Human health risks and main concerns of PFAS

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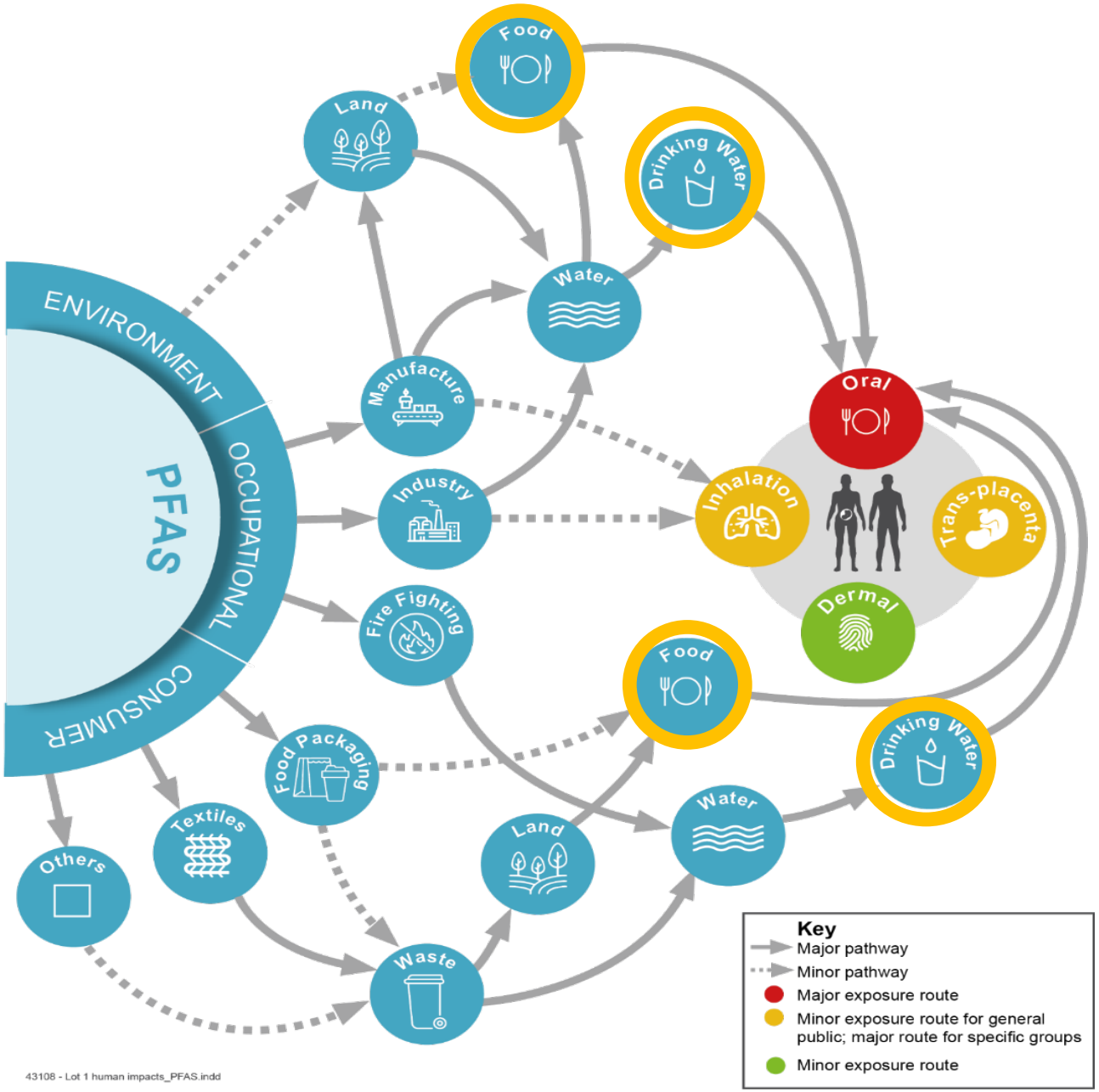
18th Sept 2023

Online Nordic meeting

Which exposure sources?

Is the exposure decreasing, increasing or unchanged?

