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Dietary exposure and biomonitoring

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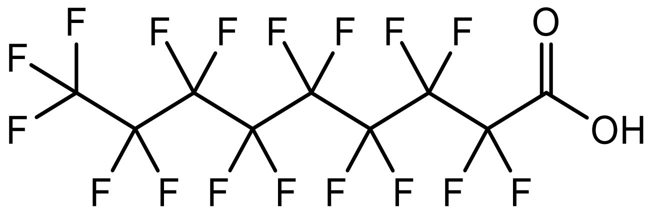
Outline

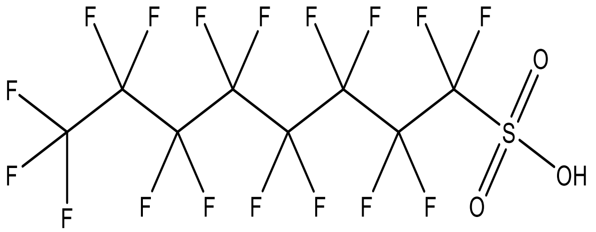
- PFASs included in the risk assessment
- Food consumption and occurrence data
- Current exposure assessment
- Uncertainties in exposure assessment
- Toxicokinetics
- Levels in general European populations
- Levels in occupationally exposed adults and populations with elevated drinking water exposure
- Uncertainties in biomonitoring

PFASs included in the risk assessment

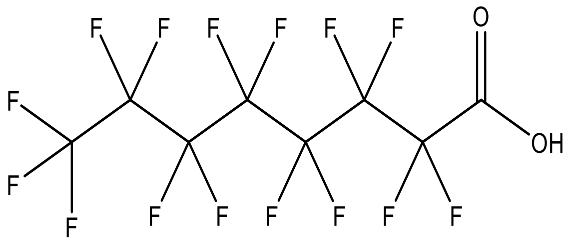
- Based on several similar **effects in animals**, **toxicokinetics** and **observed levels in human blood**, the CONTAM Panel performed the current risk assessment for the sum of four PFASs: PFOA, PFNA, PFHxS and PFOS



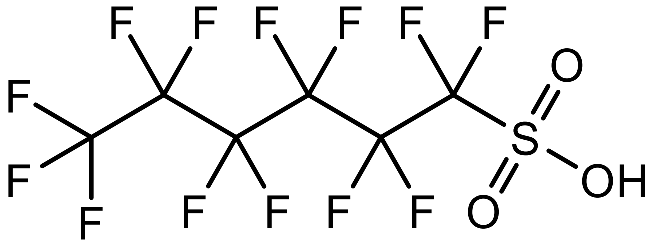
PFNA



PFOS



PFOA



PFHxS

Consumption data

- Chronic exposure
- Food consumption data from in total 35 surveys in 19 European countries for seven different age groups
- Individual consumption and body weight data used
- All surveys treated individually
- Information from surveys categorised in Foodex levels

  Example

  Foodex 1: Fish and other seafood (including amphibians, reptiles, snails and insects)

  Foodex 2: Fish meat, fish products, fish offal, water molluscs

  Foodex 3:Herring, salmon and trout, perch, fish roe, prawns, etc.

