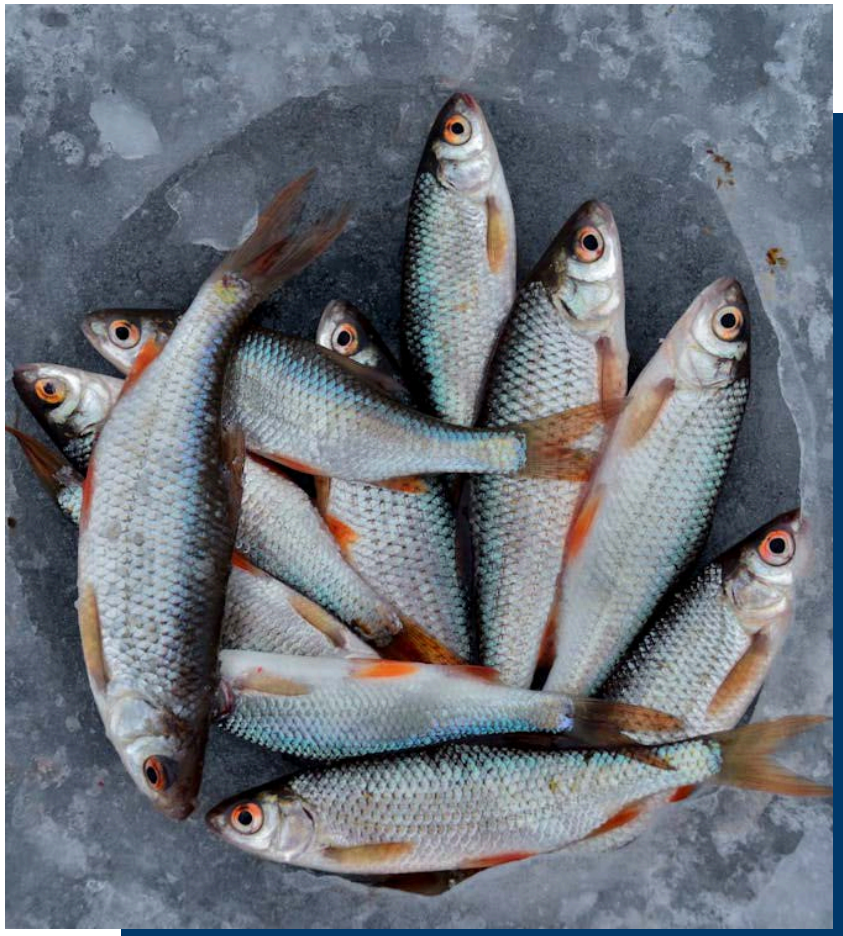
PFAS in food: Data sources and exposure estimates



