

PFAS in Breast Milk from the United States

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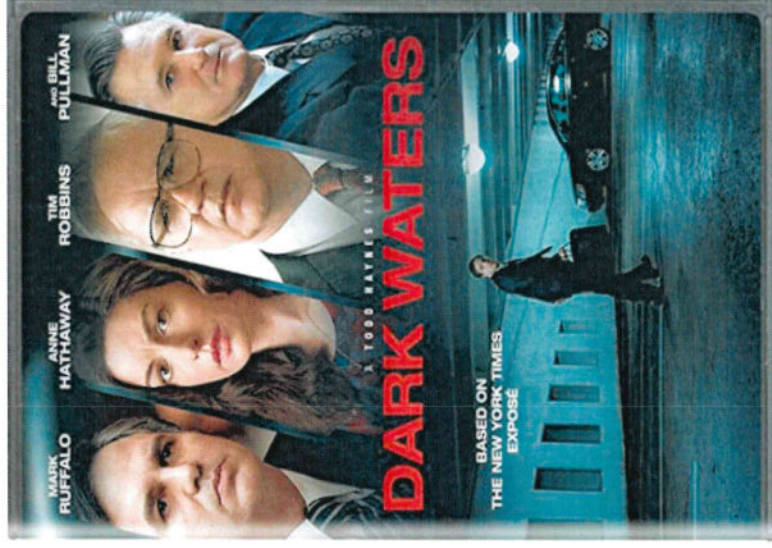
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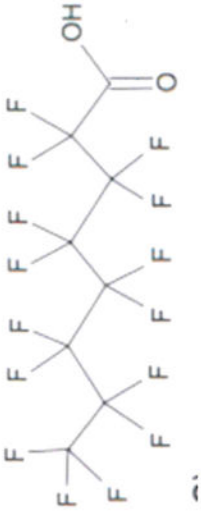


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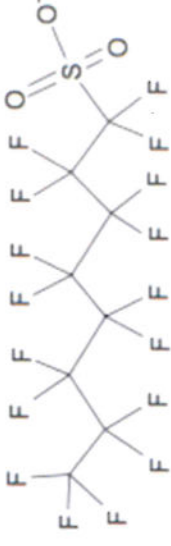
PFAS: the Basics

- PFAS stands for per- and polyfluoroalkyl substances
- Large class of chemicals (>9,000)
- Primary use types:
 - Fluorinated plastics (i.e. Teflon)
 - Processing aids in manufacture of fluorinated plastics
 - Surface coatings
 - Surfactants

