

Systematic evidence mapping of potential exposure pathways for per chemicals based on measured occurrence in multiple media

- and poly - fluoroalkyl (PFAS)



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. Background

Rationale

- The ubiquitous presence of PFAS in the human body, as demonstrated by the National Health and Nutrition Examination Survey, suggests exposure sources beyond contaminated water play an important role
- Sources in the residential environment may include building materials, consumer products, food packaging
- Data on levels of PFAS chemicals in multiple media are required to identify, understand, and mitigate human-exposure pathways

Objectives

- Compile evidence for important pathways of exposure to PFAS chemicals
- Review literature reporting measured occurrence of PFAS chemicals in exposure media
- Identify data gaps that may be filled by future research
- Make the occurrence database from the literature review accessible to the public for additional research

2. Approach to Literature Review

Basic Relevancy Criteria

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elevancy Criteria	Evidence
pulation	Adults or children in general or
	impacted populations
posure Outcomes	Measurements of real-world
	occurrence of PFOA, PFOS, PFBA,
	PFBS, PFDA, PFHxA, PFHxS, PFNA
	in human blood, serum, or urine,
	ambient or indoor air, indoor dust,
	drinking water, food (including
	breast milk), food packaging,
	articles and consumer products,
	soil

Workflow

Databases Searched	Web of Science, Pub Med, ToxNet/ToxLine, ProQuest					
Additional Criteria	Peer-reviewed, English language, published 2003-July 2020					
Initial Paper Count	3,622, after filtering with evidence-stream tags in Sciome's SWIFT-Review software					
Screen for Relevancy	Used ICF's <i>litstream</i> TM; focused on primary non-cohort data from samples in the US, Canada, and Europe; did not utilize any supplemental material from the publications					
Final Paper Count	196 (included data on indoor and environmental media) 422 (only data from human biomatrices)					
Build Occurrence Database	Used ICF's litstream TM; parameters of interest included sampling dates & locations, numbers of collection sites & subjects, detection, concentration statistics (e.g., mean, percentiles, etc.).					
	Also collected data on landfills, sediment, and wastewater if present in the 196 papers. Collected limited data ("light extractions") on the 422 papers with only biomatrix data.					

3. Results of Evidence Mapping

Fig. 1. Counts of Papers and What They Sampled

- The most frequently studied were:
 - o PFOA (96%), PFOS (93%)
- o Food (41%), Drinking Water (25%)
- Relatively less studied were:
- o PFBA (40%), PFBS (53%)
- o Ambient Air (4%), Food Packaging (5%), Indoor Air (5%), Consumer Products (7%)

Medium	Chemical PFBA PFBS PFDA PFHxAPFHxS PFNA PFOA PFOS							
Human Blood/Serum/Urine + High-priority Exposure Medium (Full Extractions)	3	5	6	5	15	10	15	15
Indoor Air	1	3	5	4	6	7	9	7
Dust	10	15	18	15	21	20	24	24
Drinking Water	23	32	30	36	38	34	47	46
Food	20	35	50	49	56	56	76	78
Food Packaging	5	4	6	5	4	5	9	7
Products	9	6	10	11	7	11	14	8
Ambient Air	4	5	4	4	7	5	7	8
Soil	14	16	12	17	20	13	24	25

Fig. 2. Counts of Papers Reporting Concurrent Measurements in Biomatrices and Other Media

- These studies were rare (15 studies, or 8%)
- These primarily focused on food and drinking water

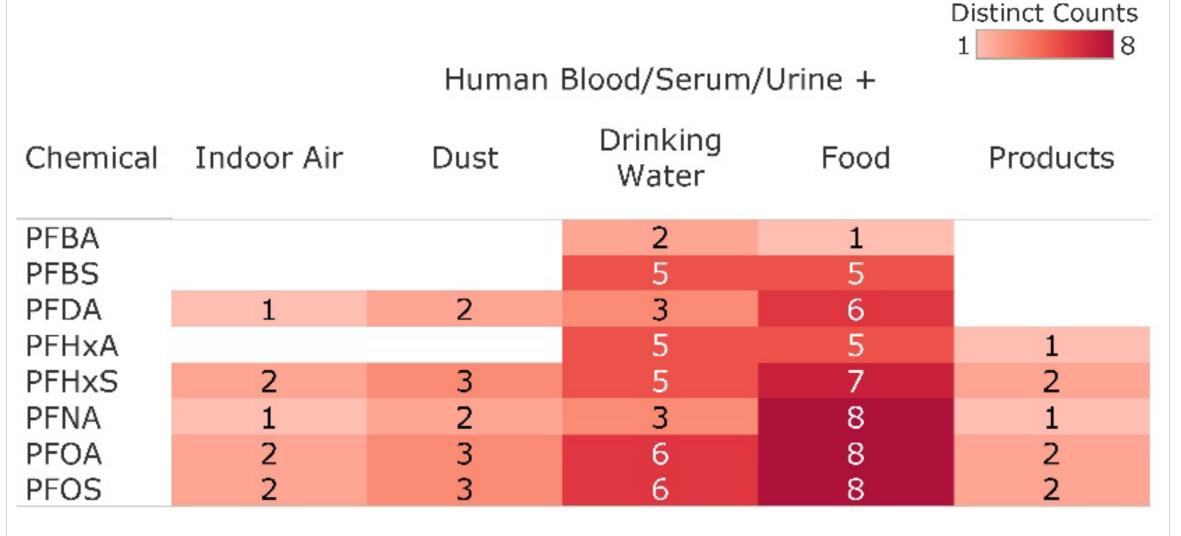


Fig. 3. Counts of Papers Reporting: [Detection

Frequencies \geq 50%] / [Any Detection Frequencies] • The most frequently detected were:

- o PFOA, PFOS
- o Indoor Dust, Soil, Biomatrices, Consumer Products
- Relatively less detected were:

o Food Packaging, Ambient Air, Food

- o PFBS, PFDA, PFHxA
- PFBA PFBS PFDA PFHxAPFHxS PFNA PFOA PFOS Human Blood/Serum/Urine 0/3 0/3 2/4 0/4 8/9 7/7 9/9 9/9 High-priority Exposure Medium 0/1 1/3 2/3 2/3 1/4 3/5 5/6 2/5 Indoor Air 6/14 10/15 9/13 13/19 13/17 20/20 20/20 Dust 11/14 11/20 <mark>6/23</mark> 15/23 15/26 <mark>9/24</mark> 22/32 20/33 Drinking Water 6/16 4/28 11/38 7/39 14/46 13/46 32/60 43/61 Food 1/5 0/4 2/6 2/5 0/4 1/5 3/8 3/7 Food Packaging Products Ambient Air **2/8** 5/6 7/10 6/11 6/7 13/14 14/14

4. Potential Applications

- We procured a database with over 14,000 rows of study metadata and quantitative information from peer-reviewed studies
- Potential uses of the database for future work:
- o Enable or improve interpretation of PFAS biomonitoring
- o Inform understanding of important PFAS sources and pathways of personal exposure, including through modeling
- o Chemicals and media currently not well studied might benefit from further investigation
- o Future studies might focus on those chemicals more often detected in particular media
- o Identify where a focused systematic review of data subsets might answer specific research questions
- o Conduct meta-analyses to synthesize results across multiple studies
- We encourage database users to conduct their own critical appraisal of the data to suit their specific research needs

*Public accessibility is pending manuscript preparation.

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