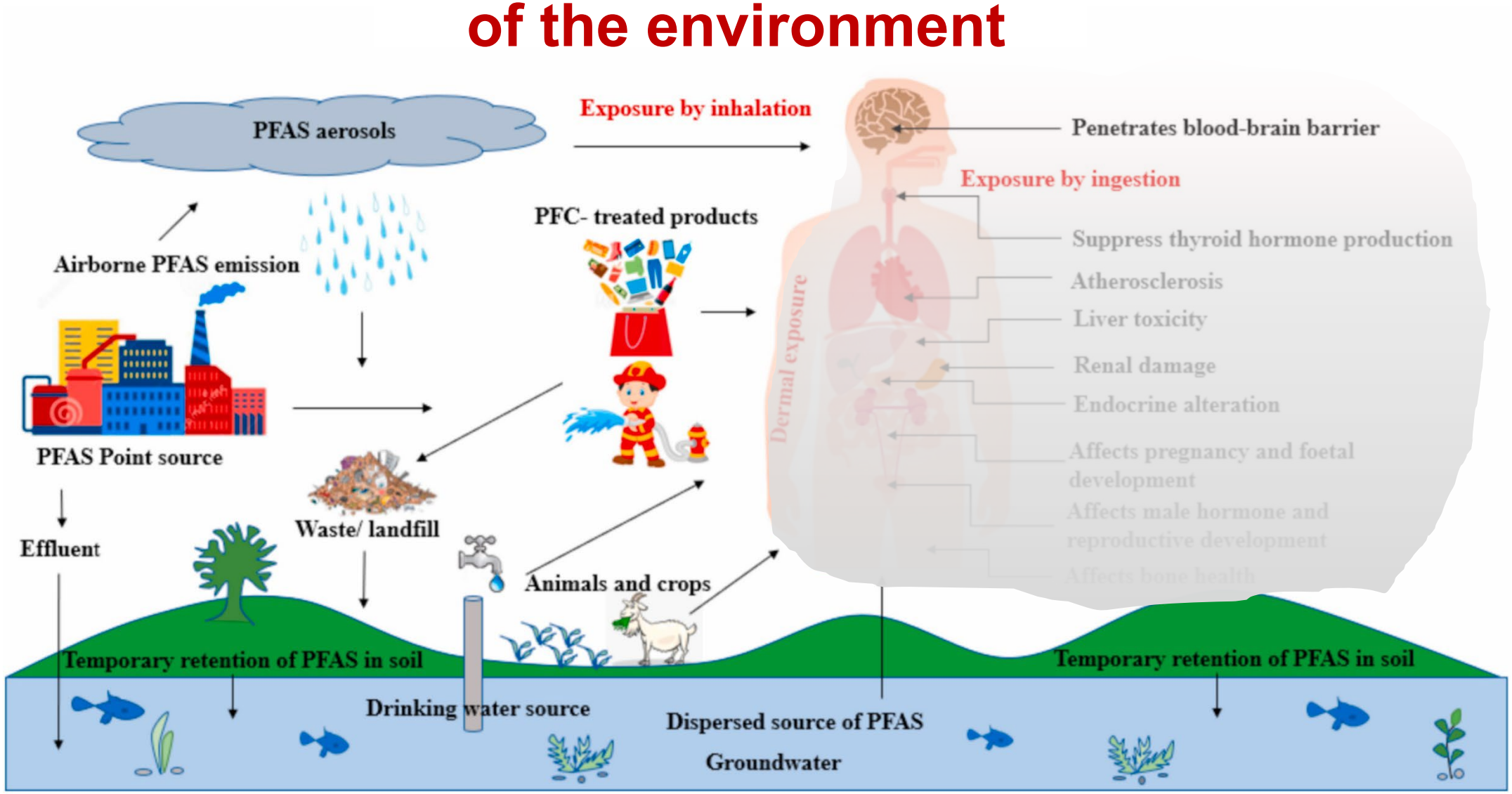
Sources of human exposure to PFAS



Ref: HBM4EU Policy brief, 2021

- PFAS – a broad class of **anthropogenic** chemicals
- EPA (2023): **14,000** PFAS
- Extremely **persistent**, some are bioaccumulating

Diffuse versus ‘hot spot’ PFAS contamination of the environment



Modified from Espartero et al. Health-related toxicity of emerging per- and polyfluoroalkyl substances: Comparison to legacy PFOS and PFOA. Environ Res 2022

Exposure sources

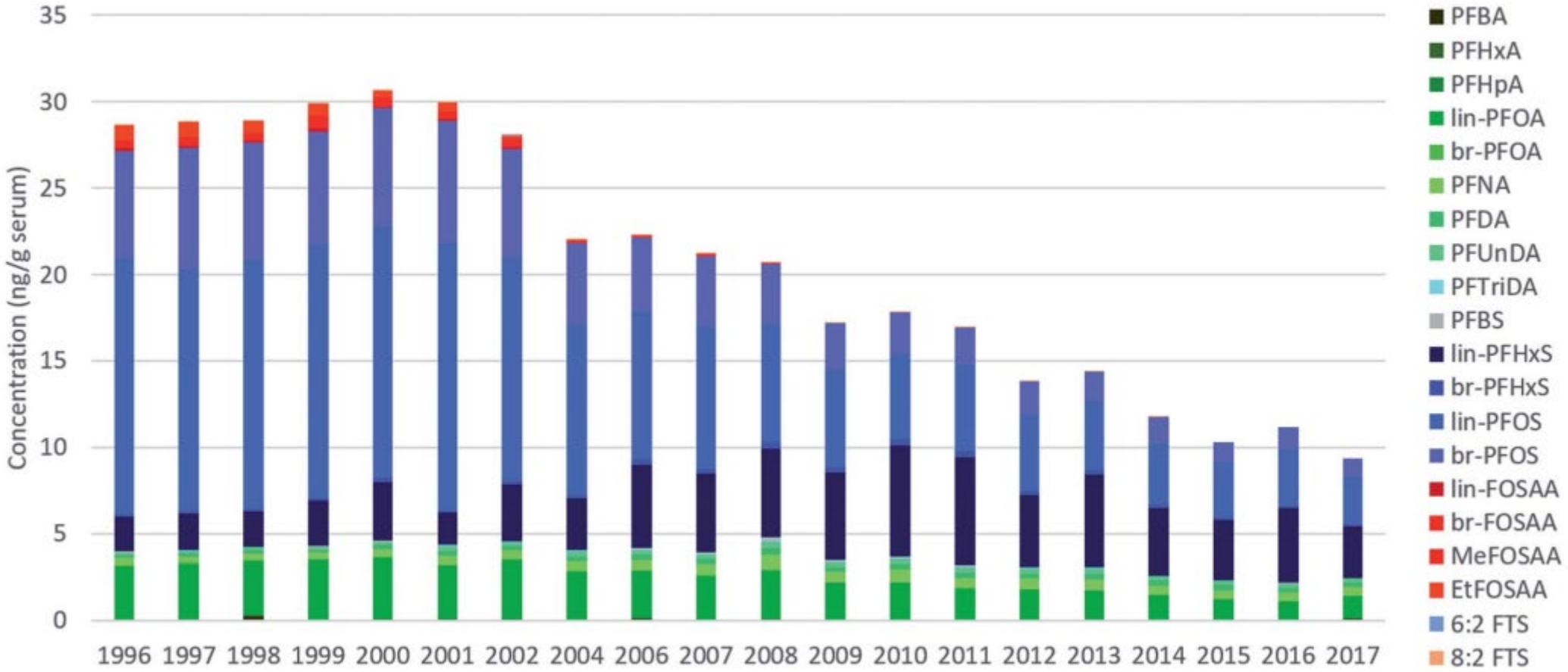
Foods are the main source of human exposure to several PFAS but variability across populations and PFAS compounds exists