08.10.2025. PFAS – Challenges and Scientific Perspectives in Human Health Risk Assessment

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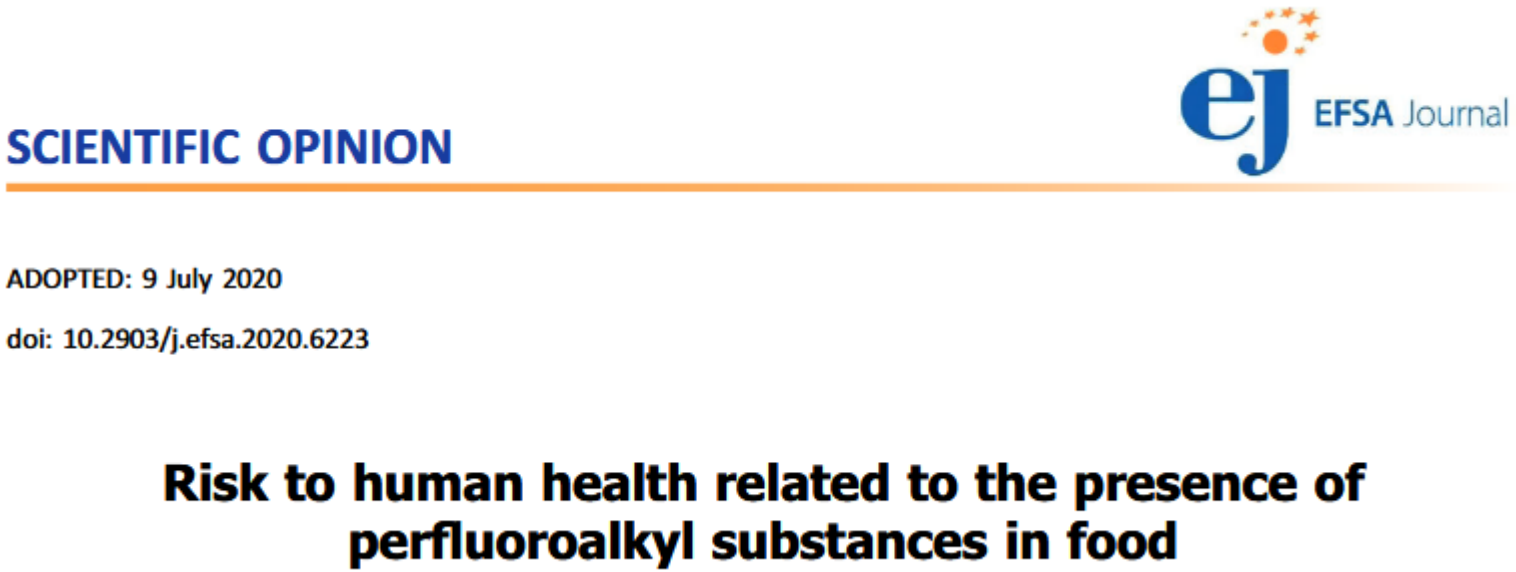
Agenda

- Occurence data basis for PFAS
- Exposure estimates and their interpretation
- Uncertainties
- Future

The initial situation

Early 2020: new EFSA opinion significantly lowering the TWI (from 1.5/0.15 µg/kg d to 4.4 ng/kg w)

Need for a new exposure estimate for Germany was raised



Data from the official controls of the Federal States in Germany

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Data from the official controls of the Federal States in Germany

- Data from the federal states from 2007 to 2020 queried
- Total data on 13.018 samples with 97.857 individual measurements
- The majority was excluded from further consideration:
  - Not tested for all four EFSA PFAS (only PFOS and PFOA)
  - Samples with non-representative sampling
- 3.128 samples with 12.512 individual measurements remained

Data from the official controls of the Federal States in Germany

- Only a few groups with sufficient samples
- Some food groups not sampled at all (e.g. juices, alcoholic beverages)
- Very high proportion of values below the detection and determination limits
- Average limit of quantification in the range of 0.5-1 µg/kg
- Highest values in meat and fish

Table 4: Concentrations for the sum of PFHxS, PFNA, PFOA and PFOS from the monitoring programs of the German federal states by main food groups in µg/kg using the LB

	Sum (PFHxS, PFNA, PFOA, PFOS)			
Main food group	**No. of samples**	**Proportion of determinable values[a]**	**Mean concentrations [µg/kg]**	**95th percentile concentrations [µg/kg]**
Cereals and cereal-based products	21	4.8 %	0.07	0[b]
Vegetables and vegetable products	184	17.4 %	0.18	1.29
Starchy roots or tubers and their products	95	1.1 %	0.01	0[b]
Fruit and fruit products	108	0.9 %	0.01	0[b]
Meat and meat products	762	41.3 %	52.90	339.87
Fish and fish products	904	45.0 %	5.38	30.00
Milk and milk products	379	13.7 %	0.01	0.04
Eggs and egg products	26	23.1 %	0.36	1.60
Sugar, confectionery, and water-based sweet desserts	34	0 %	0	0
Water and water-based drinks[c]	554	14.4 %	0.001	0.004
Products for babies and infants	61	0 %	0	0

