by the square root of 2. For blood, all PFAS and all samples were reported from the laboratory with an LOD of 0.1 µg/L, and non-detect observations were therefore substituted with a value equal to 0.071 µg/L. The same method was applied to urine results (LOD=0.1 µg/L) and dust (LOD varies by PFAS and sample); no summary statistics were computed for tap water for this EA due to low detection frequency.

The study protocol also notes that a sensitivity analysis of aggregate PFAS blood data should be performed using other statistical methods to account for censoring. More specifically, for datasets in which less than 50% of the data are censored (i.e., not detected), the Kaplan-Meier method should be used to calculate summary statistics; and for data sets with between 50% and 80% censored results, maximum likelihood estimation should be used. Only high sample percentiles should be reported for data sets with more than 80% censoring. Given that no nationally representative comparison values using these methods are available, results of this sensitivity analyses should only be used as a comparison to results obtained using the simpler substitution method described above.

Based on these criteria, ATSDR compared geometric means for all PFAS measured in blood (except Sb-PFOA) using the two alternate substitution methods. As shown in Table B1, there is little to no difference in geometric mean estimates when using these methods, and alterative substitution methods would therefore have no effect on the conclusions of this report. This is expected for these data due to the single censoring threshold for all PFAS and blood samples [Helsel 2009].

Table B1. Comparison of geometric mean blood levels with various substitution methods

PFAS	Geometric Mean Calculated with LOD/Square Root of 2 (µg/L)	Geometric Mean Calculated with Kaplan Meier Approach (µg/L)	Geometric Mean Calculated with Maximum Likelihood Estimation (µg/L)
PFHxS	4.67	4.68	4.71
n-PFOS	3.93	3.94	3.95
sm-PFOS	1.86	1.86	1.87
n-PFOA	1.82	1.82	1.83
sb-PFOA	—*	—*	—*
PFNA	0.43	0.43	0.43
PFDA	0.15	0.16	0.15
PFUnA	0.12	0.14	0.10
MeFOSAA	0.12	0.14	0.10

LOD = limit of detection, µg/L = micrograms per liter

* LOD does not meet the threshold set in EA protocol for sensitivity analyses (<20%).

More details on precision and clustering for PFAS blood data

As noted in the study protocol, this investigation was designed to estimate mean concentrations of PFAS in blood for the sampling frame population, with a given level of precision. The target sample size for this EA was based on a desired precision of 15% and 5% level of significance. Table B2 presents the estimated precision for the mean of the log transformed (ln) PFAS concentrations. This was calculated as the difference between the upper confidence interval of ln(PFAS) and the mean ln(PFAS), divided by mean ln(PFAS). Precision estimates ranged from approximately 8% to 14%, which were below the target precision of 15% for the EA. Additional information on target precision is provided in the study protocol.

Note that throughout the main body of the report and Appendix C, geometric means are presented with 95% confidence intervals and regression modeling results are presented with p-values. These statistics provide further insight into the precision of those estimates.

To quantify the effect of clustering and to compare the results of this EA to the assumptions used to determine the target sample size for the EA (listed in the protocol), ATSDR calculated the intra-cluster correlation coefficient (ICC) and design effect for each PFAS that was detected in at least 60% of blood samples (Table B2). ICCs were estimated using variance components from the MIXED procedure in SAS. In brief, a mixed model was run for each PFAS while treating clusters (i.e., households) as a random effect. The ICC was calculated as the ratio of the variance attributable to the random effect (households) divided by the total of the random effect and error variances. The design effect was calculated using the DEFF option in the MODEL statement of the SURVEYREG procedure in SAS. This provides an estimate of the ratio of the actual variance to the variance computed under the assumption of simple random sampling. This information, along with the average number of study participants per house, was then used to calculate the effective sample size for each PFAS. This statistic provides an estimate of the sample size that would be required to achieve the same level of precision if a simple random sample study design was used.

The target sample size for this EA was 395 people, based on (1) an ICC of 0.54 for PFOS calculated from data collected as part of biomonitoring study conducted by the New York State Department of Health and the Pennsylvania Department of Health, (2) a design effect of 2.1, and (3) an effective sample size of 188 people. Refer to the study protocol for more details on how these values were derived.

Table B2. Statistics related to clustering in blood data (all participants)

PFAS	Household ICC (Unitless)	Design Effect (Unitless)	Effective Sample Size (n)	Standard Deviation of ln(PFAS) (µg/L)	Precision of Mean ln(PFAS) (%)
PFHxS	0.48	1.62	284	1.34	7.9
PFOS	0.29	1.47	311	0.91	4.7
n-PFOS	0.30	1.49	309	0.94	6.3
Sm-PFOS	0.29	1.45	317	0.93	13.7
PFOA	0.31	1.46	315	0.72	10.1
n-PFOA	0.28	1.42	323	0.75	11.5
Sb-PFOA	NA*	NA*	NA*	NA*	NA*
PFNA	0.19	1.24	370	0.71	7.7
PFDA	0.42	1.47	312	0.67	3.3
PFUnA	NA*	NA*	NA*	NA*	NA*
MeFOSAA	NA*	NA*	NA*	NA*	NA*

µg/L = micrograms per liter, NA = not applicable

* Per the protocol, geometric means were not calculated for PFAS detected in less than 60% of samples.

Blood ICCs for this EA ranged from 0.19 to 0.48, suggesting weak to moderate correlation. The design effects ranged from 1.24 to 1.62, all of which are lower than the assumed design effect of 2.1. Effective sample size estimates ranged from 284 to 370, all of which are greater than the effective sample size of 188. The design effect in this EA is smaller than that assumed in the protocol in part because of a smaller standard deviation of ln(PFAS) (the protocol assumed a standard deviation of 1.63), and because of a smaller number of people per household. In this EA the average number of people per household was 1.87 (compared to 3.0, assumed in the protocol).

Appendix C: PFAS Blood Levels by Demographics and Exposure Characteristics

This appendix provides geometric mean blood PFAS concentrations and 95% confidence intervals stratified by demographic or exposure characteristics for the five PFAS with detection frequencies above 60% (i.e., PFHxS, PFOS, PFOA, PFNA, and PFDA). Also included are univariate regressions, multivariate regressions, and boxplots. For each regression, the outputs shown are coefficient estimates, p-values, and marginal effects. The coefficient represents the increase in PFAS blood levels (in units of $\log_{10}$[µg/L]) per unit increase of the independent variable shown on the left side of the table for continuous variables, or when comparing to the reference category for categorical variables. The p-value indicates the significance of the results. Generally, p-values less than 0.05 indicate significant results. The marginal effect is the percent change in PFAS blood levels (in units of µg/L) per unit increase of the continuous variables, or in comparison to the reference category for categorical variables.

Contents

Table C1. Adult geometric means (GM), 95% lower confidence intervals (LCI), and 95% upper confidence intervals (UCI) in micrograms per liter*,†,‡

Variable	Category	Frequency§	PFHxS			PFOS			PFOA			PFNA			PFDA		
			GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI
All Adults		410	**5.04**	4.45	5.70	**6.31**	5.81	6.84	**1.97**	1.84	2.11	**0.43**	0.40	0.46	**0.16**	0.15	0.17
Age (years)	18 to <50	147	**3.06**	2.56	3.65	**4.40**	3.90	4.95	**1.56**	1.41	1.72	**0.36**	0.32	0.40	**0.15**	0.14	0.17
	50+	262	**6.68**	5.80	7.69	**7.70**	7.02	8.45	**2.24**	2.07	2.43	**0.48**	0.44	0.52	**0.16**	0.15	0.17
Sex	Female	221	**4.65**	4.00	5.41	**5.35**	4.82	5.94	**1.83**	1.68	1.99	**0.40**	0.36	0.44	**0.16**	0.14	0.17
	Male	188	**5.55**	4.77	6.46	**7.67**	6.93	8.49	**2.16**	1.98	2.35	**0.48**	0.44	0.52	**0.16**	0.15	0.18
Body mass index (kilograms per square meter)	15 to 20	26	**3.54**	2.28	5.51	**4.76**	3.58	6.34	**1.62**	1.31	2.01	**0.34**	0.26	0.43	**0.13**	0.11	0.15
	20 to <25	88	**4.78**	3.67	6.22	**5.60**	4.67	6.72	**1.89**	1.64	2.18	**0.42**	0.37	0.48	**0.17**	0.15	0.19
	25 to <30	139	**5.65**	4.64	6.88	**7.14**	6.25	8.15	**2.12**	1.89	2.38	**0.45**	0.40	0.51	**0.17**	0.16	0.19
	30 to <35	97	**5.13**	4.30	6.13	**7.08**	6.24	8.02	**2.06**	1.86	2.27	**0.50**	0.45	0.56	**0.16**	0.14	0.17
	35+	47	**4.66**	3.29	6.61	**5.32**	4.19	6.77	**1.82**	1.50	2.20	**0.35**	0.30	0.41	**0.13**	0.11	0.15
Race and ethnicity combined	White alone, not Hispanic	369	**5.23**	4.60	5.95	**6.45**	5.92	7.01	**2.02**	1.88	2.16	**0.43**	0.40	0.47	**0.16**	0.15	0.17
	Not white, or Hispanic	32	**3.41**	2.32	5.02	**5.14**	3.85	6.86	**1.55**	1.26	1.91	**0.42**	0.32	0.56	**0.17**	0.14	0.22
Length of residence at current address (years)	<10	112	**3.33**	2.75	4.02	**4.92**	4.29	5.64	**1.71**	1.52	1.92	**0.38**	0.34	0.43	**0.16**	0.14	0.18
	10 to <20	132	**4.76**	3.83	5.93	**5.65**	4.89	6.53	**1.80**	1.60	2.03	**0.39**	0.35	0.44	**0.15**	0.14	0.17
	20 to <30	70	**5.75**	4.20	7.85	**7.51**	6.30	8.96	**2.14**	1.85	2.47	**0.48**	0.41	0.56	**0.16**	0.13	0.18
	30+	96	**8.01**	6.41	10.01	**8.61**	7.36	10.08	**2.49**	2.19	2.82	**0.54**	0.47	0.62	**0.17**	0.15	0.20
Total length of residence in sampling frame over the past 20 years (years)	<10	54	**3.16**	2.36	4.23	**5.30**	4.40	6.39	**1.75**	1.47	2.09	**0.39**	0.32	0.46	**0.17**	0.15	0.20
	10 to <15	44	**3.64**	2.49	5.33	**4.62**	3.55	6.01	**1.55**	1.28	1.88	**0.35**	0.29	0.42	**0.16**	0.13	0.19
	15 to 20	312	**5.72**	4.99	6.55	**6.79**	6.20	7.43	**2.08**	1.93	2.24	**0.46**	0.42	0.49	**0.16**	0.14	0.17
Current and primary source of drinking water	Public water system§	302	**5.37**	4.62	6.23	**6.57**	5.97	7.24	**2.02**	1.86	2.19	**0.43**	0.40	0.47	**0.16**	0.15	0.17
	Bottled water	103	**4.26**	3.46	5.25	**5.59**	4.81	6.50	**1.84**	1.63	2.07	**0.43**	0.37	0.50	**0.15**	0.13	0.17