Drinking water can be the dominating exposure source in contaminated areas (‘hot spots’)

Exposure from dust, personal consumer products, indoor environment and other sources do also play a role

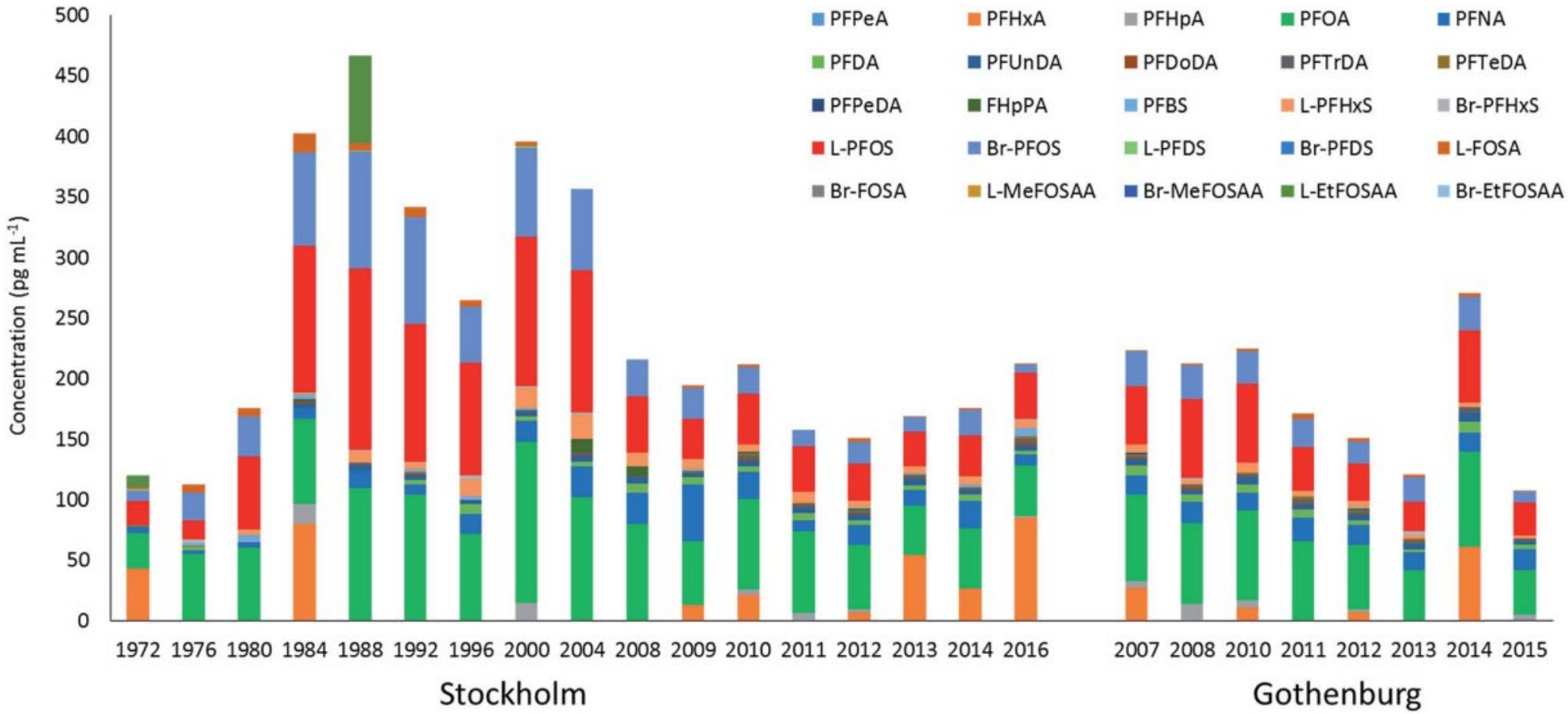
De Silva et al. PFAS Exposure Pathways for Humans and Wildlife: A Synthesis of Current Knowledge and Key Gaps in Understanding. Enviro Toxic and Chemistry, 40 (3), 631-657, 2020

PFAS in serum from Swedish first-time mothers 1996-2017



Ref: Miaz et al. Environ. Sci.: Processes Impacts, 2020, 22, 1071

PFAS in breast milk from Swedish mothers 1972-2016



Ref: Nyberg et al. Environ. Sci.: Processes Impacts, 2018, 20, 1136

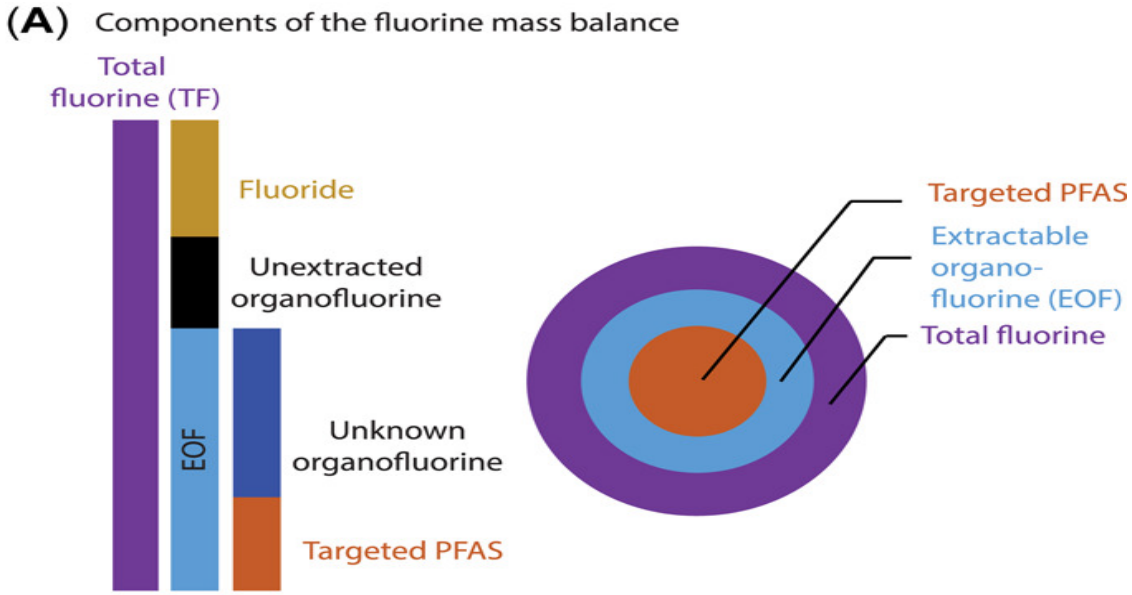
Drinking water, human blood and breast milk is analyzed for just a few parts per thousand of all PFAS