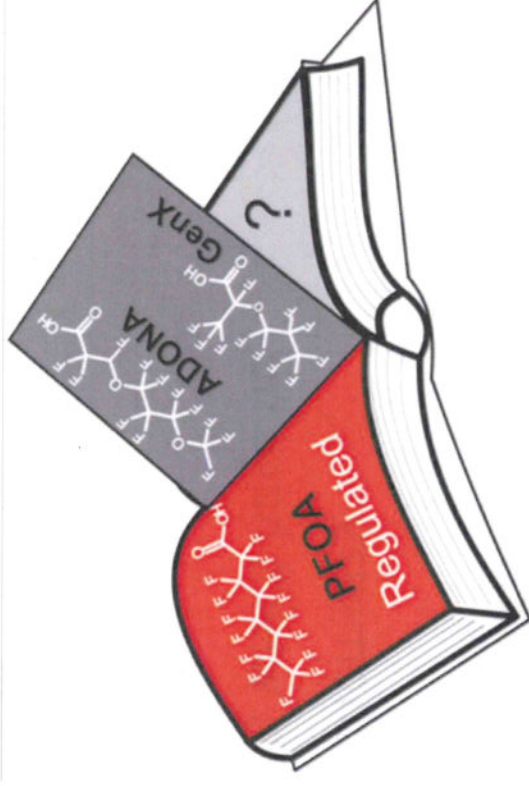




Types of PFAS

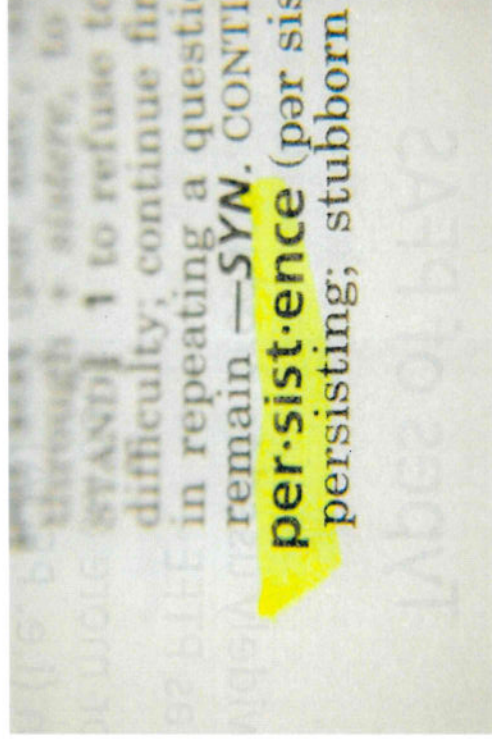


- Carboxylates: PFOA widely used to produce fluoropolymers such as PTFE
- Carboxylates with 8 or more carbons considered long chain (i.e. PFOA)
- Sulfonates: contain sulfonic acid or sulfonate group; PFOS best known example
- Sulfonates with 6 or more carbons considered long chain
- Many others: see Wang et al. ES&T 2017 “A Never-Ending Story of Per- and Polyfluoroalkyl Substances (PFASs)?”