Variable	Category	Frequency[§]	PFHxS			PFOS			PFOA			PFNA			PFDA		
			GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI
Tap water consumption at current home (average cups per day)	0	58	**4.38**	3.39	5.65	**5.82**	4.79	7.08	**1.83**	1.56	2.15	**0.44**	0.37	0.53	**0.14**	0.12	0.17
	>0 to <2	23	**4.50**	3.11	6.52	**6.38**	4.92	8.26	**1.85**	1.58	2.17	**0.54**	0.40	0.74	**0.15**	0.12	0.19
	2 to <4	81	**4.75**	3.78	5.97	**6.19**	5.26	7.28	**1.92**	1.67	2.21	**0.41**	0.35	0.47	**0.17**	0.15	0.20
	4 to <6	86	**4.56**	3.68	5.65	**6.38**	5.62	7.24	**1.86**	1.70	2.04	**0.46**	0.40	0.52	**0.16**	0.14	0.18
	6 to <8	57	**5.25**	3.61	7.62	**5.99**	4.70	7.63	**2.00**	1.61	2.48	**0.45**	0.37	0.55	**0.16**	0.14	0.20
	8+	105	**6.19**	4.78	8.02	**6.79**	5.66	8.15	**2.20**	1.92	2.54	**0.40**	0.35	0.45	**0.16**	0.14	0.18
Current use of filter or treatment device for tap water at home	None, no filter or treatment device	104	**5.66**	4.48	7.15	**6.56**	5.61	7.67	**2.10**	1.83	2.41	**0.45**	0.39	0.51	**0.15**	0.13	0.18
	None, drink bottled water only	68	**4.64**	3.69	5.83	**5.78**	4.83	6.91	**1.75**	1.51	2.02	**0.40**	0.34	0.48	**0.15**	0.13	0.17
	Use at least one filter or treatment device	236	**4.90**	4.14	5.79	**6.35**	5.71	7.06	**1.98**	1.82	2.16	**0.44**	0.40	0.47	**0.17**	0.15	0.18
History of kidney disease	No	374	**5.01**	4.42	5.69	**6.35**	5.85	6.89	**1.98**	1.86	2.12	**0.43**	0.40	0.46	**0.16**	0.15	0.17
	Yes	32	**4.91**	3.43	7.05	**5.60**	4.30	7.28	**1.75**	1.41	2.17	**0.40**	0.34	0.48	**0.17**	0.15	0.20
Frequency of blood donation	Never/rarely	375	**5.21**	4.58	5.93	**6.44**	5.92	7.01	**1.99**	1.86	2.14	**0.44**	0.41	0.47	**0.16**	0.15	0.17
	Once or more a year	35	**3.52**	2.61	4.73	**5.02**	4.02	6.27	**1.73**	1.47	2.04	**0.40**	0.33	0.47	**0.14**	0.12	0.16
Frequency of house cleaning	A few times per month or less	221	**5.02**	4.21	5.98	**6.30**	5.61	7.07	**2.02**	1.84	2.21	**0.43**	0.39	0.47	**0.16**	0.15	0.17
	Three times per week or more	189	**5.06**	4.28	5.98	**6.32**	5.65	7.06	**1.92**	1.75	2.11	**0.44**	0.40	0.49	**0.16**	0.14	0.18
Frequency of stain-resistant product use	Never	360	**4.78**	4.19	5.46	**6.12**	5.61	6.68	**1.94**	1.81	2.08	**0.43**	0.40	0.47	**0.16**	0.15	0.17
	Rarely or more frequently	49	**7.35**	5.25	10.28	**7.87**	6.26	9.90	**2.26**	1.86	2.75	**0.43**	0.35	0.53	**0.16**	0.14	0.20

Variable	Category	Frequency[§]	PFHxS			PFOS			PFOA			PFNA			PFDA		
			GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI
Frequency of direct contact with soil at locations within the sampling frame	A few times per year or less	145	**4.60**	3.80	5.57	**6.00**	5.31	6.77	**1.82**	1.64	2.02	**0.41**	0.37	0.46	**0.15**	0.14	0.17
	A few times per month	125	**5.00**	4.07	6.12	**6.44**	5.63	7.38	**2.08**	1.85	2.33	**0.45**	0.39	0.51	**0.16**	0.14	0.18
	Three times per week or more	140	**5.57**	4.57	6.80	**6.51**	5.67	7.48	**2.04**	1.83	2.27	**0.44**	0.40	0.48	**0.16**	0.15	0.18
Consumption of fruits and vegetables from locations within the sampling frame	No	114	**4.32**	3.49	5.36	**6.18**	5.40	7.07	**1.77**	1.58	1.98	**0.41**	0.36	0.46	**0.14**	0.13	0.16
	Yes	288	**5.46**	4.70	6.34	**6.47**	5.85	7.15	**2.07**	1.91	2.25	**0.45**	0.42	0.49	**0.17**	0.15	0.18
Consumption of local fish (i.e., fish caught within the sampling frame)	No	394	**5.15**	4.55	5.83	**6.40**	5.89	6.95	**1.98**	1.85	2.12	**0.43**	0.40	0.46	**0.16**	0.15	0.17
	Yes	12	**2.87**	1.51	5.46	**4.23**	2.79	6.40	**1.76**	1.33	2.34	**0.46**	0.29	0.72	**0.16**	0.12	0.21
Frequency of local milk consumption (i.e., milk from animals within the sampling frame)	Never	384	**5.12**	4.51	5.81	**6.37**	5.87	6.92	**2.00**	1.87	2.14	**0.44**	0.41	0.47	**0.16**	0.15	0.17
	Rarely or more frequently	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Frequency of fast food consumption	Three times per week or more	63	**4.09**	3.17	5.27	**5.90**	4.92	7.08	**1.94**	1.69	2.21	**0.40**	0.35	0.47	**0.13**	0.12	0.15
	A few times per month	215	**5.14**	4.36	6.06	**6.36**	5.72	7.08	**1.95**	1.77	2.14	**0.44**	0.40	0.49	**0.17**	0.15	0.18
	A few times per year or less	130	**5.37**	4.29	6.72	**6.39**	5.51	7.41	**2.03**	1.81	2.28	**0.43**	0.38	0.48	**0.16**	0.14	0.18

Variable	Category	Frequency[§]	PFHxS			PFOS			PFOA			PFNA			PFDA		
			GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI
Presence of carpeting in bedroom, living room, or kitchen	No	136	**4.67**	3.74	5.82	**6.08**	5.24	7.04	**1.91**	1.69	2.16	**0.44**	0.38	0.50	**0.16**	0.14	0.18
	Yes	274	**5.23**	4.52	6.06	**6.42**	5.83	7.08	**2.00**	1.85	2.17	**0.43**	0.40	0.47	**0.16**	0.15	0.17
Occupational exposures (count of jobs with potential PFAS exposures)	None	348	**5.02**	4.38	5.74	**6.24**	5.70	6.84	**1.96**	1.83	2.11	**0.43**	0.40	0.47	**0.16**	0.15	0.17
	One or more	30	**5.92**	4.24	8.27	**7.26**	5.96	8.84	**2.22**	1.81	2.72	**0.47**	0.39	0.57	**0.19**	0.16	0.23
Females only																	
Biological children	No	50	**4.03**	2.97	5.48	**4.82**	3.88	5.98	**1.85**	1.58	2.17	**0.42**	0.36	0.48	**0.16**	0.13	0.18
	Yes	172	**4.83**	4.09	5.70	**5.50**	4.90	6.17	**1.82**	1.65	2.00	**0.39**	0.35	0.44	**0.16**	0.14	0.17
Number of biological children	0	50	**4.03**	2.97	5.48	**4.82**	3.88	5.98	**1.85**	1.58	2.17	**0.42**	0.36	0.48	**0.16**	0.13	0.18
	1	41	**4.05**	2.87	5.70	**5.17**	4.11	6.51	**1.73**	1.42	2.12	**0.41**	0.33	0.52	**0.15**	0.13	0.19
	2	83	**4.56**	3.60	5.78	**5.29**	4.47	6.27	**1.79**	1.56	2.06	**0.38**	0.33	0.44	**0.16**	0.14	0.17
	3+	48	**6.20**	4.61	8.34	**6.19**	5.05	7.60	**1.93**	1.60	2.34	**0.41**	0.32	0.51	**0.15**	0.13	0.19
Breastfeeding or previously breastfed children	No	111	**5.53**	4.45	6.89	**6.07**	5.19	7.10	**2.02**	1.79	2.28	**0.44**	0.40	0.50	**0.15**	0.14	0.17
	Yes	111	**3.88**	3.21	4.70	**4.70**	4.14	5.32	**1.65**	1.47	1.84	**0.36**	0.31	0.41	**0.16**	0.14	0.18
Total duration of breastfeeding for all children (months)	0	110	**5.59**	4.49	6.95	**6.10**	5.21	7.14	**2.03**	1.80	2.29	**0.45**	0.40	0.50	**0.15**	0.14	0.17
	>0 to <6	25	**3.42**	2.60	4.49	**4.60**	3.76	5.63	**1.77**	1.47	2.12	**0.44**	0.32	0.62	**0.19**	0.15	0.24
	6 to <12	23	**4.70**	2.93	7.52	**5.54**	4.07	7.54	**1.85**	1.45	2.36	**0.36**	0.27	0.49	**0.17**	0.13	0.22
	12 to <18	21	**4.49**	2.90	6.96	**4.99**	3.91	6.38	**1.72**	1.38	2.16	**0.38**	0.28	0.51	**0.12**	0.10	0.16
	18+	42	**3.52**	2.53	4.88	**4.21**	3.38	5.25	**1.44**	1.17	1.78	**0.30**	0.25	0.37	**0.16**	0.13	0.18

* Several variables that were collected in the questionnaire are not included in these tables. These variables may not be included because they did not have sufficient variability or were not associated with PFAS blood concentrations in preliminary analyses. These variables include full-time vs. part-time residence, behavior change questions, and occupational history in specific industries.

† Geometric means and confidence levels are not shown for categories with fewer than 10 responses.

‡ Detection limits for all PFAS are 0.1 micrograms per liter (µg/L).

§ Some frequency counts may not sum to the total because of missing values. Some variable categories that were presented in the questionnaire were collapsed into larger variable categories.