[a] A value was counted as determinable if at least one of the four PFAS was determinable in the sample.
[b] Proportion of determinable values <5 %, therefore in the 95th percentile 0
[c] Without drinking water

BfR statement 020/2021 DOI 10.17590/20210914-121236

Exposure Assessment: Data from official controls

- Majority of the population already above the reference value in LB
- Exposure in the upper bound significantly higher (~50 ng/(kg w))
- High level of uncertainty due to the difference between the lower bound and upper bound

Table 8: Exposure to the sum of PFHxS, PFNA, PFOA and PFOS for adolescents and adults in the German population using data from the monitoring programs of the German federal states in the "Lower Bound" (basis: NVS II; all respondents)

Population group	Total (PFHxS, PFNA, PFOA, PFOS)			
	Number of people	Exposure [ng/kg bw per week]		
	Valid N	Mean	P50	P95
All (14–80 years)	13,926	8.0	4.4	19.8
Male	6,897	8.7	4.7	21.2
Female	7,029	7.4	4.1	18.6
Adolescents (14-17 years)	744	6.2	4.3	17.3
Adults (18-64 years)	10,525	8.0	4.4	19.8
Seniors (65-74 years)	2,008	8.5	4.4	21.3
Very old (≥ 75 years)	649	8.6	4.4	16.6

Table 11: Exposure to the sum of PFHxS, PFNA, PFOA and PFOS for children in the German population using data from the monitoring programs of the German federal states in the LB (based on: VELS; all respondents)

Population group		Total (PFHxS, PFNA, PFOA, PFOS)		
	Number of people	Exposure [ng/kg bw per week]		
	Valid N	Mean	P50	P95
All	732	19.5	14.7	48.5
Male	368	20.7	15.5	50.4
Female	364	18.4	13.8	41.9
Other children (VELS 3-5 years)	297	18.3	13.1	44.5
Infants (VELS 1-2 years)	340	20.4	15.3	49.5
Babies (VELS >0.5–<1 years)	95	20.4	19.3	45.2

BfR Opinion 020/2021 DOI 10.17590/20210914-121236

Uncertainties: Regional distribution of data

- Sampling density shows imbalance between individual states

- Both across all samples and for individual foods

- Indications of increased sampling density in more heavily contaminated regions

Summary of uncertainties in monitoring data

- Inadequate coverage of food groups

- Uneven sampling density

- More frequent sampling of more highly contaminated food

→ Conclusion: LB probably closer to reality than UB

→ Also fits with internal exposure

- High proportion of left-censored data / Inadequate limits of quantification

Data from the BFR MEAL study

General: BfR MEAL study

- The sample design itself is very well suited to performing an overall exposure assessment:
  - At least 90% of consumption in all food groups taken into account
  - Additional sampling of foodstuffs with known high contamination but comparatively low consumption (e.g. offal)

- Regional sampling
- Pooled investigation

Top ten concentrations in pooled samples of the BfR MEAL study

- Significantly better detection limits than in food monitoring data (0.005–2 µg/kg)
- Depending on the individual PFAS 94.2–99.8% values left-censored
- Huge margin of uncertainty due to high coverage of foods

No.	MEAL food	Stratification	Occurrence [µg/kg]
1	Sheep Liver	National	4.54
2	Karp	North	1.65
3	Cooked Pork Liver	North	1.41
4	Poultry Liver	National	1.31
5	Trout	South	1.25
6	Cooked Beef Liver	South	1.22
7	Eel	National	1.13
8	Cooked Beef Liver	North	0.95
9	Smoked Eel	National	0.94
10	Cooked Pork Liver	West	0.92

BfR – unpublished

Exposure Assessment: MEAL data

- LB exposure shown
- Significantly lower LB exposure estimate in comparison to monitoring data
- Most children and adults show exposure below the reference value
- Upper bound significantly higher (~75 ng/(kg bw) in adults)