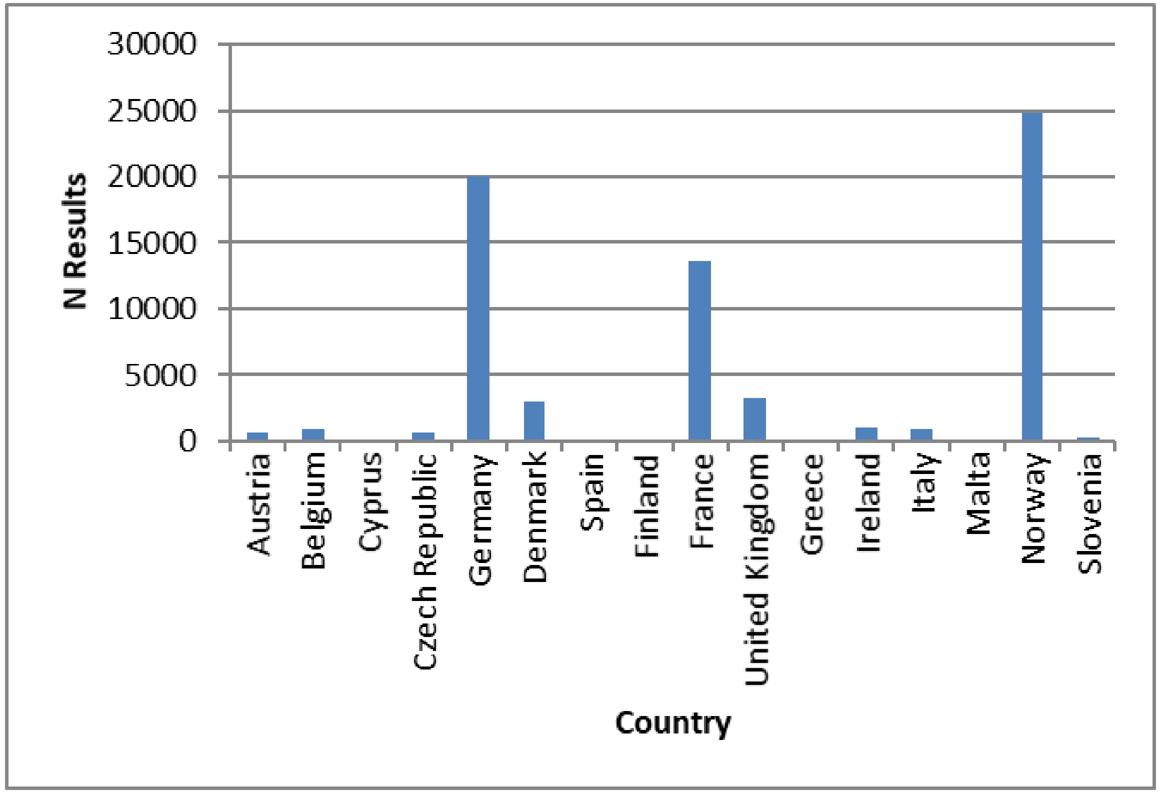
Occurrence data

- ≈97,000 results on 28 PFASs from 16 countries (2000-2016)
- Origin of samples are not always in Europe, but placed on the European market

Exclusion criteria:

- PFASs with 100% <LOQ
- Samples collected before 2007
- Suspect samples
- High LOQs

67,839 result for 17 PFASs



Current exposure assessment - considerations

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- Proportion of results below LOQ was >90% for all 17 PFASs except for PFOS which was 80%
- Lower bound approach: all results < LOQ = 0
- Upper bound approach: all results < LOQ = LOQ

- Mean upper bound levels much higher than mean lower bound levels, thus:
  - Rough indication of the range of chronic dietary exposure
- LB exposure is considered to be more realistic than UB exposure

Dietary exposure – sum of PFOA, PFNA, PFHxS, PFOS

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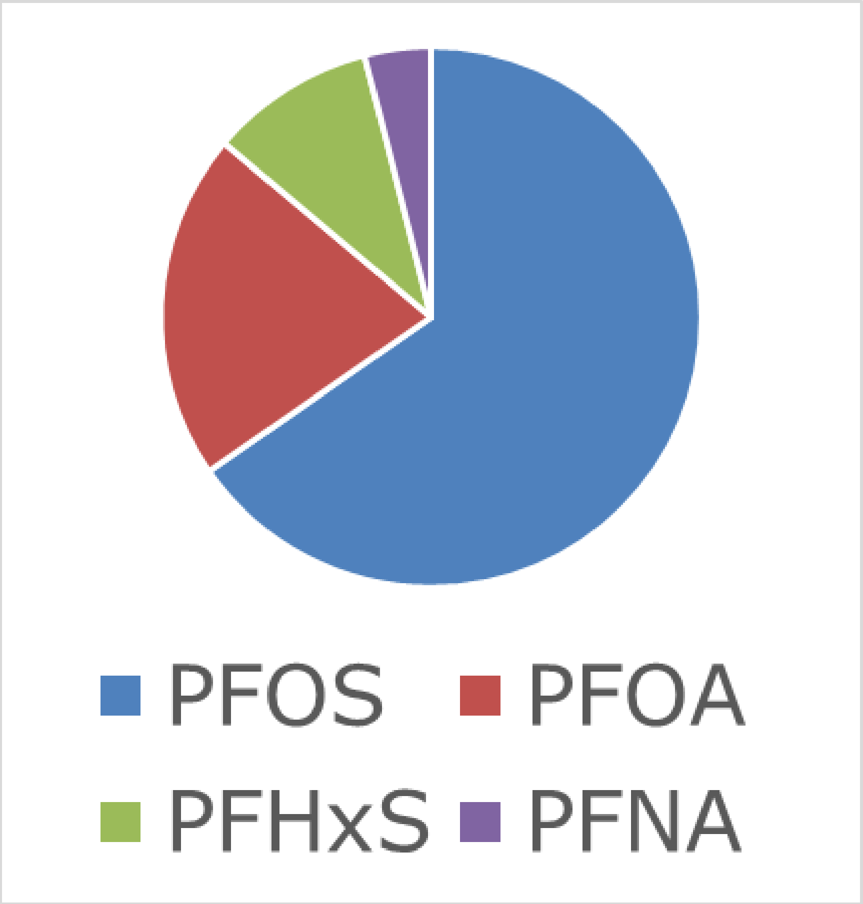
ng/kg body weight per day