Table C2. Child geometric means (GM), lower confidence intervals (LCI), and upper confidence intervals (UCI) in micrograms per liter*,†,‡

Variable	Category	Frequency§	PFHxS			PFOS			PFOA			PFNA			PFDA		
			GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI
All Children		49	**2.49**	2.03	3.06	**3.23**	2.78	3.76	**1.47**	1.31	1.66	**0.41**	0.35	0.48	**0.11**	0.10	0.12
Age (years)	3 to <12	22	**2.75**	2.08	3.64	**3.06**	2.44	3.84	**1.66**	1.41	1.95	**0.36**	0.30	0.43	**0.12**	0.10	0.14
	12 to <18	27	**2.30**	1.70	3.11	**3.38**	2.76	4.15	**1.34**	1.13	1.59	**0.46**	0.35	0.60	**0.09**	0.08	0.10
Sex	Female	24	**2.47**	1.90	3.22	**3.18**	2.54	3.99	**1.45**	1.21	1.75	**0.34**	0.28	0.42	**0.10**	0.09	0.12
	Male	25	**2.51**	1.81	3.50	**3.28**	2.72	3.96	**1.49**	1.27	1.76	**0.49**	0.41	0.59	**0.11**	0.10	0.12
Body mass index (kilograms per square meter)	<15	7	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	15 to 20	22	**2.37**	1.70	3.29	**3.23**	2.65	3.95	**1.45**	1.20	1.76	**0.42**	0.33	0.52	**0.11**	0.09	0.13
	20 to <25	10	**2.46**	1.83	3.32	**3.48**	2.52	4.81	**1.44**	1.11	1.87	**0.43**	0.27	0.69	**0.09**	0.08	0.11
	25+	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Birth order	First born	24	**2.45**	1.76	3.40	**3.20**	2.64	3.89	**1.47**	1.25	1.72	**0.44**	0.36	0.53	**0.10**	0.09	0.11
	Second born	16	**3.00**	2.38	3.78	**3.39**	2.86	4.02	**1.60**	1.37	1.86	**0.42**	0.31	0.56	**0.11**	0.10	0.13
	Third born	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Fourth born	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Race and ethnicity combined	White alone, Not Hispanic	36	**2.38**	1.85	3.08	**3.27**	2.69	3.98	**1.51**	1.31	1.74	**0.42**	0.34	0.52	**0.10**	0.09	0.11
	Not white alone, or Hispanic	12	**2.85**	2.02	4.02	**3.17**	2.53	3.99	**1.38**	1.04	1.83	**0.39**	0.30	0.50	**0.11**	0.09	0.14
Water consumption at current home (average cups per day)	0 to <2	13	**2.19**	1.38	3.46	**3.18**	2.44	4.15	**1.37**	1.10	1.71	**0.45**	0.32	0.65	**0.10**	0.09	0.11
	2 to <4	13	**2.57**	1.67	3.97	**3.18**	2.58	3.92	**1.47**	1.14	1.89	**0.42**	0.34	0.53	**0.12**	0.10	0.16
	4+	22	**2.62**	1.89	3.62	**3.27**	2.43	4.40	**1.55**	1.26	1.91	**0.38**	0.28	0.50	**0.10**	0.09	0.11
Water consumption at school (average cups per day)	0 to <1	12	**1.87**	1.22	2.87	**3.09**	2.21	4.31	**1.30**	0.99	1.71	**0.40**	0.30	0.53	**0.10**	0.08	0.12
	1 to <2	12	**2.21**	1.29	3.80	**2.82**	1.91	4.14	**1.35**	1.04	1.77	**0.41**	0.30	0.58	**0.11**	0.09	0.13
	2 to <3	12	**2.98**	2.42	3.66	**3.37**	2.79	4.06	**1.67**	1.34	2.08	**0.43**	0.32	0.60	**0.13**	0.10	0.16
	3+	13	**3.07**	1.99	4.75	**3.70**	2.78	4.92	**1.59**	1.28	1.97	**0.40**	0.27	0.59	**0.09**	0.09	0.10
Length of residency in sampling frame (years)	<6	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	6 to <12	25	**2.66**	1.97	3.59	**2.96**	2.36	3.72	**1.49**	1.25	1.77	**0.36**	0.30	0.44	**0.11**	0.10	0.13
	12 to <18	20	**2.42**	1.74	3.37	**3.68**	2.92	4.64	**1.42**	1.17	1.74	**0.49**	0.35	0.68	**0.09**	0.08	0.10

Variable	Category	Frequency[§]	PFHxS			PFOS			PFOA			PFNA			PFDA		
			GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI	GM	LCI	UCI
Frequency of direct contact with soil at locations within the sampling frame	A few times per year or less	6	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	A few times per month	16	**2.01**	1.41	2.85	**3.11**	2.14	4.50	**1.38**	1.07	1.77	**0.41**	0.29	0.58	**0.10**	0.08	0.12
	Three times per week or more	27	**3.17**	2.54	3.95	**3.49**	3.02	4.03	**1.62**	1.41	1.85	**0.45**	0.38	0.53	**0.11**	0.10	0.12
Consumption of fruits and vegetables from locations within the sampling frame	No	12	**2.35**	1.40	3.94	**3.76**	2.89	4.90	**1.50**	1.12	2.01	**0.46**	0.33	0.65	**0.10**	0.08	0.11
	Yes	37	**2.54**	2.00	3.24	**3.08**	2.56	3.71	**1.46**	1.27	1.68	**0.40**	0.33	0.48	**0.11**	0.10	0.12
Frequency of local milk consumption (i.e., milk from animals within the sampling frame)	Rarely or more frequently	3	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Never	42	**1.49**	1.49	1.49	**1.76**	1.76	1.76	**1.07**	1.07	1.07	**0.29**	0.29	0.29	**0.10**	0.10	0.10
Drank formula reconstituted with tap water	No	26	**2.61**	1.86	3.68	**3.41**	2.74	4.25	**1.60**	1.34	1.91	**0.37**	0.30	0.45	**0.10**	0.09	0.11
	Yes	23	**2.36**	1.83	3.06	**3.05**	2.43	3.81	**1.34**	1.14	1.58	**0.47**	0.35	0.62	**0.11**	0.09	0.13
Duration of drinking formula reconstituted with tap water duration (months)	<7	34	**2.53**	1.92	3.35	**3.33**	2.79	3.97	**1.50**	1.28	1.75	**0.40**	0.33	0.48	**0.10**	0.09	0.11
	7 to <13	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	13 to <19	2	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	19+	4	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
Currently breastfeeding or previously breastfed	No	9	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
	Yes	40	**2.59**	2.04	3.28	**3.27**	2.72	3.92	**1.54**	1.34	1.77	**0.42**	0.35	0.51	**0.11**	0.10	0.12
Breastfeeding duration (months)	<7	26	**2.07**	1.50	2.86	**2.91**	2.31	3.66	**1.26**	1.08	1.47	**0.41**	0.31	0.55	**0.10**	0.09	0.11
	7 to <19	11	**3.04**	2.06	4.50	**3.68**	3.01	4.49	**1.58**	1.26	1.97	**0.45**	0.35	0.57	**0.10**	0.09	0.12
	19+	12	**3.11**	2.62	3.70	**3.63**	2.73	4.83	**1.94**	1.75	2.15	**0.38**	0.29	0.49	**0.13**	0.09	0.17

* Several variables that were collected in the questionnaire are not included in these tables. These variables may not be included because they did not have sufficient variability or were not associated with PFAS blood concentrations in preliminary analyses. These variables include full-time vs. part-time residence and school attendance.

† Geometric means and confidence levels are not shown for categories with fewer than 10 responses.

‡ Detection limits for all PFAS are 0.1 micrograms per liter (µg/L).

§ Some frequency counts may not sum to the total because of missing values. Some variable categories that were presented in the questionnaire were collapsed into larger variable categories.

Table C3. Adult univariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)*

Variable	Category	PFHxS			PFOS			PFOA			PFNA			PFDA		
		Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)
Age	NA—continuous variable	0.011	<.001	2.6	0.008	<.001	1.9	0.005	<.001	1.2	0.004	<.001	0.8	0.001	0.177	0.3
Sex	Male	0.077	0.047	19.3	0.157	<.001	43.4	0.072	0.002	18.2	0.077	0.003	19.3	0.020	0.317	4.8
	Female	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Body mass index	NA—continuous variable	0.002	0.709	0.4	0.001	0.624	0.3	0.001	0.607	0.3	-0.001	0.784	-0.1	-0.004	0.024	-0.9
Race and ethnicity Combined	Not white, or Hispanic	-0.186	0.038	-34.8	-0.098	0.138	-20.3	-0.114	0.020	-23.2	-0.010	0.876	-2.3	0.039	0.440	9.3
	White alone, not Hispanic	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Length of residence at current address (years)	NA—continuous variable	0.009	<.001	2.1	0.006	<.001	1.4	0.004	<.001	1.0	0.004	<.001	0.8	0.000	0.859	0.0
Total length of residence in sampling frame over the past 20 years (years)	NA—continuous variable	0.026	<.001	6.1	0.014	<.001	3.3	0.009	0.002	2.1	0.008	0.009	1.9	-0.003	0.246	-0.7
Current and primary source of drinking water	Bottled water	-0.100	0.077	-20.6	-0.070	0.076	-14.9	-0.041	0.207	-9.0	-0.005	0.903	-1.1	-0.035	0.278	-7.7
	Public water system	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Tap water consumption at current home (average cups per day)	NA—continuous variable	0.010	0.005	2.4	0.004	0.168	0.9	0.006	0.004	1.3	-0.003	0.110	-0.8	-0.000	0.876	-0.1

Variable	Category	PFHxS			PFOS			PFOA			PFNA			PFDA		
		Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)
Current use of filter or treatment device for tap water at home	None, no filter or treatment device	-0.086	0.215	-18.0	-0.055	0.285	-11.9	-0.080	0.065	-16.9	-0.044	0.357	-9.7	-0.023	0.566	-5.2
	None, drink bottled water only	-0.063	0.321	-13.5	-0.014	0.739	-3.1	-0.025	0.480	-5.6	-0.007	0.850	-1.6	0.030	0.391	7.2
	Use at least one filter or treatment device	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
History of kidney disease	Yes	-0.008	0.917	-1.9	-0.055	0.349	-11.8	-0.054	0.259	-11.7	-0.030	0.486	-6.6	0.039	0.308	9.3
	No	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frequency of blood donation	Once or more a Year	-0.171	0.013	-32.5	-0.108	0.032	-22.0	-0.061	0.110	-13.2	-0.041	0.308	-9.0	-0.055	0.131	-11.8
	Never/rarely	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frequency of house cleaning	Three times per week or more	0.004	0.942	0.9	0.001	0.970	0.3	-0.022	0.439	-5.0	0.015	0.606	3.5	-0.000	0.996	-0.0
	A few times per month or less	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frequency of stain-resistant product use	Rarely or more frequently	0.186	0.020	53.5	0.109	0.045	28.6	0.068	0.141	16.8	-0.001	0.978	-0.3	0.017	0.692	4.0
	Never	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frequency of direct contact with soil at locations within the sampling frame	A few times per month	0.036	0.545	8.6	0.031	0.412	7.5	0.057	0.079	14.1	0.035	0.360	8.3	0.012	0.718	2.7
	Three times per week or more	0.083	0.153	21.1	0.036	0.349	8.6	0.050	0.108	12.2	0.027	0.396	6.4	0.022	0.463	5.1
	A few times per year or less	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—