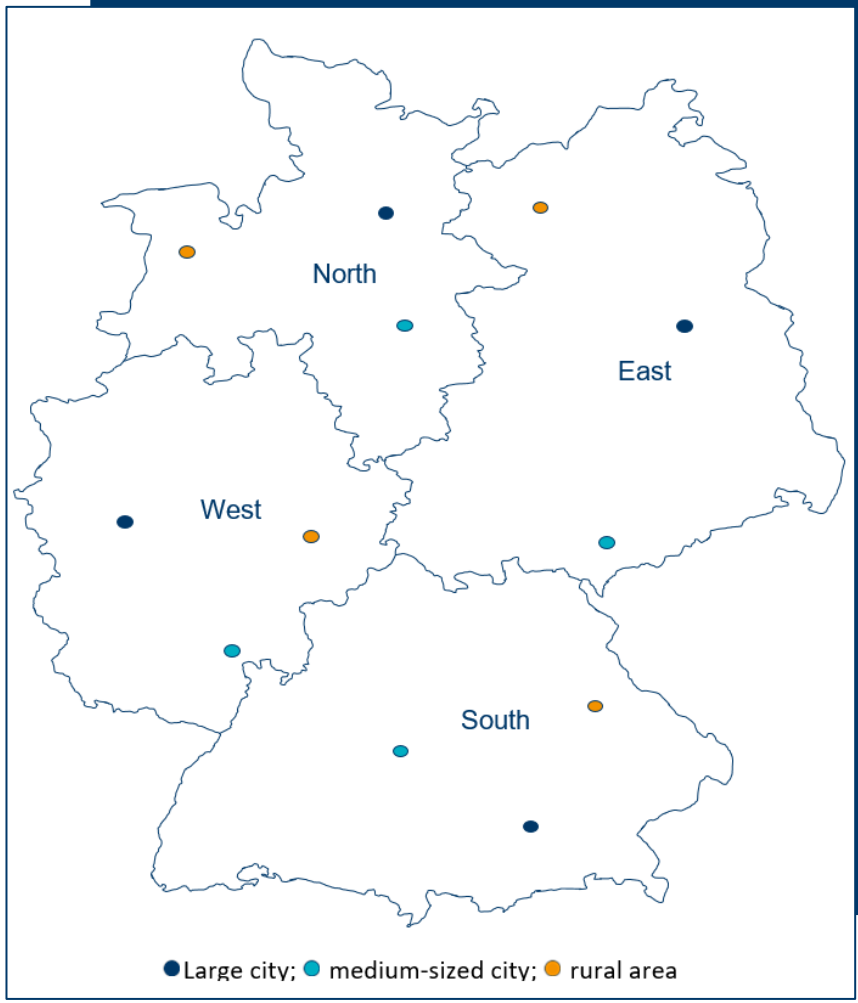
	Sum (PFHxS -PFNA -PFOA-PFOS)							
		Exposure [ng/(kg w)]			%TWI			N > reference value
	N	Mean	P50	P95	Mean	P50	P95	
All	13926	0.8	0.4	3.2	19.1%	8.5%	72.6%	380
Male	6897	1.0	0.4	3.6	21.8%	9.2%	81.5%	233
Female	7029	0.7	0.3	2.5	16.4%	7.9%	57.3%	147
Adolescents (NVS II)	744	1.0	0.4	3.8	22.7%	9.3%	85.4%	28
Adults	10525	0.9	0.4	3.2	19.3%	9.0%	72.0%	274
Elderly (65-74 Jahre)	2008	0.8	0.3	3.3	17.7%	6.8%	74.5%	64
Elderly (>=75 Jahre)	649	0.7	0.2	2.5	15.3%	5.4%	56.5%	15