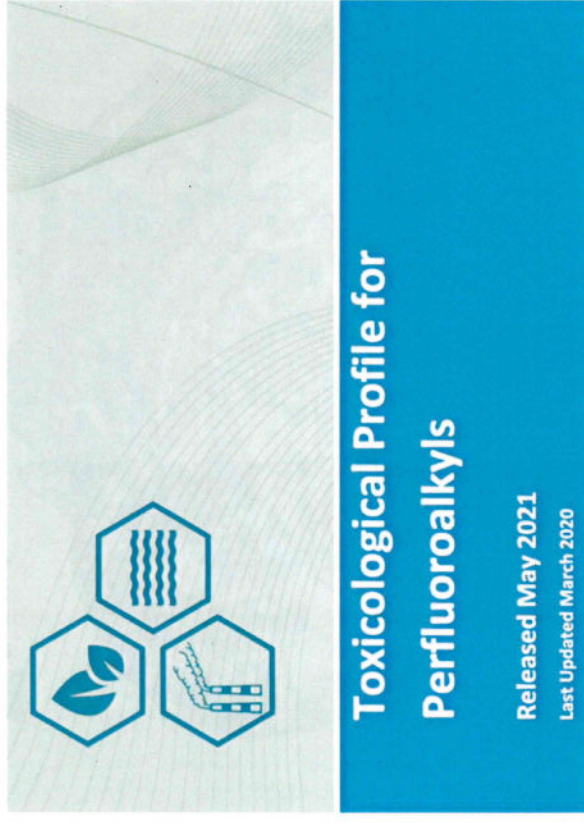
Primary Concerns: Persistence

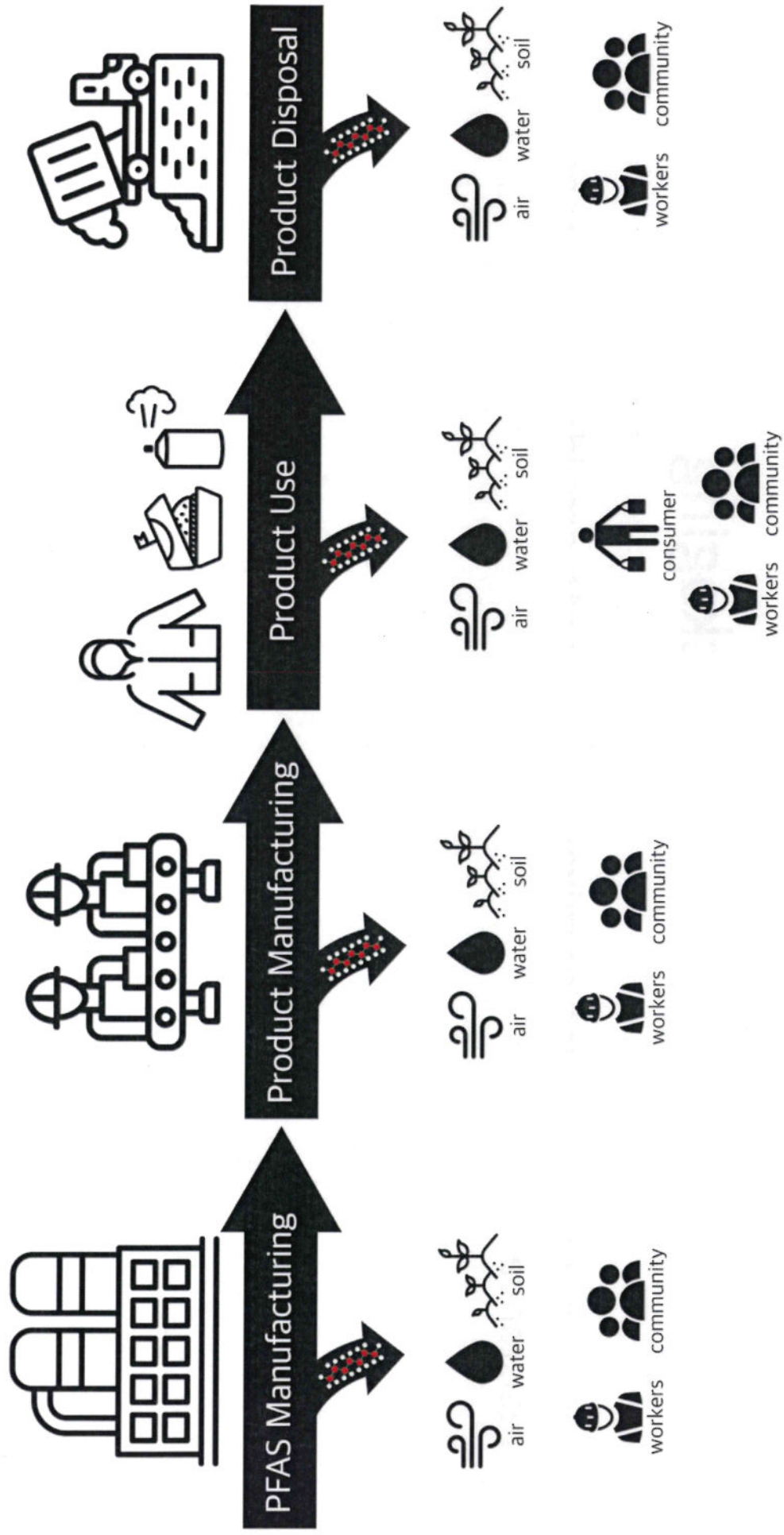
- Carbon-fluorine bond is strongest in organic chemistry
- All PFAS degrade into persistent end products, which have no known environmental degradation



Primary Concerns: Toxicity

- In people, well-studied PFAS associated with cancer, immune system depression, pregnancy-induced hypertension, high cholesterol
- In laboratory studies, well-studied PFAS associated with liver toxicity, developmental toxicity, immune effects
- In laboratory studies, current-use PFAS associated with effects on kidney, liver, thyroid, developmental toxicity





Uses: Food Packaging

Used as surface coating or mixed into paper to provide oil and grease resistance



Uses: Firefighting Foam

- Fluorine-containing foams are used as Class B foams to put out oil fires at airports, refineries, etc.
- Uncontrolled releases to the environment have resulted in contamination of drinking water