Variable	Category	PFHxS			PFOS			PFOA			PFNA			PFDA		
		Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)
Consumption of fruits and vegetables from locations within the sampling frame	Yes	0.101	0.079	26.3	0.020	0.587	4.7	0.068	0.027	17.0	0.040	0.223	9.6	0.074	0.007	18.7
	No	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Frequency of fast food consumption	A few times per month	-0.018	0.757	-4.2	-0.002	0.967	-0.4	-0.018	0.584	-4.0	0.015	0.632	3.6	0.024	0.401	5.7
	Three times per week or more	-0.118	0.115	-23.8	-0.034	0.512	-7.6	-0.020	0.611	-4.5	-0.027	0.531	-5.9	-0.078	0.024	-16.5
	A few times per year or less	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Presence of carpeting in bedroom, living room, or kitchen	Yes	0.050	0.392	12.1	0.024	0.537	5.7	0.020	0.530	4.8	-0.005	0.871	-1.2	-0.003	0.915	-0.8
	No	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Occupational exposures (count of jobs with potential PFAS exposures)	One or more occupational exposures	0.072	0.353	18.1	0.066	0.177	16.3	0.053	0.258	13.0	0.037	0.396	8.8	0.089	0.016	22.7
	None	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Females only																
Biological children	Yes	0.078	0.295	19.7	0.058	0.273	14.2	-0.008	0.849	-1.8	-0.023	0.585	-5.1	0.000	0.992	0.1
	No	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Number of biological children	NA—continuous variable	0.052	0.058	12.7	0.031	0.092	7.5	0.007	0.662	1.5	-0.006	0.731	-1.3	-0.004	0.794	-0.9
Breastfeeding or previously breastfed children	Yes	-0.154	0.015	-29.8	-0.111	0.010	-22.6	-0.090	0.014	-18.7	-0.095	0.017	-19.6	0.015	0.661	3.5
	No	0.000	—	0.0	0.000	—	0.0	0.000	—	0.0	0.000	—	0.0	0.000	—	0.0

Variable	Category	PFHxS			PFOS			PFOA			PFNA			PFDA		
		Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)
Total duration of breastfeeding for all biological children (months)	NA—continuous variable	-0.005	0.019	-1.2	-0.005	0.004	-1.0	-0.004	0.002	-0.9	-0.005	0.001	-1.1	-0.001	0.567	-0.1

* Not all categorical variables included in Table C1 are included in Table C3: variable categories that had fewer than 10 responses were not included in the regressions (Table C3). These variables include frequency of local milk consumption and the categorical version of the biological children variable.

Table C4. Child univariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

ParamModel	Parameter	PFHxS			PFOS			PFOA			PFNA			PFDA		
		Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)
Age	NA—continuous variable	-0.009	0.347	-2.0	0.008	0.243	1.8	-0.011	0.021	-2.6	0.016	0.109	3.7	-0.019	<.001	-4.3
Sex	Male	0.007	0.933	1.7	0.014	0.809	3.2	0.012	0.820	2.7	0.160	0.001	44.4	0.018	0.689	4.1
	Female	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Body mass index (kilograms per square meter)	NA—continuous variable	-0.002	0.859	-0.4	-0.002	0.782	-0.3	-0.005	0.248	-1.1	0.002	0.637	0.5	-0.005	0.103	-1.1
Race and ethnicity combined	Notwhite alone, or Hispanic	0.077	0.365	19.4	-0.013	0.829	-3.0	-0.039	0.546	-8.7	-0.041	0.553	-9.0	0.038	0.508	9.1
	White alone, not Hispanic	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Water consumption at current home (average cups per day)	NA—continuous variable	0.014	0.491	3.3	0.003	0.789	0.7	0.010	0.351	2.4	-0.013	0.310	-2.9	-0.006	0.353	-1.3
Water consumption at school (average cups per day)	NA—continuous variable	0.057	0.019	13.9	0.024	0.154	5.7	0.027	0.044	6.4	-0.004	0.885	-0.8	-0.002	0.809	-0.5
Length of residency in sampling frame (years)	NA—continuous variable	0.003	0.804	0.7	0.013	0.062	3.1	-0.003	0.623	-0.7	0.014	0.200	3.3	-0.014	0.004	-3.2
Length of residency in sampling frame prior to mitigation date (years)	NA—continuous variable	0.001	0.935	0.2	0.012	0.100	2.7	-0.004	0.491	-0.9	0.015	0.161	3.6	-0.015	0.004	-3.3

ParamModel	Parameter	PFHxS			PFOS			PFOA			PFNA			PFDA		
		Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)	Coef.	p-val	ME (%)
Consumption of fruits and vegetables from locations within the sampling frame	Yes	0.034	0.780	8.2	-0.087	0.218	-18.1	-0.012	0.867	-2.7	-0.070	0.405	-14.9	0.045	0.295	10.9
	No	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Drank formula reconstituted with tap water	Yes	-0.044	0.637	-9.5	-0.049	0.466	-10.7	-0.075	0.157	-15.8	0.106	0.158	27.6	0.033	0.446	8.0
	No	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Drank formula reconstituted with tap water duration (months)	NA—continuous variable	0.001	0.879	0.1	0.000	0.967	0.0	0.001	0.709	0.2	0.002	0.581	0.6	0.004	0.184	1.0
Breastfeeding duration (months)	NA—continuous variable	0.007	0.015	1.7	0.002	0.360	0.5	0.006	<.001	1.5	-0.001	0.726	-0.2	0.005	0.005	1.2

* Not all categorical variables in included in Table C2 are also included in Table C4: variable categories that had fewer than 10 responses were not included in the regressions (Table C4). These variables include birth order, frequency of direct contact with soil at locations within the sampling frame, frequency of local milk consumption, and currently breastfeeding or previously breastfed.

Table C5. PFHxS adult multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.015	<.0001	3.5
Sex: male* (categorical)	0.617	<.0001	314.1
Age × sex: male*,† (continuous)	-0.010	<.0001	-2.3
Years in sampling frame in the past 20 years (continuous)	0.015	0.0028	3.6
Blood donation frequency: once or more per year‡ (categorical)	-0.183	0.0092	-34.4
Stain-resistant product use: ever§ (categorical)	0.159	0.0166	44.3
Tap water consumption at home in cups per day¶ (continuous)	0.012	0.0199	2.8

Model statistics: R^2 = 0.231, p-value = <0.0001, n = 405, n-households = 244, intercept = -0.463

* Reference category is adult participants who identified as female.
† This variable is an interaction term between age and sex.
‡ Reference category is adult participants who reported donating blood never or rarely.
§ Reference category is adult participants who reported never using stain-resistant products.
¶ Two outliers were removed.

Table C6. PFHxS adult female multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.012	<.0001	2.9
Breastfed: yes* (categorical)	-0.662	0.0007	-78.2
Age × breastfed: yes*,† (continuous)	0.009	0.0062	2.2
Stain-resistant product use: ever‡ (categorical)	0.246	0.0028	76.1
Blood donation frequency: once or more a year§ (categorical)	-0.261	0.0057	-45.1

Model statistics: R^2 = 0.338, p-value = <0.0001, n = 220, n-households = 200, intercept = 0.060

* Reference category is adult female participants who reported never having breastfed.
† This variable is an interaction term between age and breastfeeding.
‡ Reference category is adult female participants who reported never using stain-resistant products.
§ Reference category is adult female participants who reported never or rarely donating blood.

Table C7. PFHxS adult male multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.004	0.0371	1.0
Years in sampling frame in the past 20 years (continuous)	0.020	0.0033	4.6
Tap water consumption at home in cups per day * (continuous)	0.019	0.0294	4.4

Model statistics: R2 = 0.116, p-value = <0.0001, n = 185, n-households = 172, intercept = 0.082

* Two outliers were removed.

Table C8. PFOS adult multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.011	0.001	2.6
Sex: male[*] (categorical)	0.500	0.089	216.2
Age × Sex: male[*,†] (continuous)	-0.006	0.002	-1.4
Blood donation frequency: once or more a year[‡] (categorical)	-0.116	0.045	-23.5

Model statistics: R2 = 0.233, p-value = <0.0001, n = 408, n-households = 246, intercept = 0.125

* Reference category is adult participants who identified as female.

† This variable is an interaction term between age and sex.

‡ Reference category is adult participants who reported donating blood never or rarely.

Table C9. PFOS adult female multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.009	<.0001	2.2
Breastfed: yes* (categorical)	-0.341	0.0200	-54.4
Age × breastfed: yes*[,†] (continuous)	0.005	0.0705	1.1
Blood donation frequency: once or more a year[‡] (categorical)	-0.173	0.0020	-32.9

Model statistics: R2 = 0.3024, p-value = <0.0001, n = 221, n-households = 201, intercept = 0.273

* Reference category is adult female participants who reported never having breastfed.

† This variable is an interaction term between age and breastfeeding.

‡ Reference category is adult female participants who reported donating blood never or rarely.

Table C10. PFOS adult male multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.005	0.0001	1.1

Model statistics: R2 = 0.06646, p-value = 0.0001, n = 187, n-households = 174, intercept = 0.623

Table C11. PFOA adult multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.008	<.0001	1.8
Sex: male* (categorical)	0.376	<.0001	137.6
Age × sex: male*,† (continuous)	-0.006	<.0001	-1.3
Tap water consumption at home in cups per day ‡ (continuous)	0.007	0.0216	1.6

Model statistics: R2 = 0.140, p-value = <0.0001, n = 406, n-households = 245, intercept = -0.197

* Reference category is adult participants who identified as female.
† This variable is an interaction term between age and sex.
‡ Two outliers were removed.

Table C12. PFOA adult female multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.005	0.0002	1.2
Breastfed: yes* (categorical)	-0.453	0.0002	-64.8
Age × breastfed: yes*,† (continuous)	0.007	0.0012	1.6

Model statistics: R2 = 0.225, p-value = <0.0001, n = 221, n-households = 201, intercept = 0.022

* Reference category is adult female participants who reported never having breastfed.
† This variable is an interaction term between age and breastfeeding.

Table C13. PFOA adult male multivariate regression results including coefficient estimate (Coef.), p-value (p-val), and marginal effect (ME)

Parameter	Coef.	p-val	ME (%)
Age (continuous)	0.002	0.0374	0.5
Tap water consumption at home in cups per day* (continuous)	0.013	0.0033	3.1

Model statistics: R2 = 0.06879, p-value = 0.0008, n = 185, n-households = 172, intercept = 0.149

* Two outliers were removed.