	Sum (PFHxS -PFNA -PFOA-PFOS)							
		Exposure [ng/(kg w)]			%TWI			N > reference value
	N	Mean	P50	P95	Mean	P50	P95	
All	732	1.4	0.7	4.5	31.9%	15.2%	101.4%	40
Male	368	1.4	0.6	4.4	31.4%	14.6%	99.6%	18
Female	364	1.4	0.7	4.7	32.3%	16.1%	107.2%	22
Other Children	297	1.4	0.5	4.6	32.5%	11.8%	105.3%	19
Toddlers	340	1.4	0.6	4.7	32.4%	14.0%	106.6%	19
Infants	95	1.2	1.1	2.0	27.8%	25.0%	46.4%	2

BfR – unpublished

Uncertainties: MEAL – Pooling/regionality

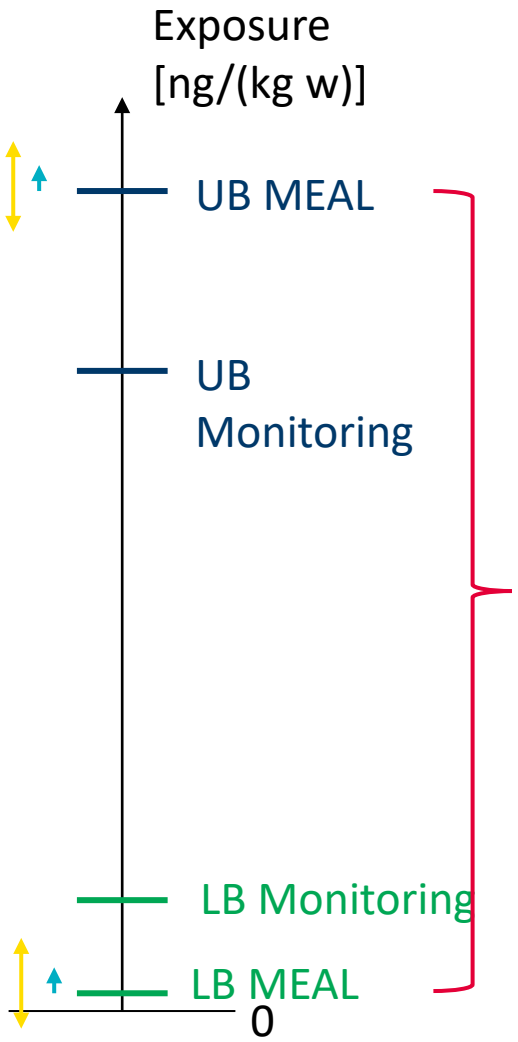
- Potential causes for the differences in monitoring:
  1. The (average) levels are actually low
  2. There are isolated high levels that are pushed below the detection limit by pooling
  3. Regional sampling leads to underrepresentation of highly contaminated areas



Summary of uncertainties MEAL

- Coverage of food groups

- Uneven sampling density



- High proportion of left-censored data / Insufficient limits of quantification

→ Conclusion: "True" exposure very likely within the LB/UB range

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Activities to improve the data situation

Food monitoring

- Reminder: rotating basket of goods over a 5-year cycle
- Still mainly animal-based foods
- **Significantly** improved detection limits