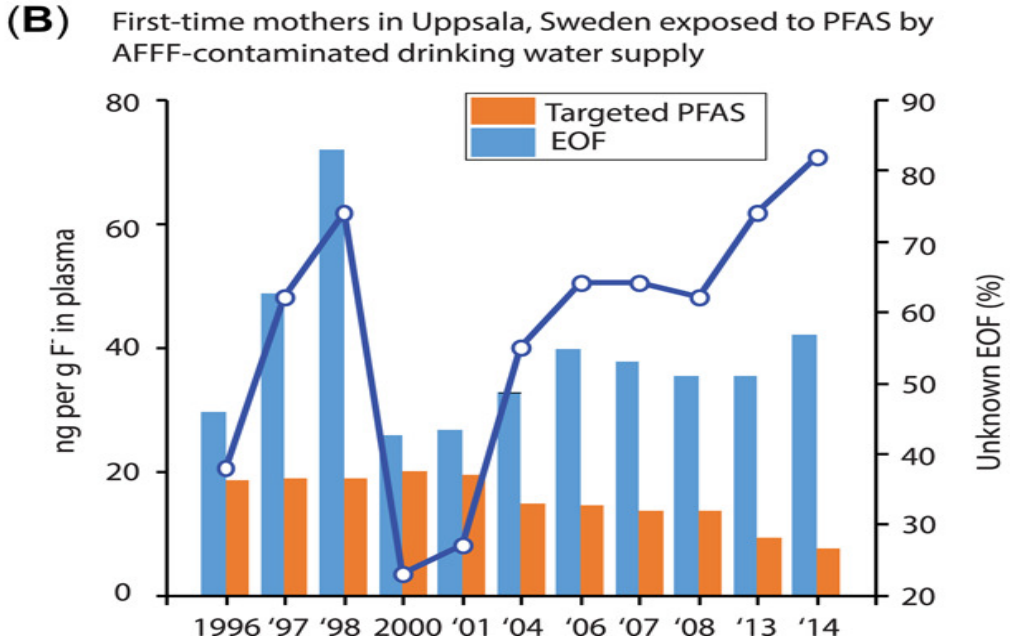
Known PFAS

Unknown or not measured PFAS

Extractable organic fluor (EOF)

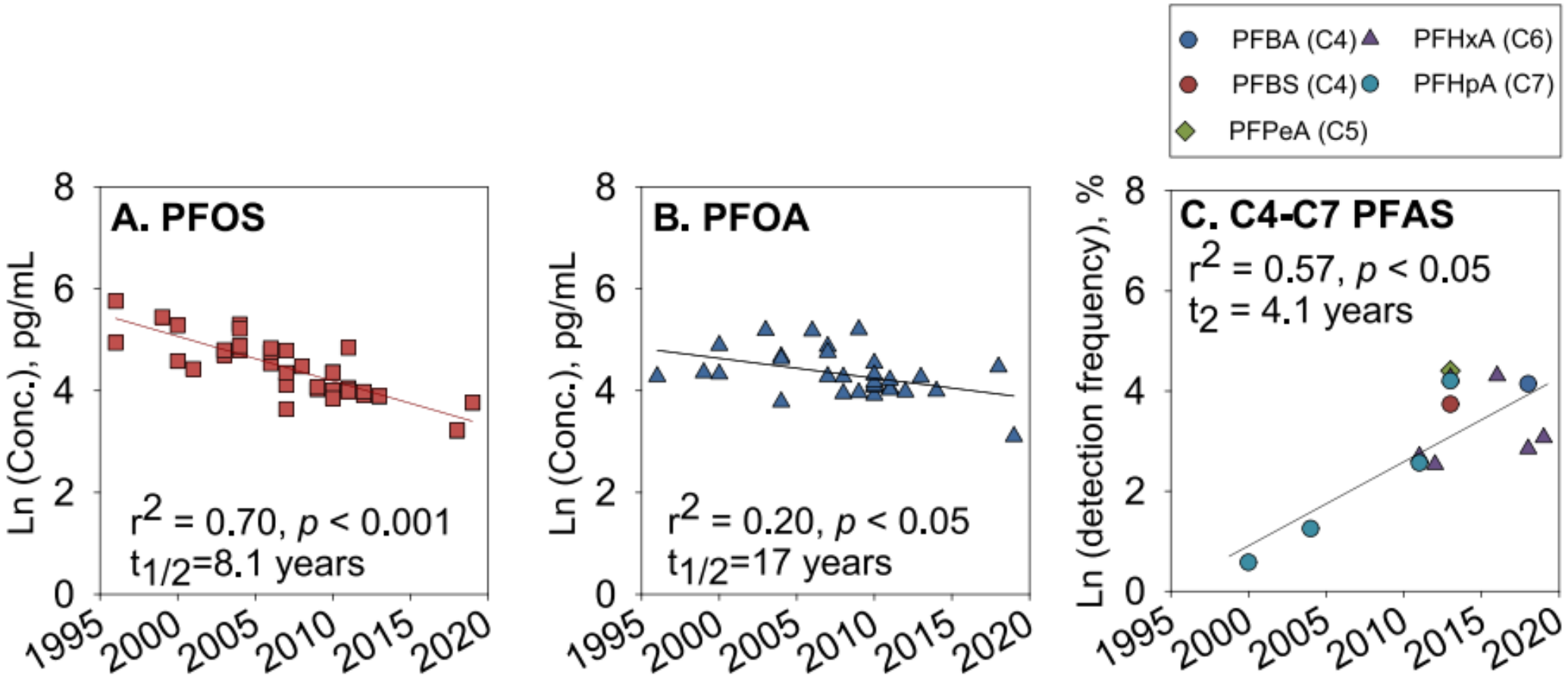
Legacy PFAS in serum are decreasing, whereas total PFAS does not