Boxplots

Figure C1. Boxplot of adult blood concentrations by age

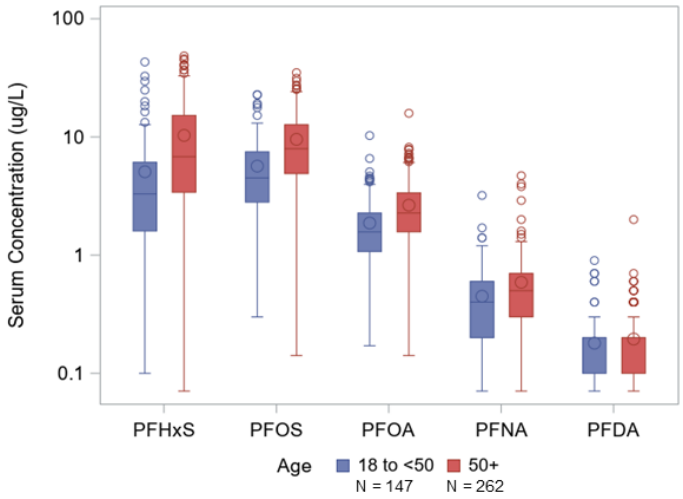

Figure C2. Boxplot of adult blood concentrations by sex

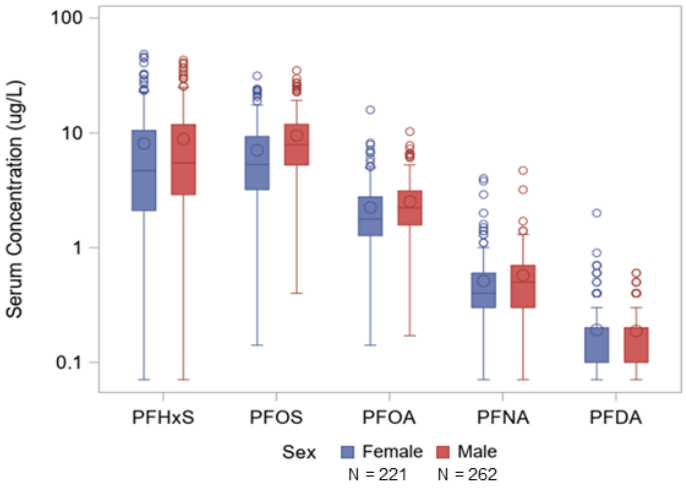

Figure C3. Boxplot of adult blood concentrations by race and ethnicity

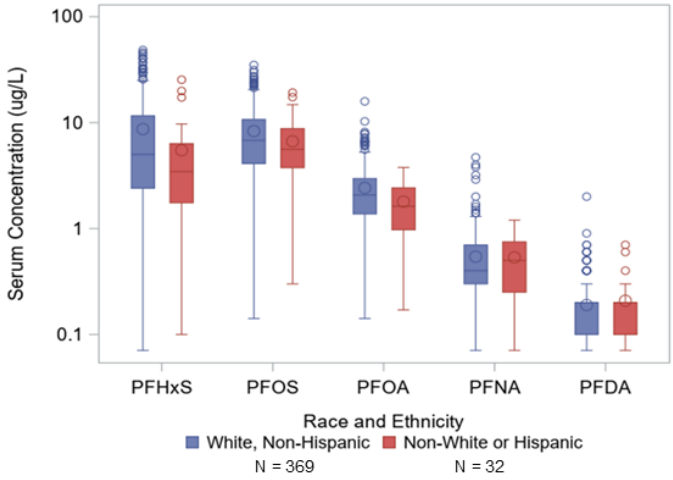

Figure C4. Boxplot of adult blood concentrations by body mass index

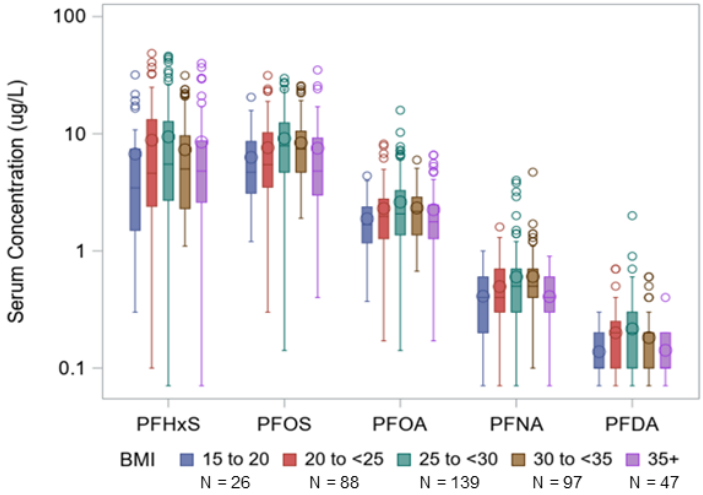

Figure C5. Boxplot of adult blood concentrations by years in current home

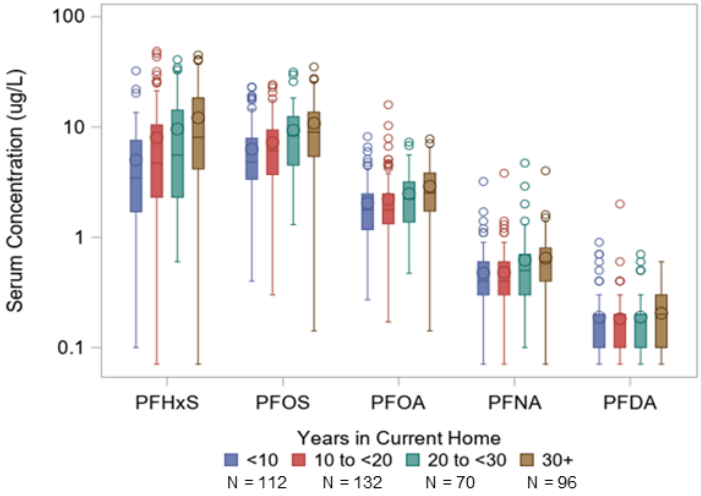

Figure C6. Boxplot of adult blood concentrations by years in sampling frame (past 20 years)

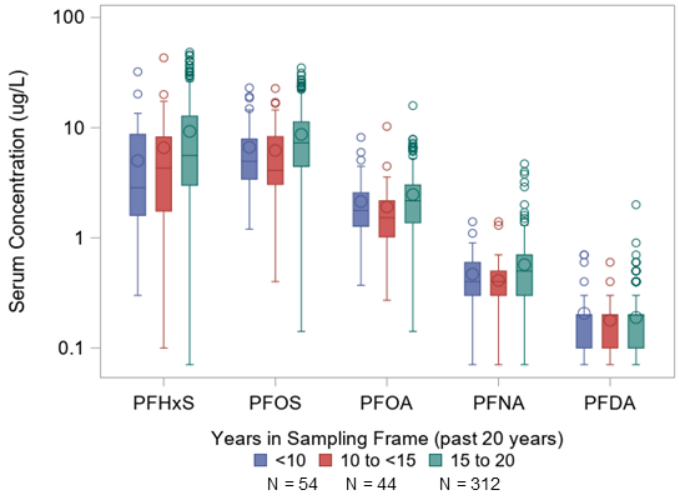

Figure C7. Boxplot of adult blood concentrations by cups of tap water drank at home