Hopefully a clearer picture in a few years

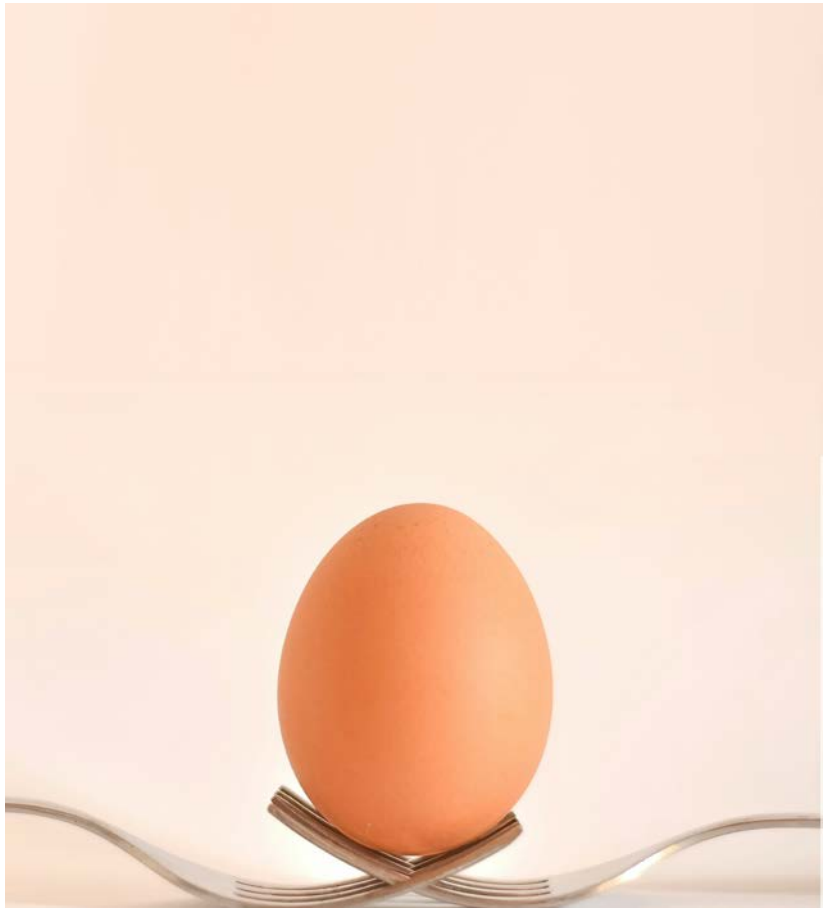
Food	Total of PFOS. PFOA. PFNA and PFHxS		
	#Samples	#Values >Limit of quantification	Average content [µg/kg]
Whole milk	86	2	0.0006
Liver Sheep/lamb	46	37	0.763
Salmon	99	16	0.013
Eel	26	19	1.51
Tuna (canned)	119	55	0.053

Adapted from BVL Report · 18.2 Food Safety Reports 2022

Food monitoring: Eggs

- Recent opinion (043/2025)
- Decent analytical sensitivity
- Occurence data shows decreasing trend for barn and free-range hens

	2018-2022				2024			
Group	**N**	**Above LOQ [%]**	**PFAS level [LB µg/kg]**		**N**	**Above LOQ [%]**	**PFAS level [LB µg/kg]**	
			Mean (95% KI)	**P95 (95% KI)**			**Mean (95% KI)**	**P95 (95% KI)**
All	181	31	0.29 (0.12-0.55)	1.00 (0.40-2.30)	68	24	0.06 (0.03-0.1)	0.42 (0.22-0.57)
Barn	55	9	0.05 (0-0.11)	0.20 (0-1.06)	11	9	0.001 (0-0.003)	0.01 (0 -0.01)
Free-range	93	41	0.49 (0.16-0.97)	1.70 (0.50-6.99)	40	20	0.07 (0.02-0.12)	0.36 (0.23-0.62)
organic	33	42	0.10 (0.05-0.16)	0.37 (0.24-0.65)	16	44	0.09 (0.02-0.18)	0.49 (0.08-0.57)



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Project monitoring

- Proposals initiated by the BfR selected primarily based on high consumption
  - Potatoes (2024), results expected in 2025
  - Fruit and vegetables (2025), ongoing
  - Flour (Wheat: 2026; Rye: 2027 approved)
- Further projects are planned

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Summary

- Exposure estimation for PFAS complicated by significant uncertainties

- Indication that exposure is at least close to the reference value for parts of the population

- More data with better analytics will hopefully bring more clarity in the future

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