Ref: De Silva et al. Environmental Toxicology and Chemistry, 40 (3), 631–657, 2021

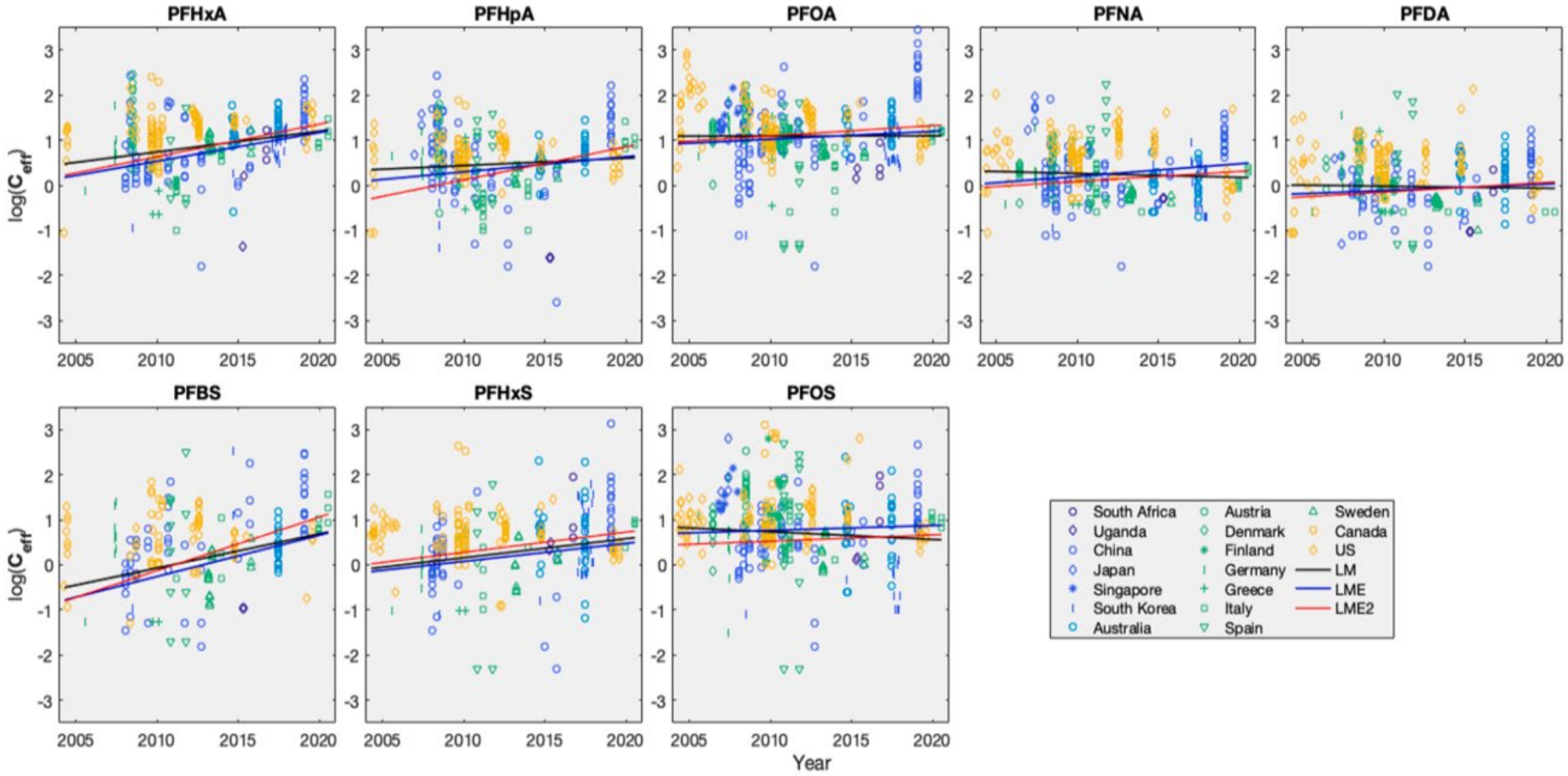
PFAS in human breast milk in USA 1995-2020