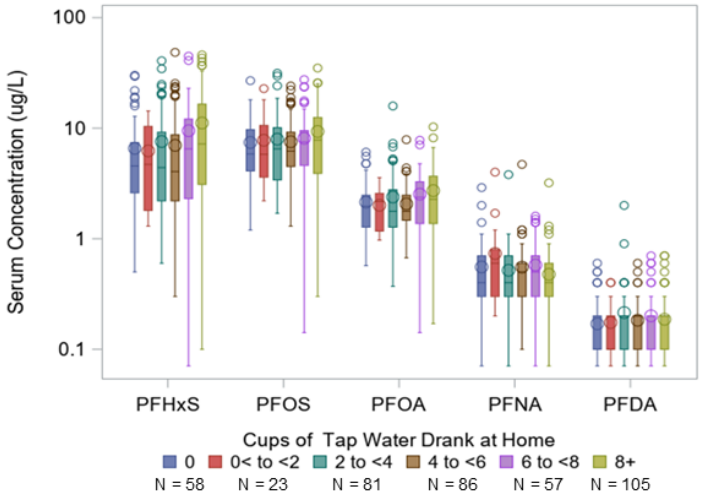

Figure C8. Boxplot of adult blood concentrations by drinking water source

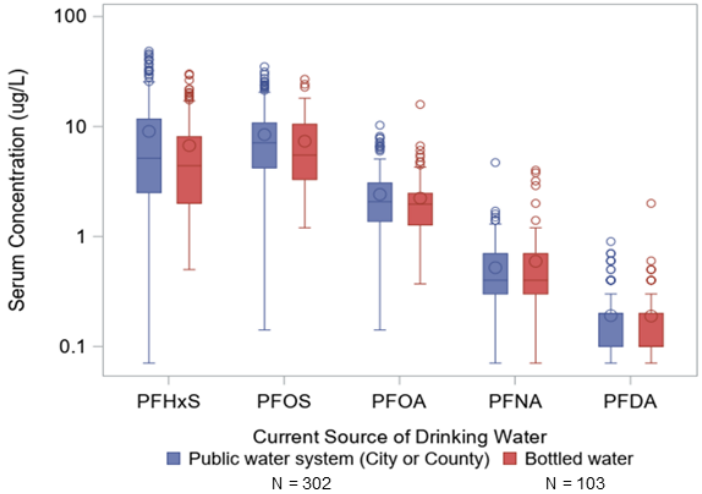

Figure C9. Boxplot of adult blood concentrations by water filter type

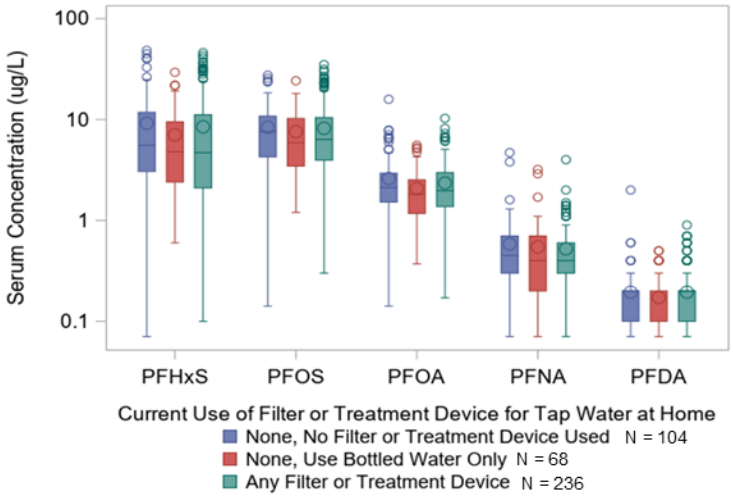

Figure C10. Boxplot of adult blood concentrations by kidney disease history

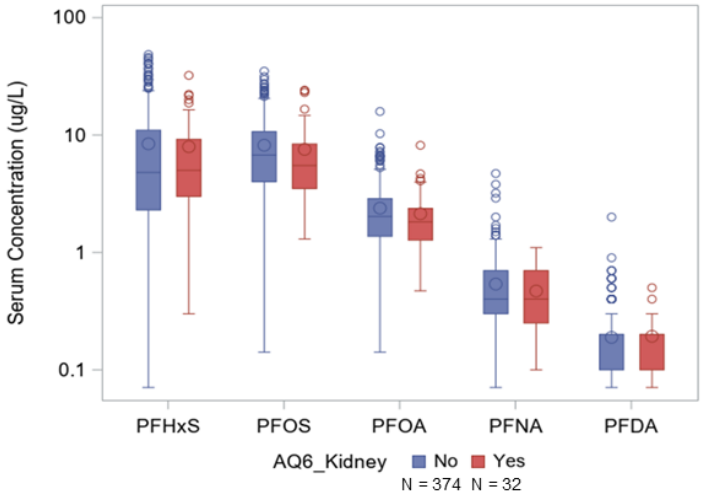

Figure C11. Boxplot of adult blood concentrations by blood donation frequency

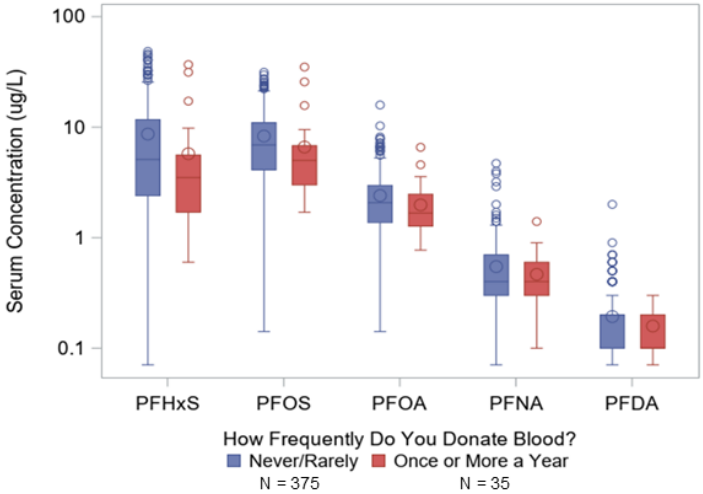

Figure C12. Boxplot of adult blood concentrations by home cleaning frequency

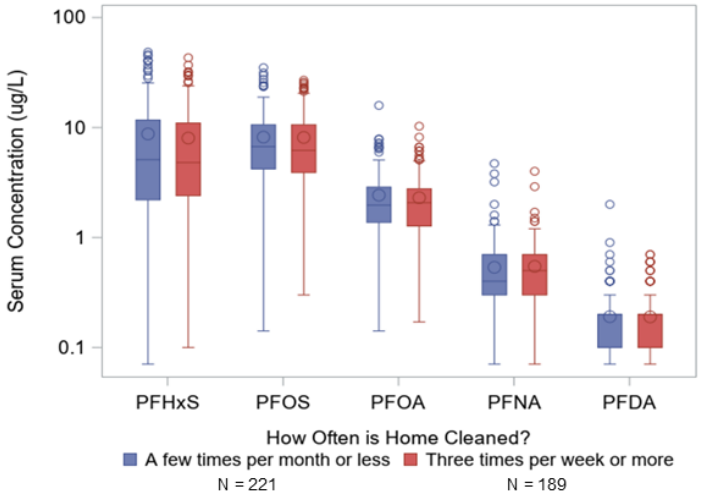

Figure C13. Boxplot of adult blood concentrations by stain-resistant product use

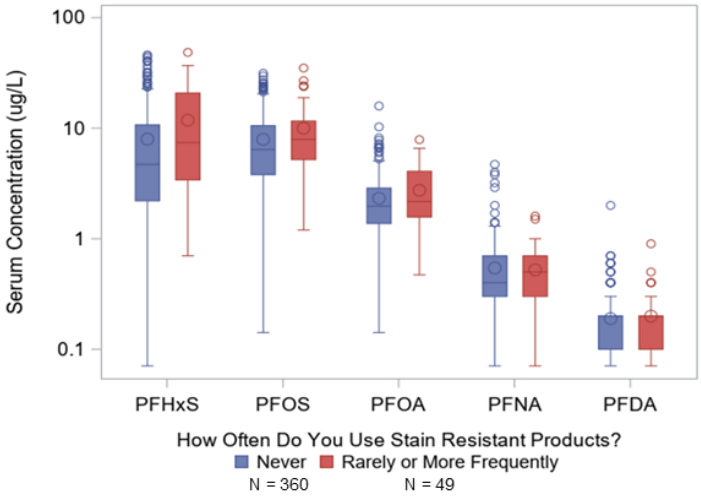

Figure C14. Boxplot of adult blood concentrations by frequency of contact with soil

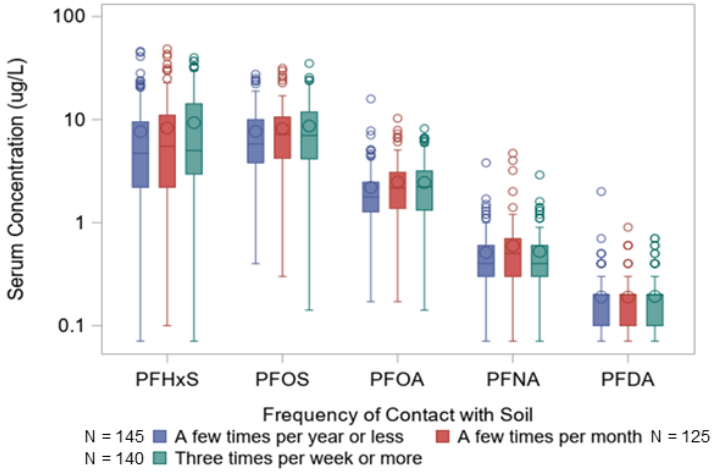

Figure C15. Boxplot of adult blood concentrations by local fruit and vegetable consumption

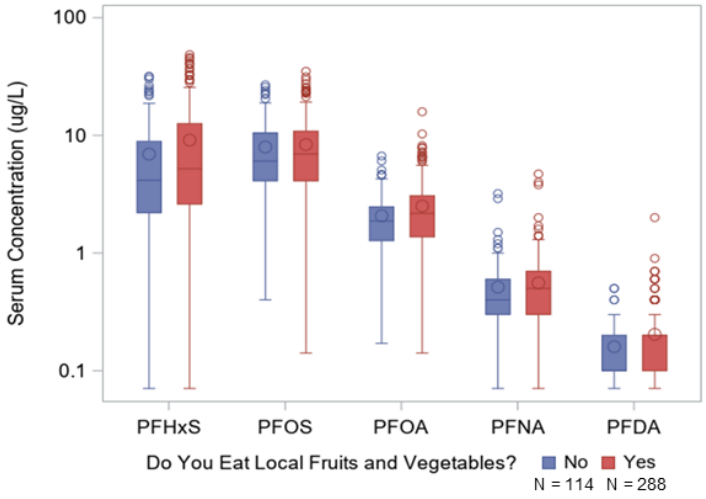

Figure C16. Boxplot of adult blood concentrations by local fish consumption

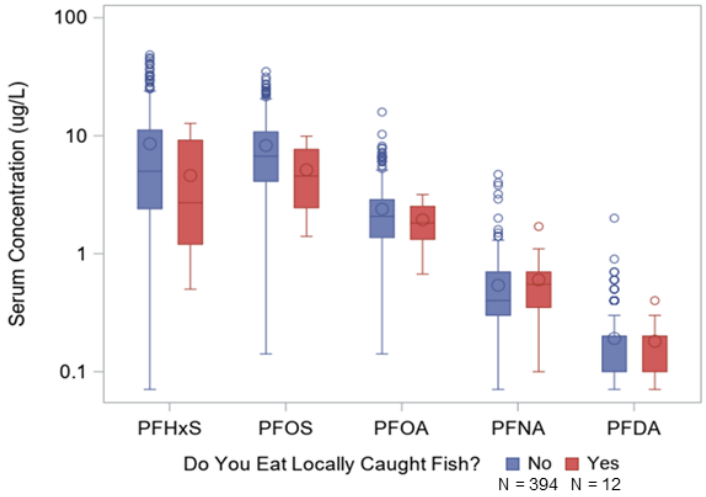

Figure C17. Boxplot of adult blood concentrations by local milk consumption

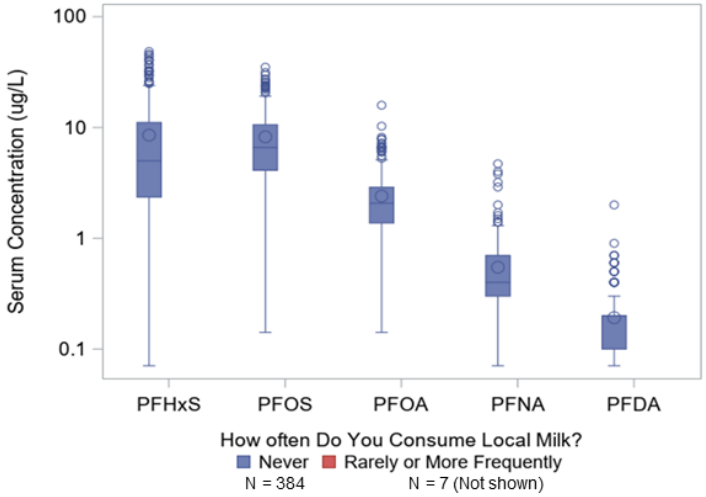

Figure C18. Boxplot of adult blood concentrations by fast food consumption frequency

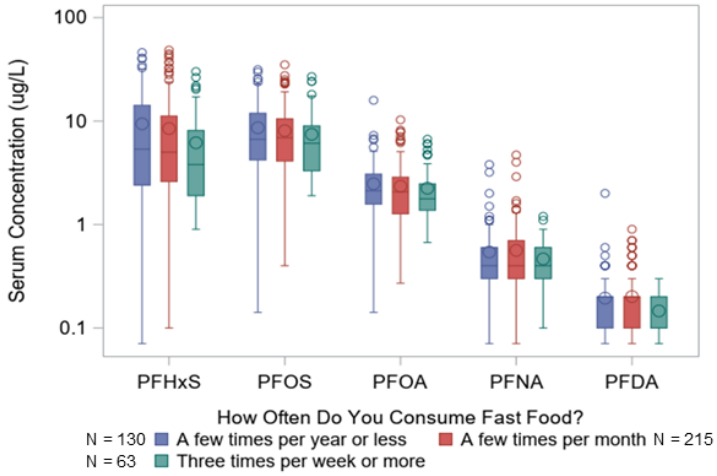

Figure C19. Boxplot of adult blood concentrations by presence of carpet in home

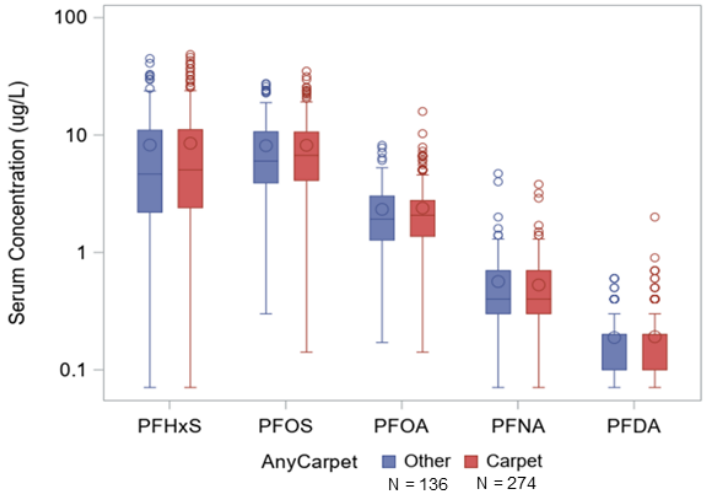

Figure C20. Boxplot of adult blood concentrations by occupational exposure

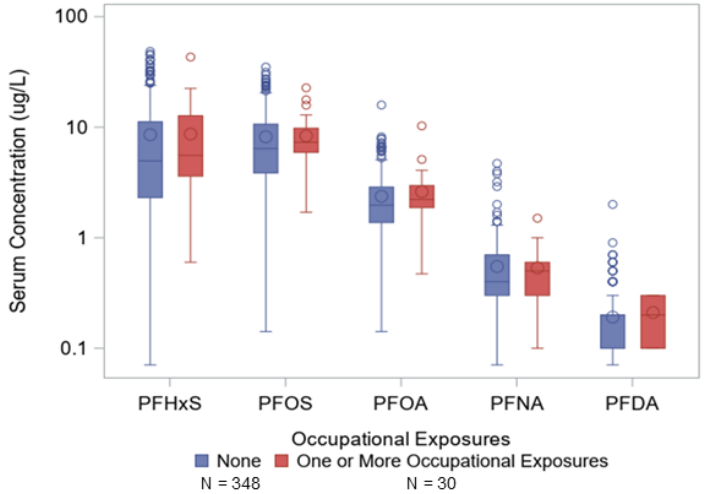

Figure C21. Boxplot of adult female blood concentrations by breastfeeding history