Uses: Textiles

- PFAS used for stain protection and water resistance in furniture, other indoor furnishings, and apparel
- PFAS applied in surface coatings as well as in polymer membrane
- Weathering results in shedding of PFAS over time



Result: Exposures From Multiple Sources & Routes

- Food
- Drinking water
- Indoor air
- House dust
- Cord blood, breast milk



Early-life PFAS Exposure

- Early-life exposure may lead to adverse effects later in life
- Breastfeeding is an important exposure pathway
- The last two studies on PFAS in breast milk from the U.S. mothers date back to 2004
- More recent studies from Asia have reported build up of the current-use PFAS



PFAS in Breast Milk Study

- Recruited 50 first-time moms residing in and near Seattle, WA (2019)
- Outreach via parenting groups, social media, paper flyers
- Moms asked to manually express 50 ml into a provided glass container
- Researchers collected milk within 24 hours and maintained frozen until shipment for analysis

Demographics

- Race: 95% Caucasian
- Maternal age: mean 34 (24-42 yrs old)
- Residence time in Washington: mean 13
- Education: 94% had higher education
- Economic status: 82% in middle class or upper-middle class neighborhoods

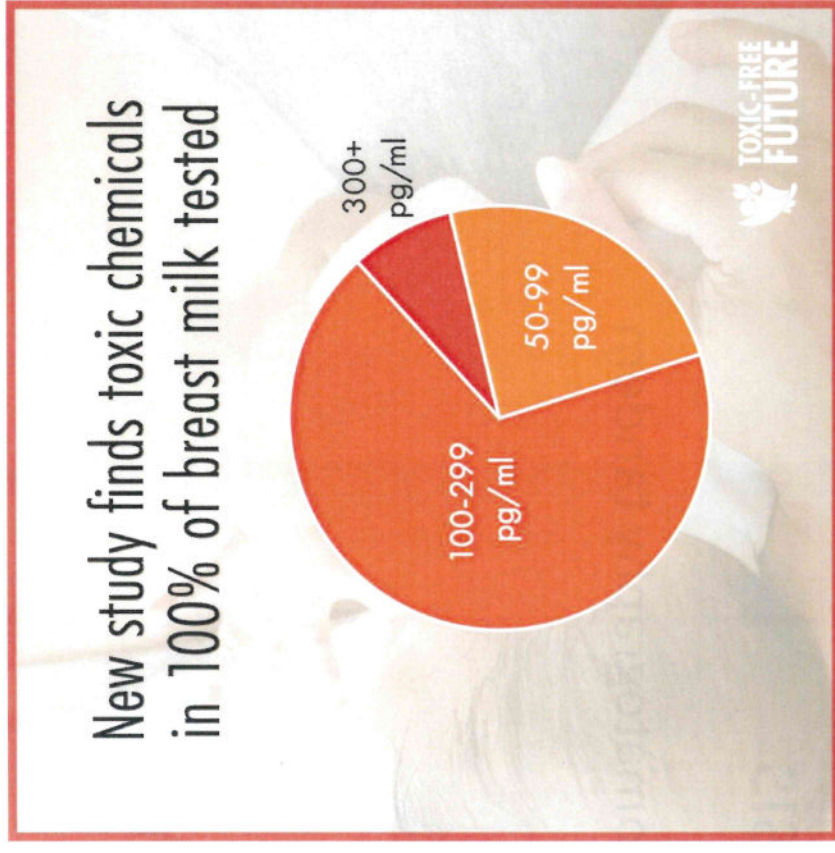


Analysis

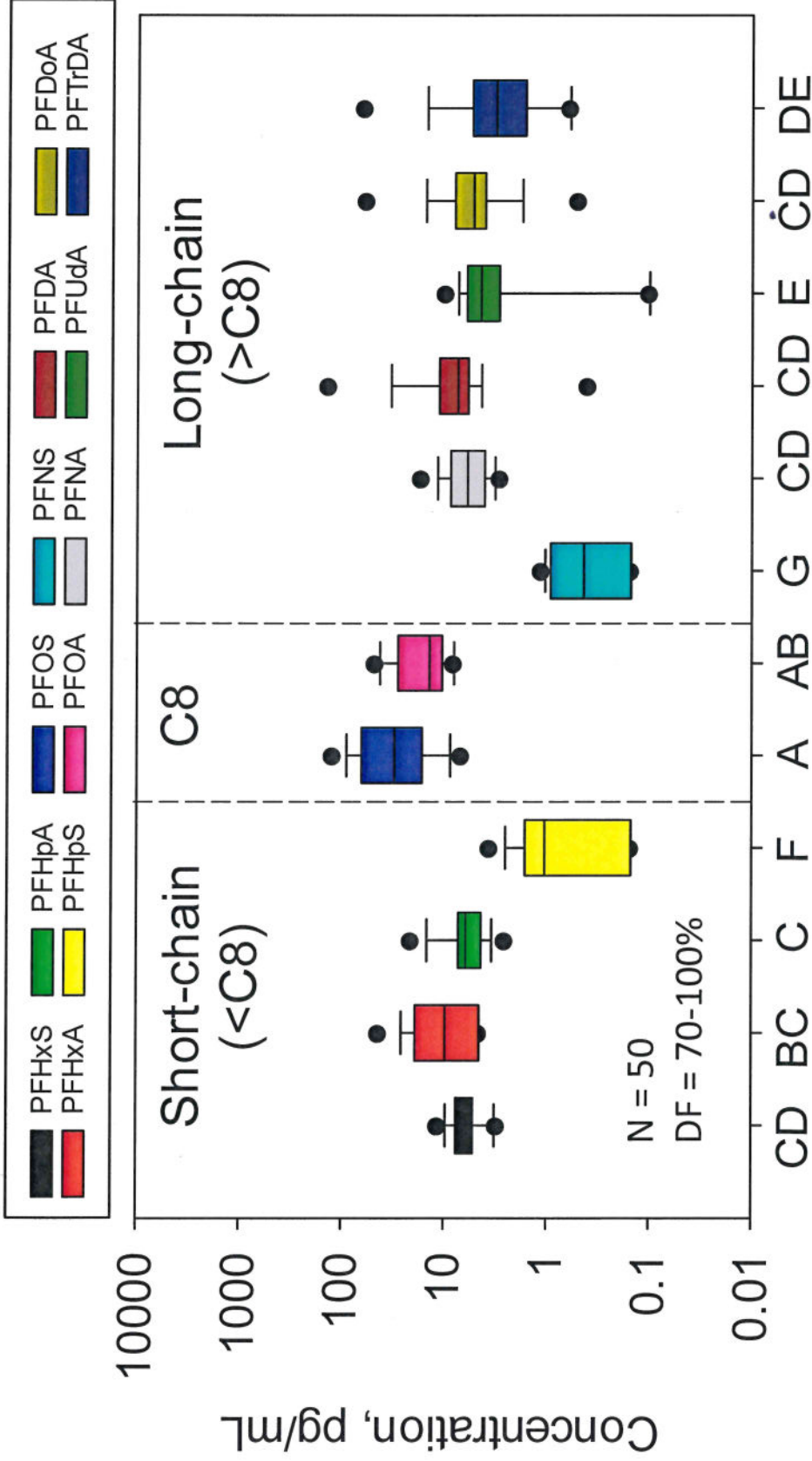
- Samples were analyzed with liquid chromatography tandem mass spectrometry for 39 PFAS:
 - PFOS & PFOA
 - Long-chain (C10-C16)
 - Short-chain (C4-C7)
 - PFAS precursors
- For details see Zheng et al., ES&T 2021

Results

- PFAS detected in 100% of samples
- 16 PFAS total detected, 12 PFAS detected in more than 50% of samples
- Σ PFAS ranged from 52 to 1,580 pg/mL