Ref: Zheng et al. Environ. Sci. Technol. 2021, 55, 7510−7520

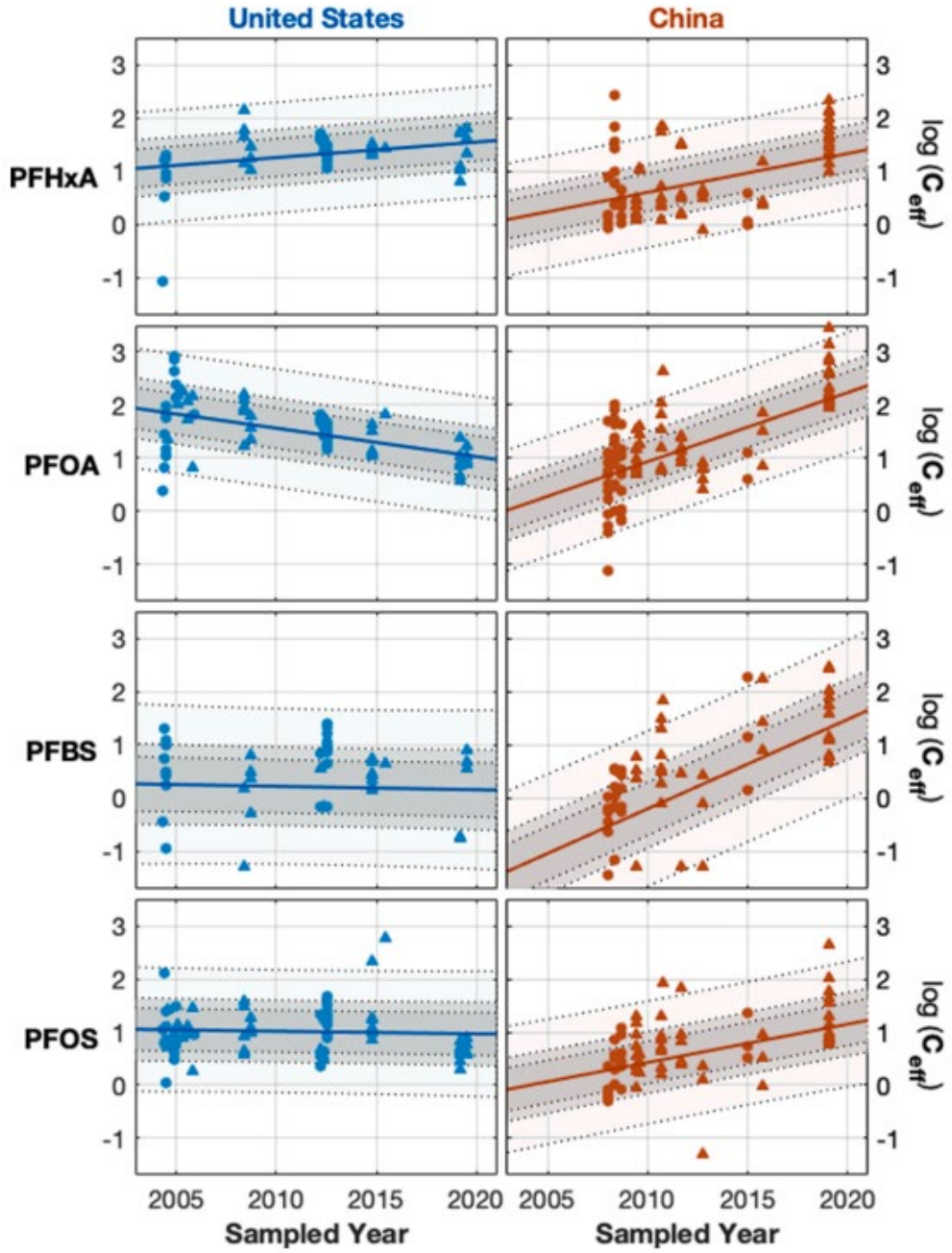
Global perspective: Time trends of PFAS content in waste-water 2005-2020

Metanalysis of **310 WWTP in 17 countries** (44 papers)



Ref: Cookson & Dewiler. Global patterns and temporal trends of perfluoroalkyl substances in municipal wastewater: A meta-analysis. Water Res 2022

Comparison of PFAS levels in waste-water from US and China



Ref: Cookson & Dewiler. Global patterns and temporal trends of perfluoroalkyl substances in municipal wastewater: A meta-analysis. Water Res 2022

Time trends of PFAS in biological tissues based on existing knowledge:

Some legacy PFAS have descreased during the latest couple of decades in the Western world, whereas 'new' PFAS seem to increase

In other parts of the World do the legacy PFAS increase

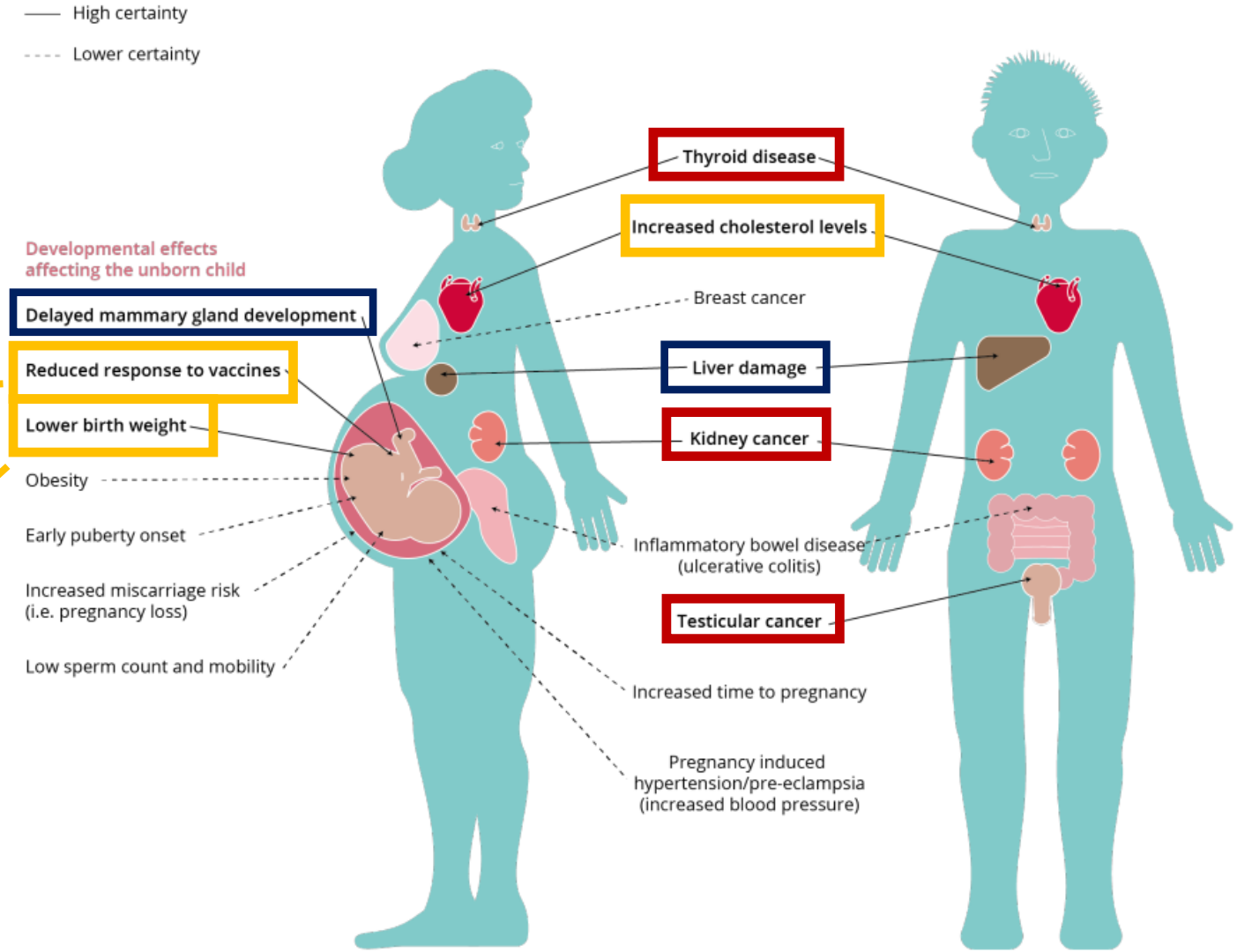
Which human health risks?