	Mean lower bound			Mean upper bound		
	Min	Med	Max	Min	Med	Max
Toddlers (n=14)	1.47	2.94	6.51	61.20	74.17	112.09
Adolescents (n=18)	0.42	0.84	1.52	20.59	26.48	41.45
Adults (n=19)	0.55	0.92	1.34	13.54	15.94	21.97
	P95 lower bound			**P95 upper bound**		
Toddlers (n=14)	3.35	7.55	13.69	100.65	134.01	229.04
Adolescents (n=18)	1.27	2.13	5.22	44.17	57.04	89.40
Adults (n=19)	1.30	2.29	5.04	26.29	32.78	62.70

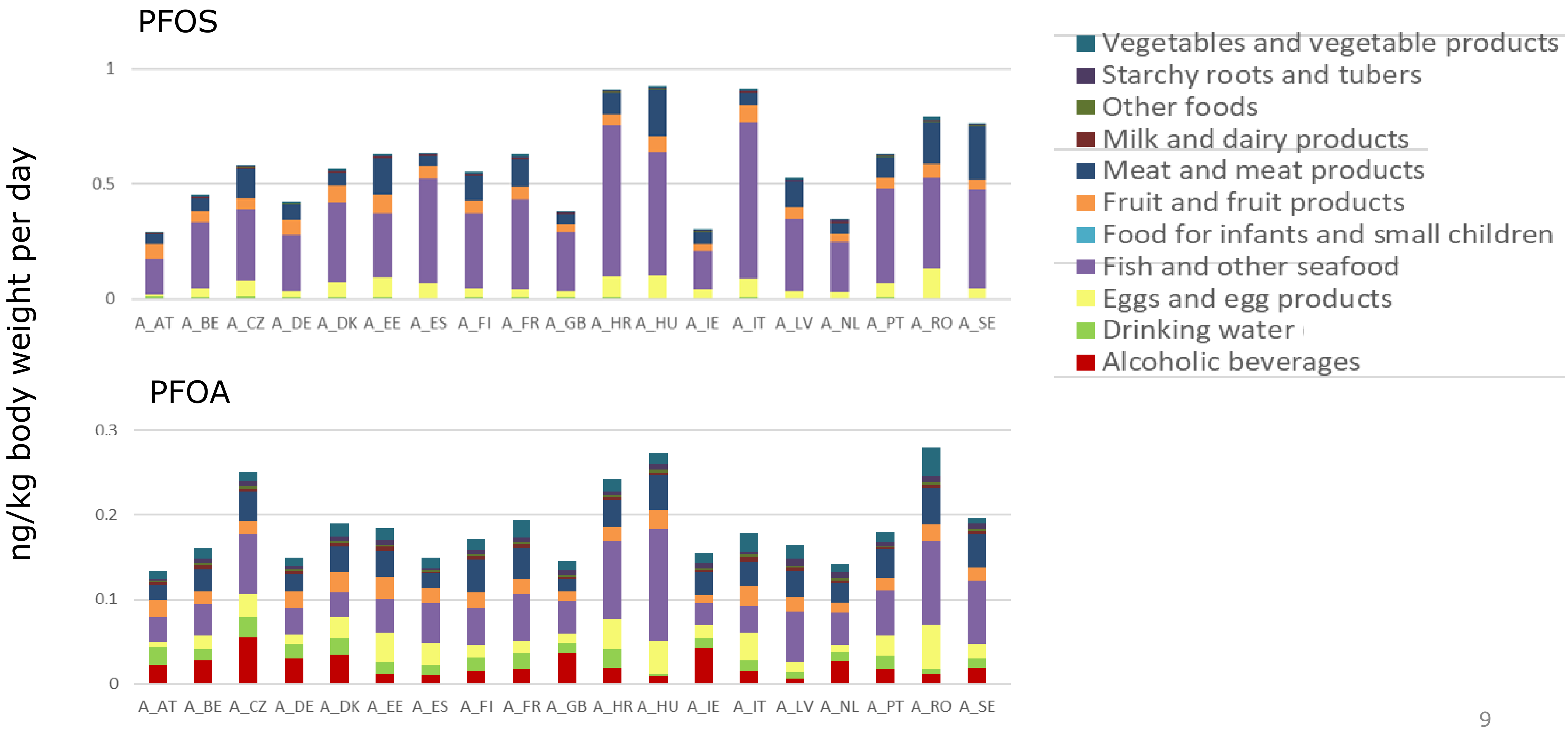
Relative contribution of PFASs for adults