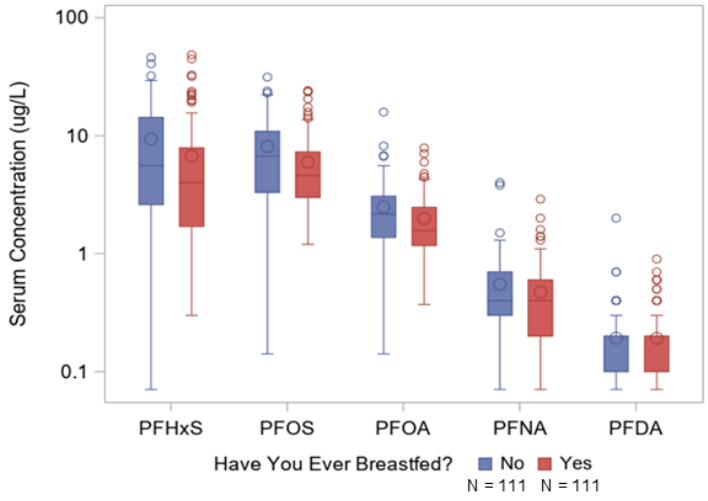

Figure C22. Boxplot of adult female blood concentrations by breastfeeding duration

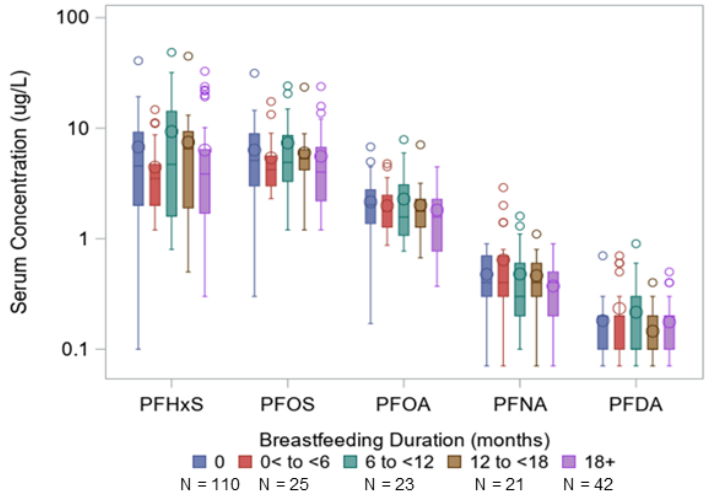

Figure C23. Boxplot of adult female blood concentrations by biological children variable

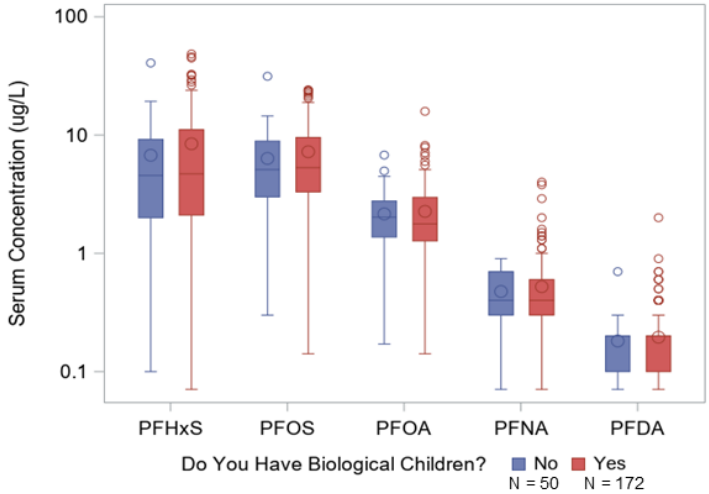

Figure C24. Boxplot of adult female blood concentrations by number of biological children

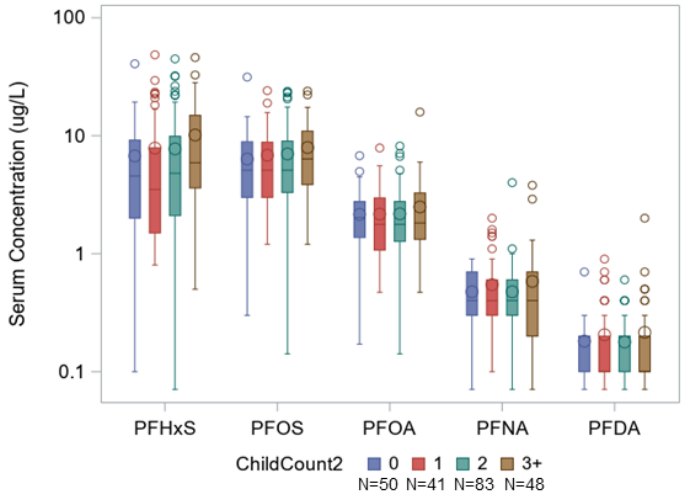

Figure C25. Boxplot of child blood concentrations by age

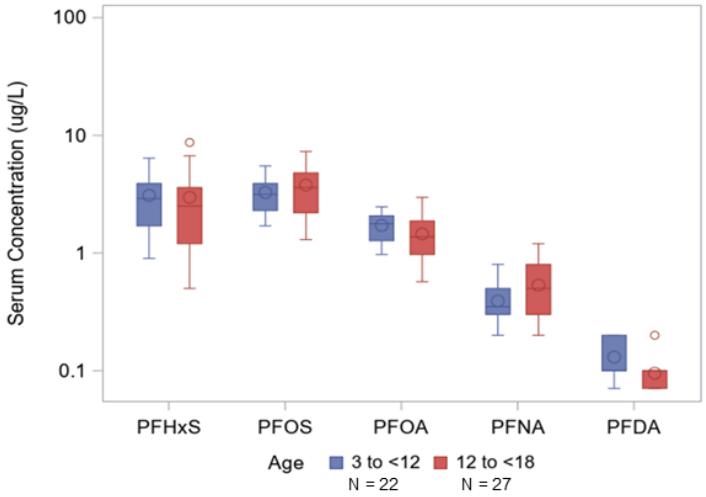

Figure C26. Boxplot of child blood concentrations by sex

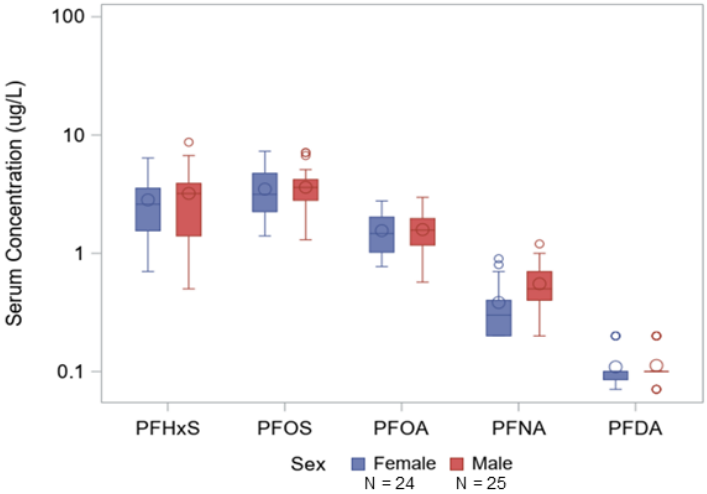

Figure C27. Boxplot of child blood concentrations by body mass index

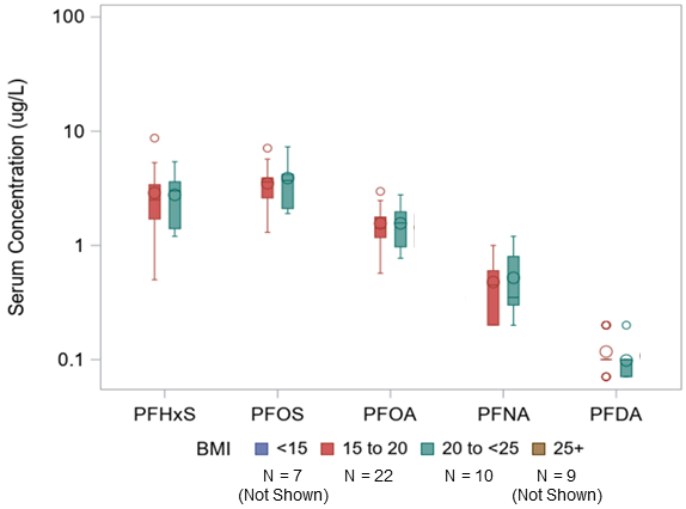

Figure C28. Boxplot of child blood concentrations by birth order

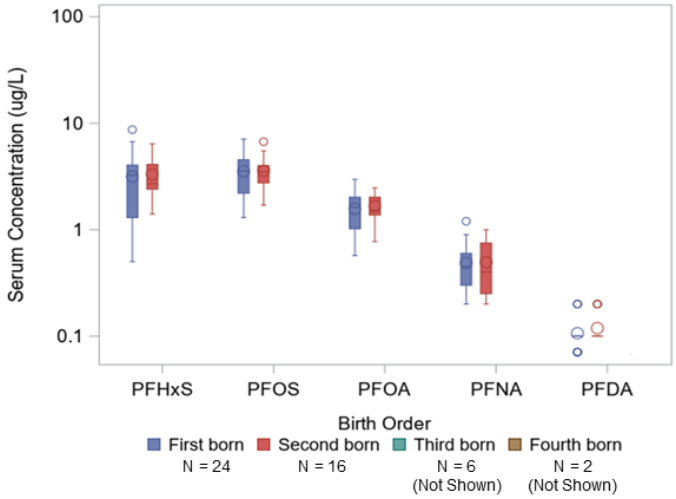

Figure C29. Boxplot of child blood concentrations by race and ethnicity combined

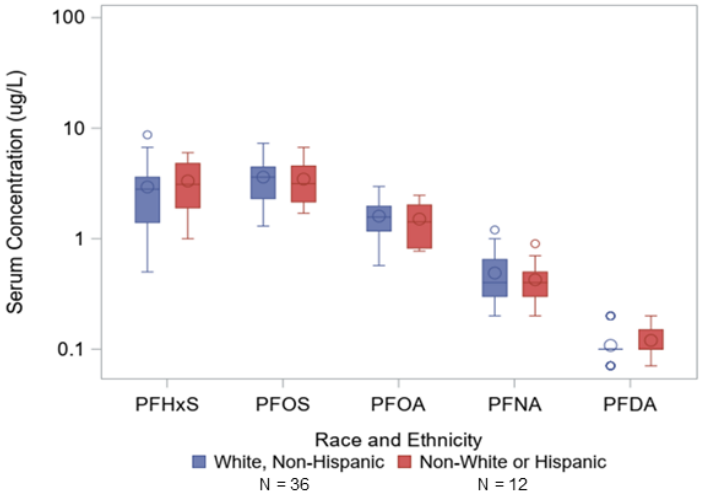

Figure C30. Boxplot of child blood concentrations by water consumption at current home