How big is the risk?

Effects of PFAS on human health

~0-50% reduced Ab response by a doubling of PFAS exposure

~50-100 gr reduced birth weight



Critical effects!

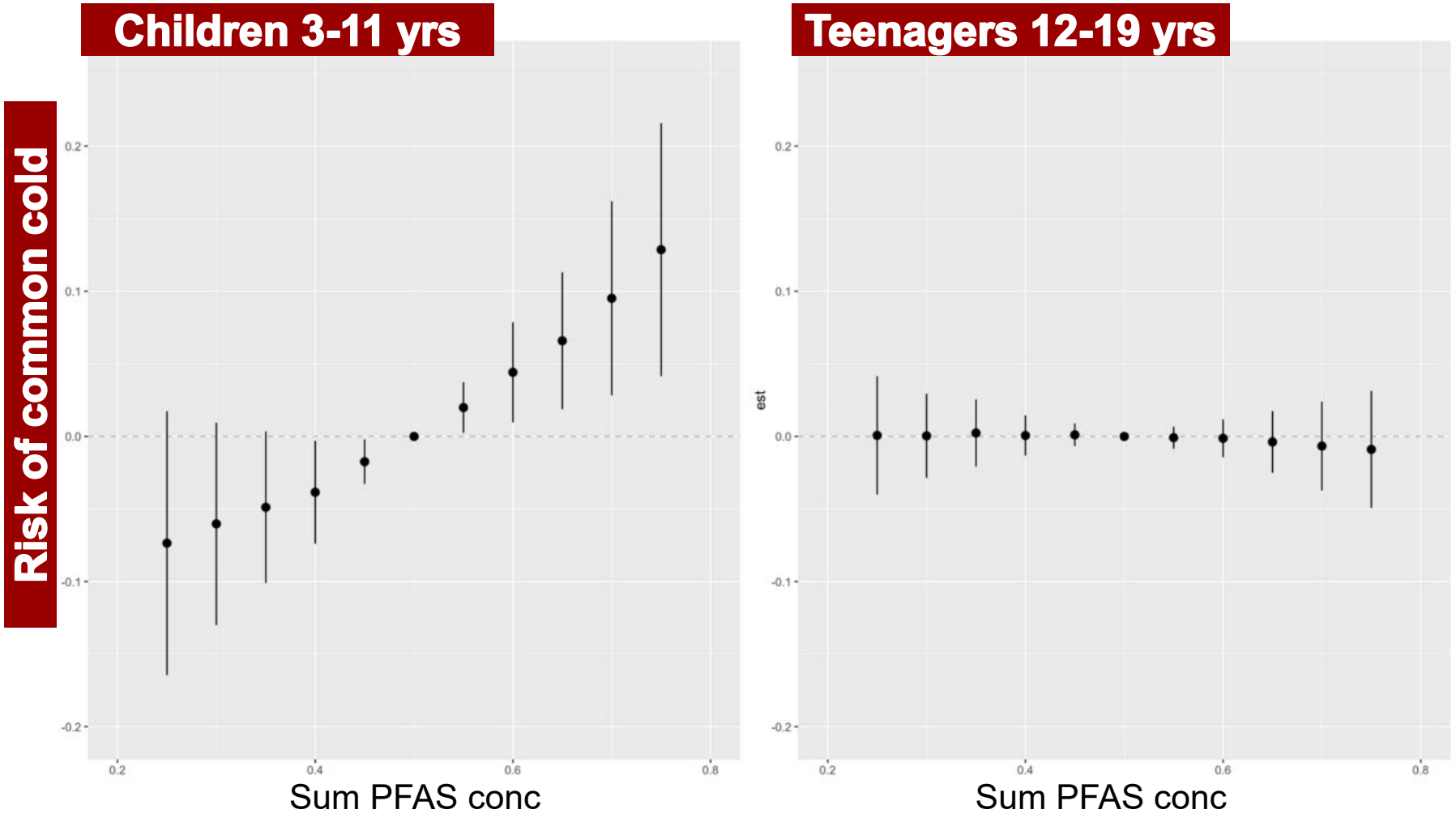
Observed in normal population

Observed in populations from contaminated areas

Observered in rats/mice

Modified from Fenton et al. 2020. Per- and Polyfluoroalkyl Substance Toxicity and Human Health Review: Current State of Knowledge and Strategies for Informing Future Research. Environ Tox Chem

The risk of common colds increases with increasing PFAS exposure in 3 to 11-year children in the US



Zhang et al. Association between serum per- and polyfluoroalkyl substances concentrations and common cold among children and adolescents in the United States. Environ Int, 164, 107239, 2022

Maternal PFAS and rate of hospitalization for infectious diseases in 1503 Danish children 0-4 yrs