Based on median of the mean LB across surveys

- PFOA, PFNA , PFHxS and PFOS contributed approximately 46% to the sum of 17 PFASs
- Other PFASs that contributed more than 5% to this sum were PFBA (16%) and PFHxA (15%)

Food groups contributing to exposure - adults



Food groups contributing to exposure - adults

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- For the combined exposure to PFOA, PFNA, PFHxS and PFOS, the main contributing food categories were:
  - “Fish meat”,
  - “Fruit and fruit products”
  - “Eggs and egg products”
  - observed for all population groups

Comparison of dietary exposure with EFSA 2018

Differences in method for calculations of exposure from EFSA 2018:

- Updated and additional food consumption surveys and occurrence data
- Changes in cut-offs applied for LOQs
- Replacing missing occurrence data with values in similar food categories
- Mean occurrence levels changed, in particular in drinking water, fish, and meat, because occurrence was weighted for consumption
- Mean PFOA levels in milk were reduced due to withdrawal of data by data provider

Dietary exposure in this opinion vs EFSA 2018:
PFOA is lower while PFOS is similar

Uncertainties in exposure assessment (1)

- Most of the results were submitted by only three European countries, thus levels of PFASs might not be representative for all of Europe
- It is not known to what extent PFASs released from materials in contact with food is covered by the occurrence database
- Overall, the majority of the results were reported below LOD/LOQ:
  - increasing the disparity between LB and UB exposure
  - resulting in a very limited set of detected levels for some compounds in some food groups, like PFNA in “food for infants and small children”

Uncertainties in exposure assessment (2)

- There are also food groups where the detected levels were below the LOQs/LODs of other reported data sets, meaning that the mean levels used in the assessment were underestimated.
- For several food groups, it was assumed that measured levels in a subgroup are representative for the whole food group, despite the absence of data for other products. This could result in under- or overestimation
- Estimates of exposure based on data collected over a period of time will not necessarily reflect the current situation
- Neither non-dietary exposure nor exposure to precursors have been considered, resulting in an underestimation of exposure

Toxicokinetics in humans

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- Readily absorbed in the gastrointestinal tract
- Distributed predominantly to the plasma and liver
- Not metabolised
- Excreted in both urine and faeces
- Biological half-lives are different between species, mainly due to differences in renal clearance
- Estimated half-lives in humans; PFOA/PFNA approx. 2-4 years, PFHxS approx. 5-8 years and PFOS approx. 3-6 years
- Maternal transfer occurs prenatally to the fetus and postnatally through breastfeeding