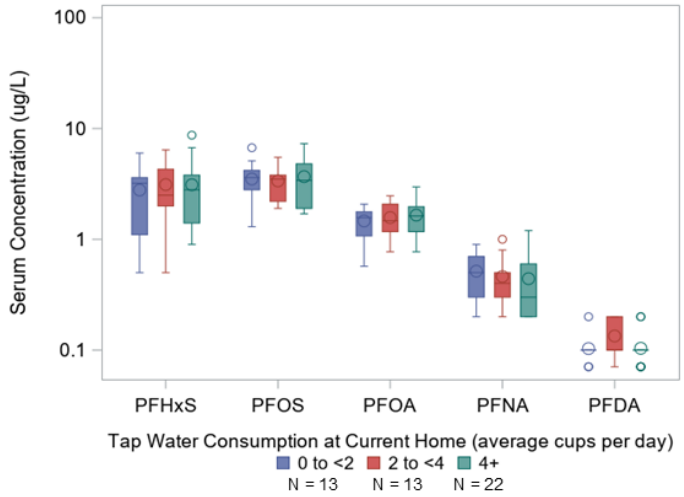

Figure C31. Boxplot of child blood concentrations by water consumption at school

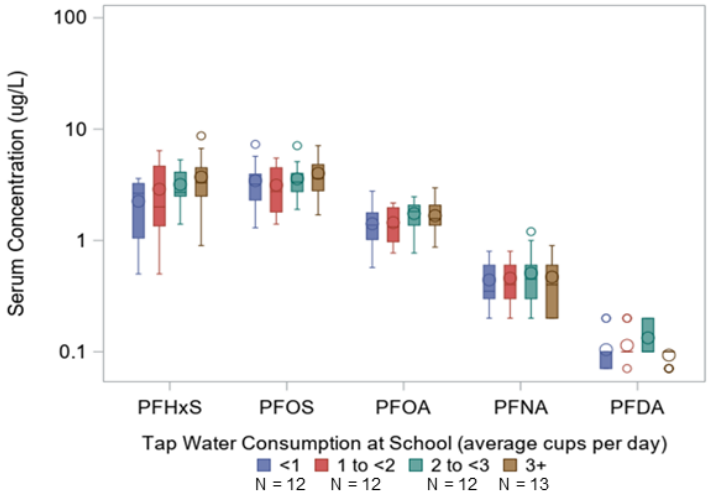

Figure C32. Boxplot of child blood concentrations by length of residency in sampling frame

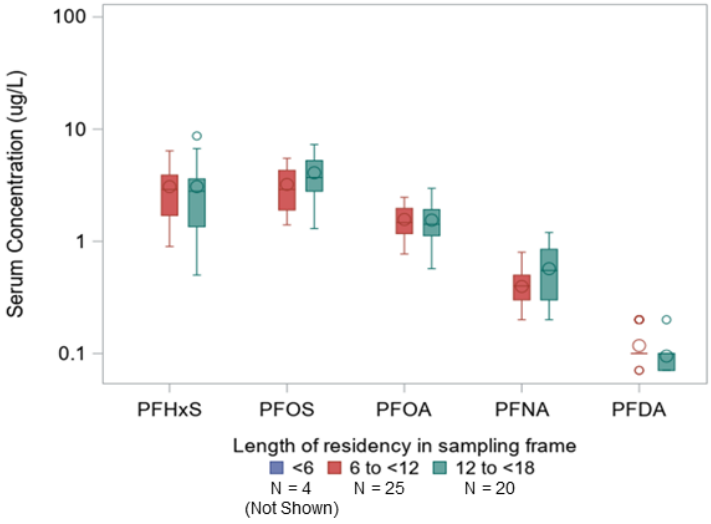

Figure C33. Boxplot of child blood concentrations by frequency of contact with soil

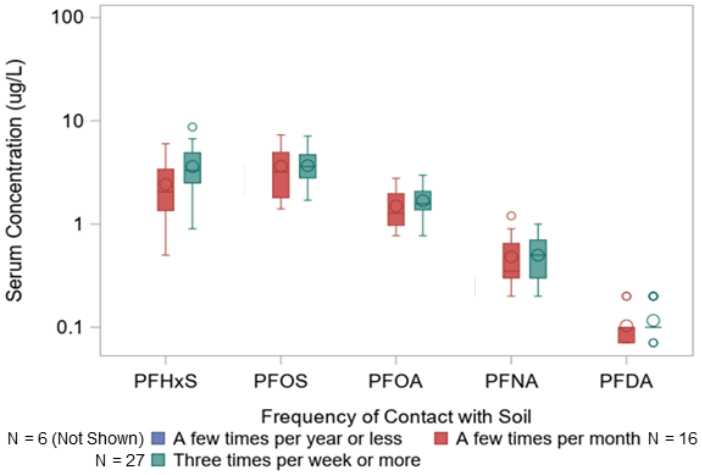

Figure C34. Boxplot of child blood concentrations by local fruit and vegetable consumption

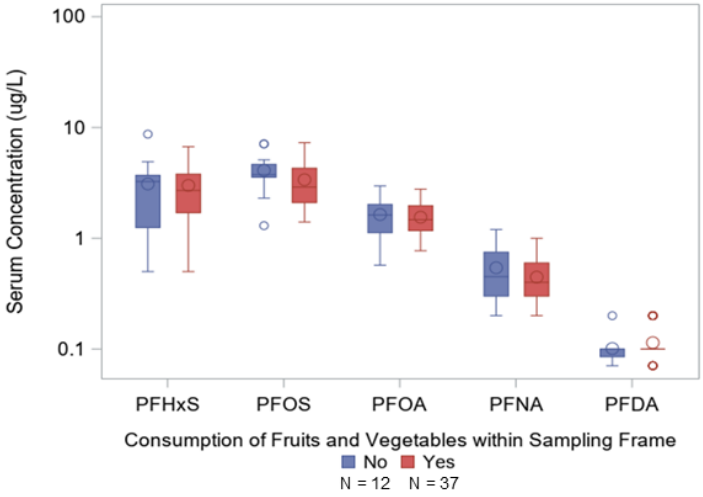

Figure C35. Boxplot of child blood concentrations by local milk consumption

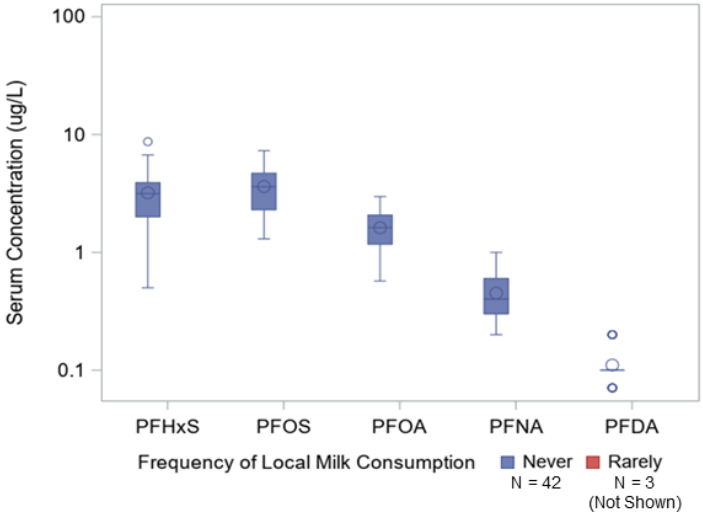

Figure C36. Boxplot of child blood concentrations by drinking formula reconstituted with tap water

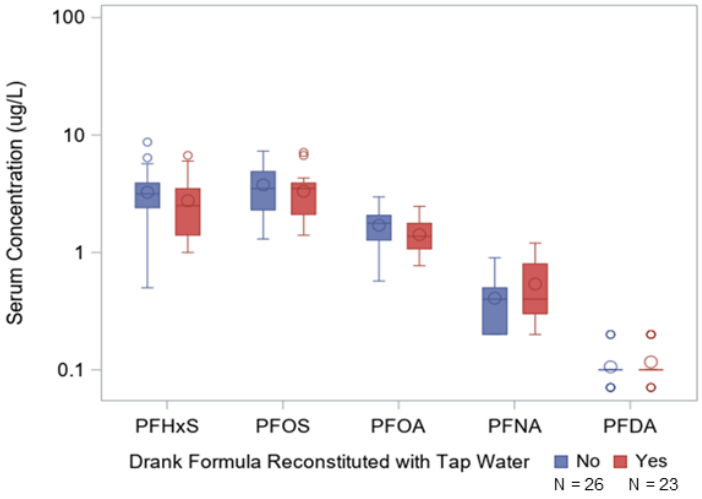

Figure C37. Boxplot of child blood concentrations by duration of drinking formula reconstituted with tap water

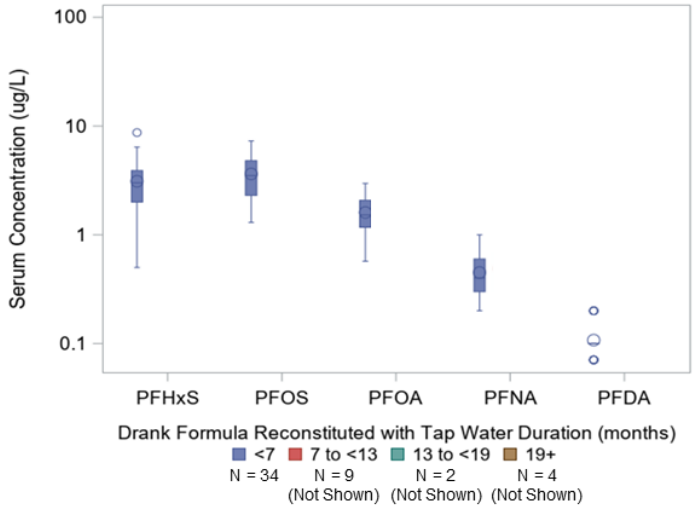

Figure C38. Boxplot of child blood concentrations by history of breastfeeding

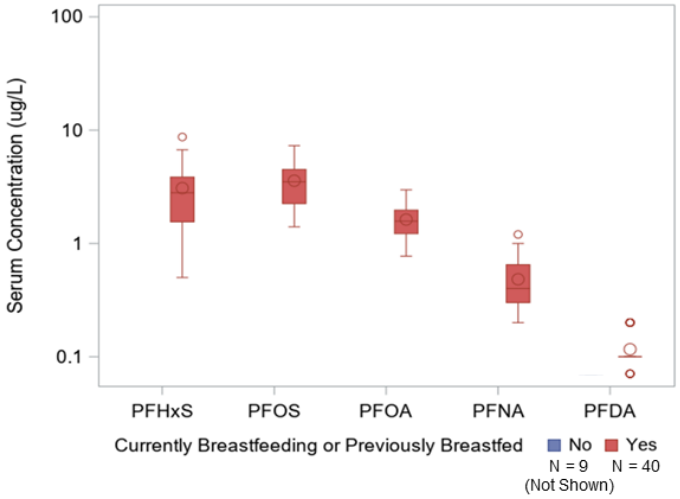

Figure C39. Boxplot of child blood concentrations by breastfeeding duration