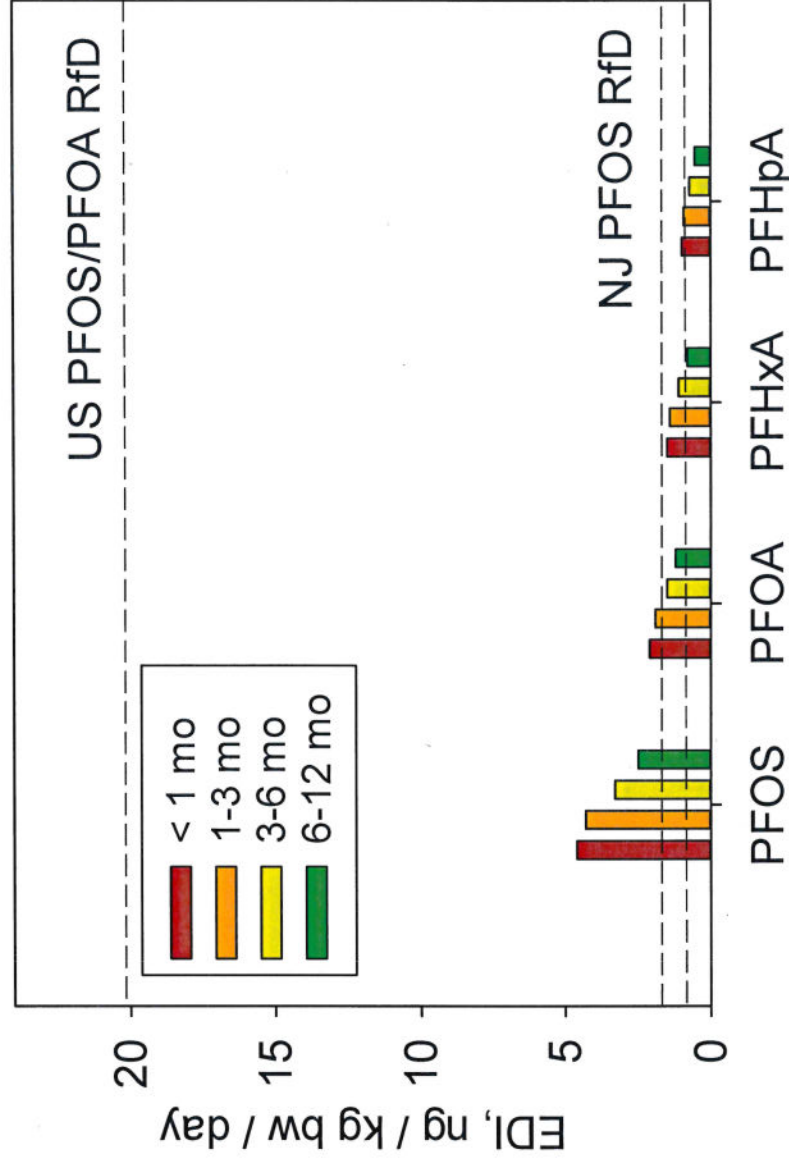


Current-Use PFAS are Abundant in Breast Milk



Zheng et al.,
EST, 2021

PFAS Estimated Daily Intakes (EDIs)



$$EDI = \frac{C_{milk} \times FIR}{1000}$$

C_{milk} : Median milk concentrations, ng/mL

FIR: Food ingestion rate, ml/kg bw/day

Adult dietary EDI

Zheng et al.,
EST, 2021¹⁸

Comparison to 2008 Study (Tao et al.)

Compound	Detection Frequency, median 2004	Detection Frequency, median 2019
PFOS (C8)	96%, 106 pg/mL	100%, 30.4 pg/mL
PFOA (C8)	80%, 36.1	86%, 13.9
PFHxS (C6)	51%, 12.1	90%, 6.55
PFHxA (C6)		64%, 9.69
PFHpA (C7)	6.7%, < 24	98%, 6.10
PFNA (C9)	64%, 6.97	100%, 5.98
PFDA (C10)	8.9%, < 24	94%, 7.40
PFDoA (C12)	2.2%, < 24	94%, 5.26

Global Changes in Breast Milk Concentrations: PFOS 1996-2019