Selection of biomarker and appropriate matrix

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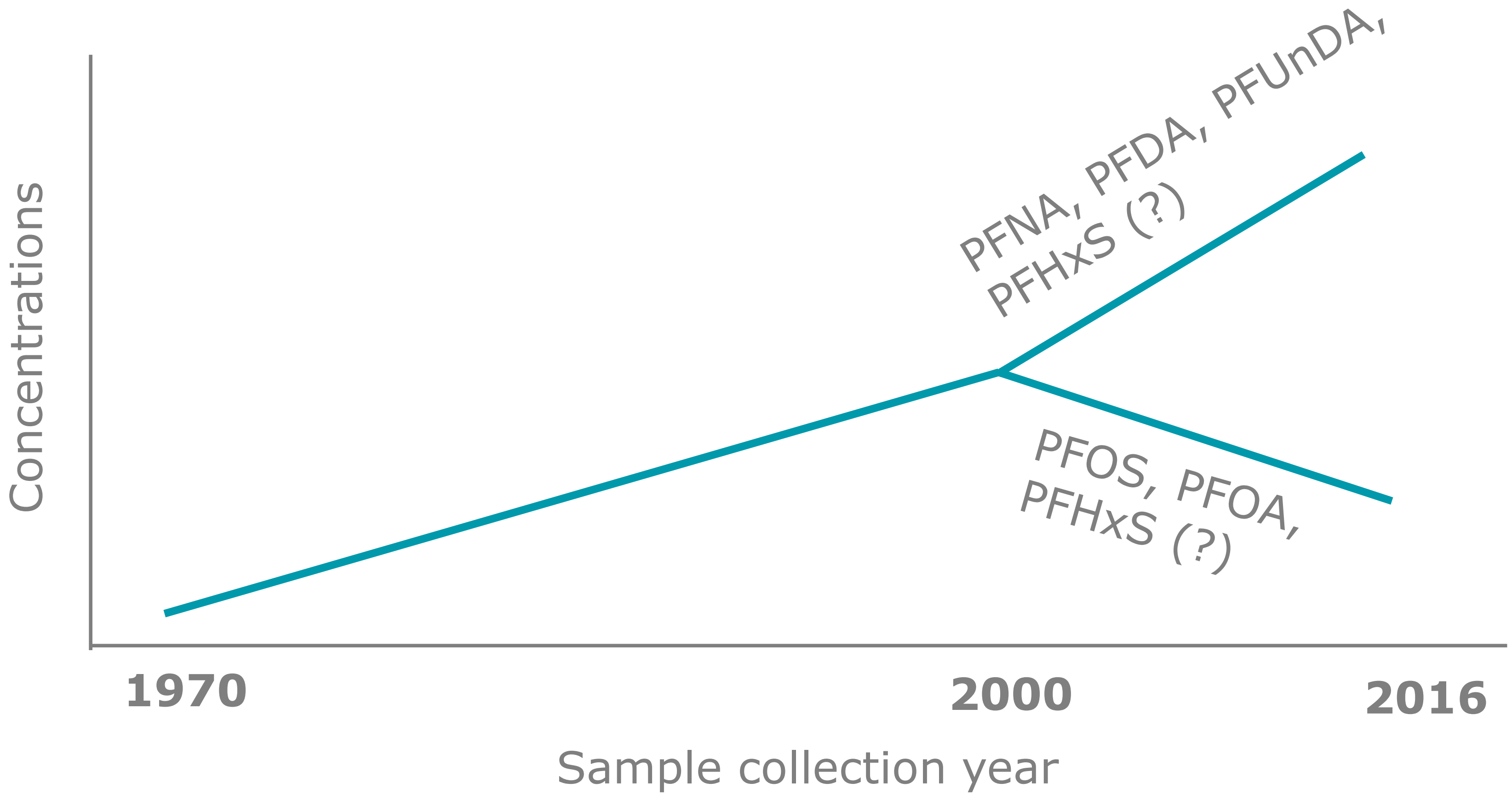
- Most of the included PFASs have high persistency and are thus measured unchanged in biological matrices
- Precursors such as for example FTOHs and PAPs may be biodegraded, and thus contribute to the internal dose
- Preferred matrix – human blood and in particular serum or plasma for most PFASs
- Urine and breast milk – low concentrations, challenging analyses
- Some measurements in non-invasive samples, but unclear how to compare with results in other biological matrices

Time trends



Indication of magnitude in change per year after 2000:

- PFOS: 5-20% decrease
- PFOA: < 5% decrease
- PFNA: ≤ 10% increase
- PFHxS: ?

Levels in general European populations

- European studies
- General populations
- Samples collected in 2007-2008 and onwards
- Only results from the most recent years were described for time trend studies
- Adults
- Children

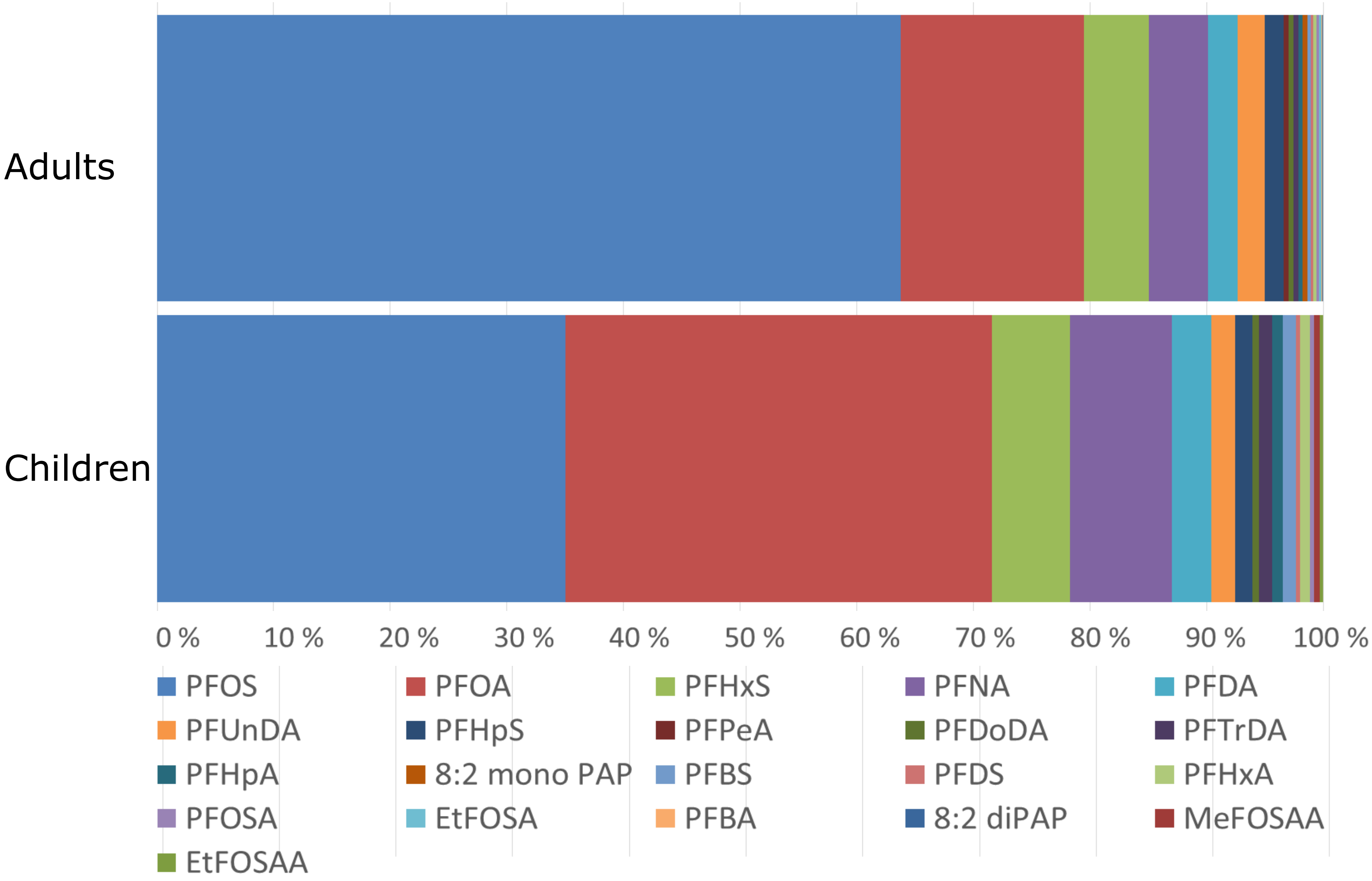
Levels in general European populations

ng/mL

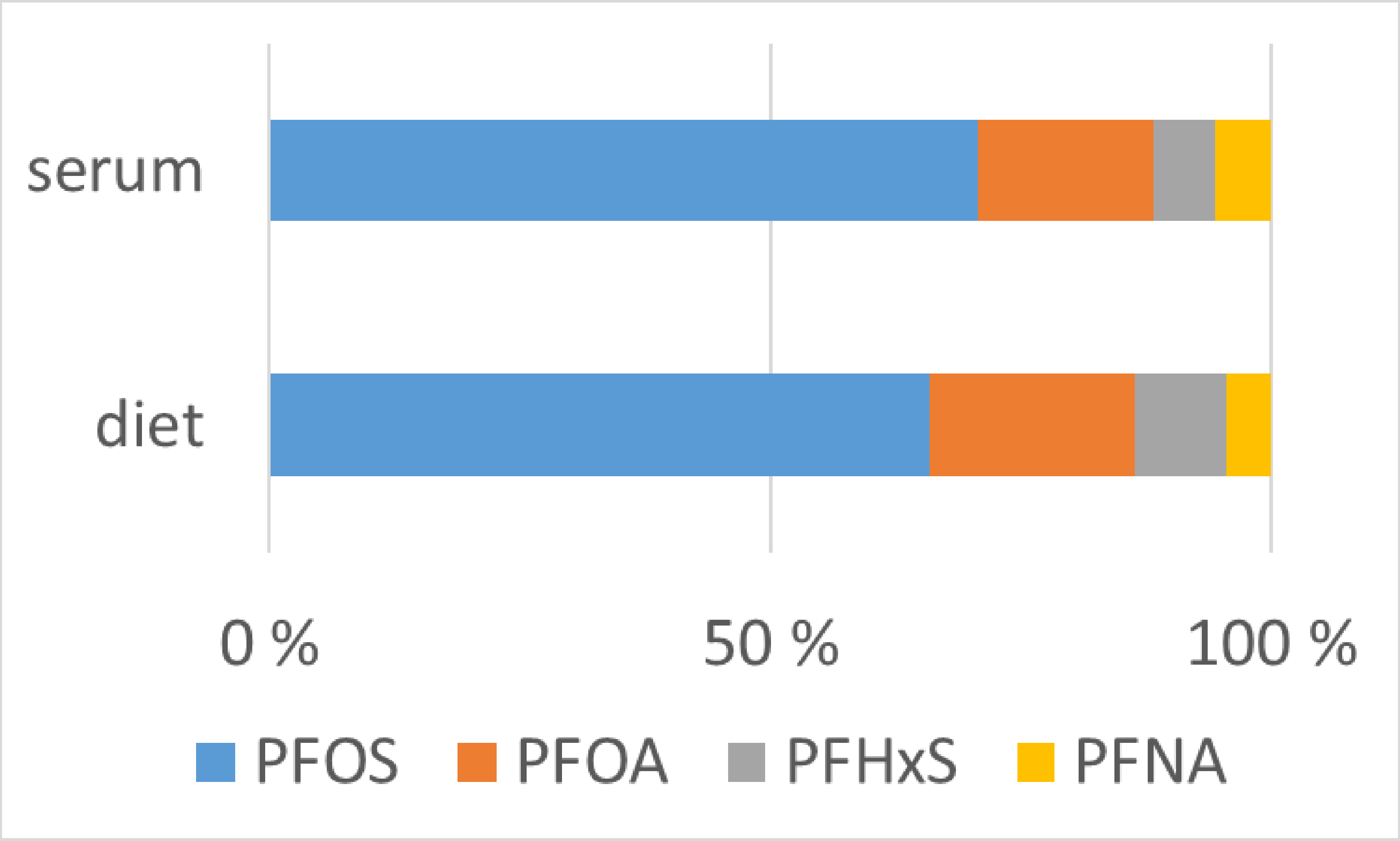
	PFOA*		PFNA		PFHxS		PFOS*	
	adults	children	adults	children	adults	children	adults	children
Median	1.9	3.3	0.61	0.79	0.67	0.60	7.7	3.2
Mean	2.1	3.3	0.74	0.92	4.94	0.56	7.5	3.3
Min	0.76	0.49	0.30	0.5	0.20	0.3	1.7	0.49
Max	4.9	6.9	2.64	2.13	152	0.81	27.4	8.6
n studies	32	8	37	9	37	9	32	8
Min Individ. samp.	0.03	0.45	< 0.013	0.12	0.008	<0.03	0.06	0.47
Max. individ. samp.	80.8	19.5 (P95)	8.6	23.96	1790	84.7	392.3	23.0

* from EFSA 2018

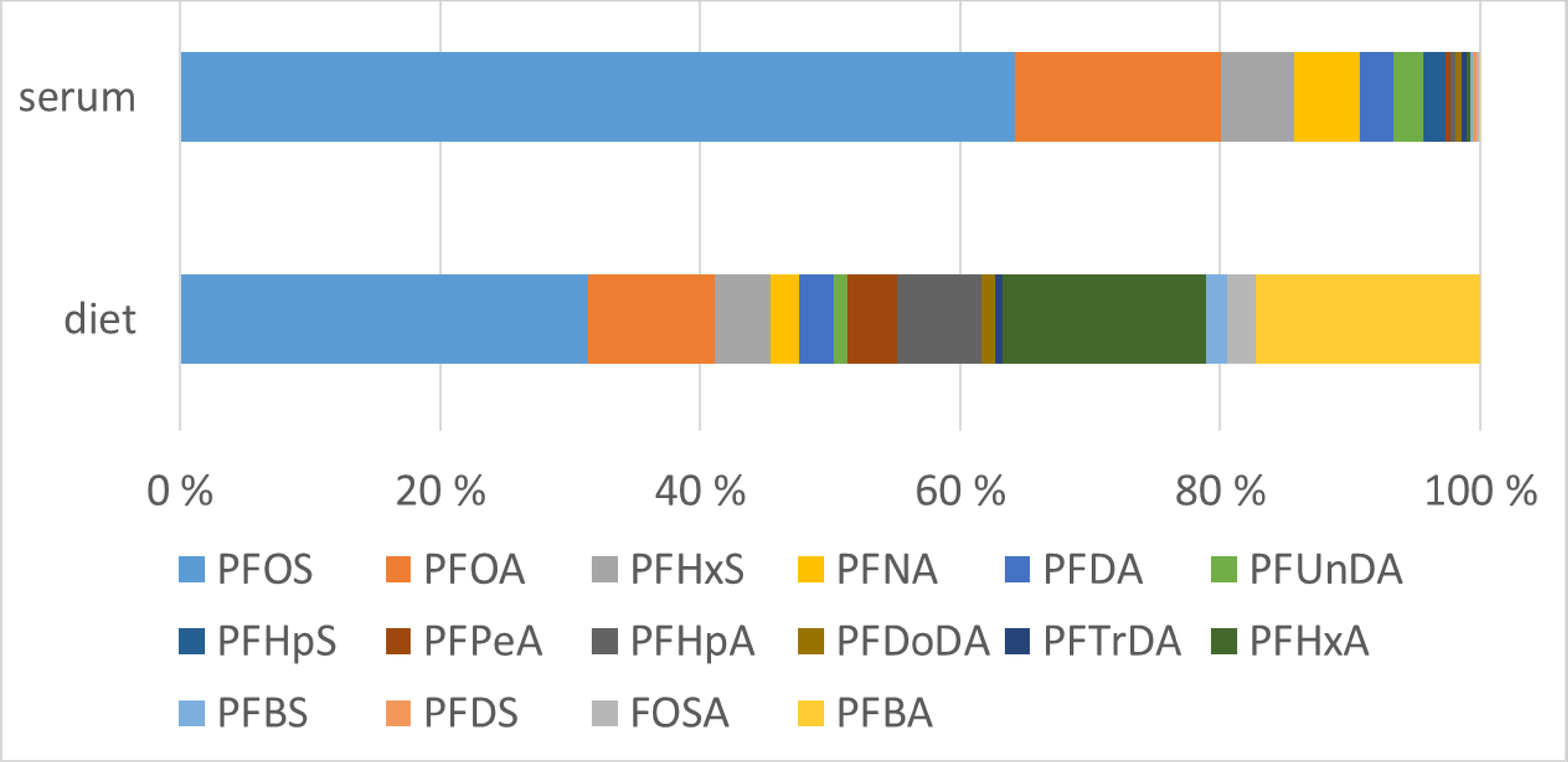
Levels in general European populations



Patterns in diet and serum for adults – 4 PFASs



Patterns in diet and serum for adults – 17 PFASs



Diet; PFHpS, PFDS, PFTeDA: <0.01 ng/kg bw per day
Serum: PFTeDA: no data available

Levels in occupationally exposed adults

- Fluorochemical production workers (PFOS/PFOA; mean 500-7000 ng/mL serum, PFHxS mean up to 700 ng/mL) (1)

- Professional skiwaxers (PFOA; up to around 1000 ng/mL serum, PFNA; up to around 300 ng/mL serum, PFDA up to around 50 ng/mL serum and PFUnDA; up to around 5 ng/mL serum) (2)

- Firefighters (e.g. In Australia median concentrations of 66 and 25 ng/mL serum were reported for PFOS and PFHxS, respectively) (3)

1) Fromme et al. 2009. Int J Hyg Environ Health. 212, 239-270
2) Nilsson et al. 2010. Environ Sci Technol. 44(6),2150-5
3) Rotander et al. 2015. Environ Int. 82,28-34

Levels in populations with elevated drinking water exposure

- Several episodes of contamination of drinking water
  - Near production facilities (e.g. Mid-Ohio River Valley, USA)
  - Near training facilities for fire fighting (e.g. Ronneby, Sweden)
  - Contaminated waste material applied to agricultural areas (e.g. Arnsberg, Germany)

- Concentrations of 1000 ng/mL and even higher have been reported for both PFOS, PFOA and PFHxS

Factors that may have an impact on the internal dose

- Transplacental transfer (+)
- Breast feeding (+)
- Regional differences (?) Somewhat lower in low-income countries (?)
- Age (+)
- Gender (+); may be due to differences in exposure, differences in renal reabsorption, menses, pregnancy and lactation
- Ethnicity (+)
- Body weight (?)
- Socio-economical status; income (+), education (?)

+ : confirmed associations ?: possible associations

Uncertainties in biomonitoring

- Whole blood may be a more appropriate matrix for certain PFASs

- The representativeness of the biomonitoring data is affected by:
  - limited amount of data for many PFASs
  - non-equal distribution of studies between countries

- The collection time points may have had an influence on the aggregated data such as mean and median concentrations.

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