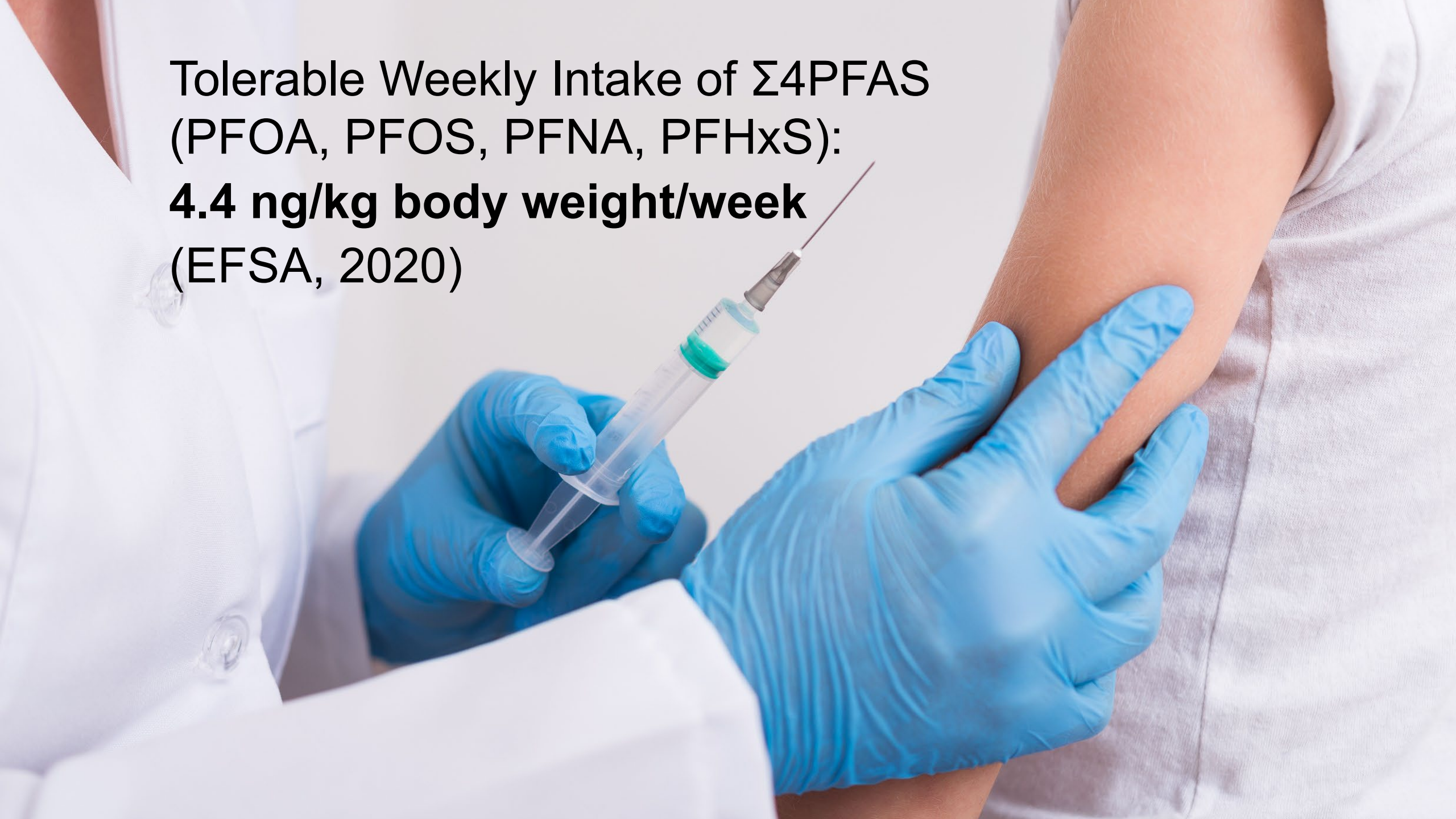
Hazard ratios (HR's) and 95% confidence intervals (95% CI) for the association between maternal PFAS concentrations and the rate of hospitalization for infections (any and according to type)

	Any infection (N = 1472, events = 633)		Interaction,PFAS and child sex, *p*-value	URTI (N = 1472, events = 167)	LRTI (N = 1472, events = 151)	GI (N = 1472, events = 40)	Other (N = 1472, events = 275)
	Crude HR[a]	Adjusted[b] HR[a]		Adjusted[b] HR[a]	Adjusted[b] HR[a]	Adjusted[b] HR[a]	Adjusted[b] HR[a]
PFOS	1.18 (1.02, 1.36)	1.23 (1.05, 1.44)	0.067	1.25 (0.97, 1.61)	1.54 (1.11, 2.15)	0.77 (0.46, 1.29)	1.17 (0.98, 1.40)
PFOA	1.12 (0.97, 1.25)	1.13 (0.97, 1.29)	0.882	1.18 (0.93, 1.50)	1.27 (1.01, 1.59)	0.55 (0.32, 0.95)	1.12 (0.93, 1.35)
PFHxS	1.00 (0.89, 1.13)	1.02 (0.90, 1.16)	0.214	1.01 (0.83, 1.21)	1.01 (0.78, 1.32)	0.85 (0.50, 1.43)	1.07 (0.91, 1.25)
PFNA	1.04 (0.90, 1.21)	1.07 (0.92, 1.25)	0.592	1.18 (0.90, 1.53)	1.17 (0.89, 1.55)	0.80 (0.46, 1.40)	1.00 (0.82, 1.22)
PFDA	1.02 (0.89, 1.18)	1.06 (0.93, 1.22)	0.061	1.16 (0.95, 1.42)	1.06 (0.85, 1.32)	0.81 (0.46, 1.43)	1.04 (0.85, 1.27)

[a] The change in the instantaneous risk with every doubling of maternal serum PFAS concentration;

[b] adjusted for maternal age, parity, maternal educational level, child sex and child age

Dalsager et al.: Exposure to perfluoroalkyl substances during fetal life and hospitalization for infectious disease in childhood: A study among 1,503 children from the Odense Child Cohort. Environ. Int. April 2021

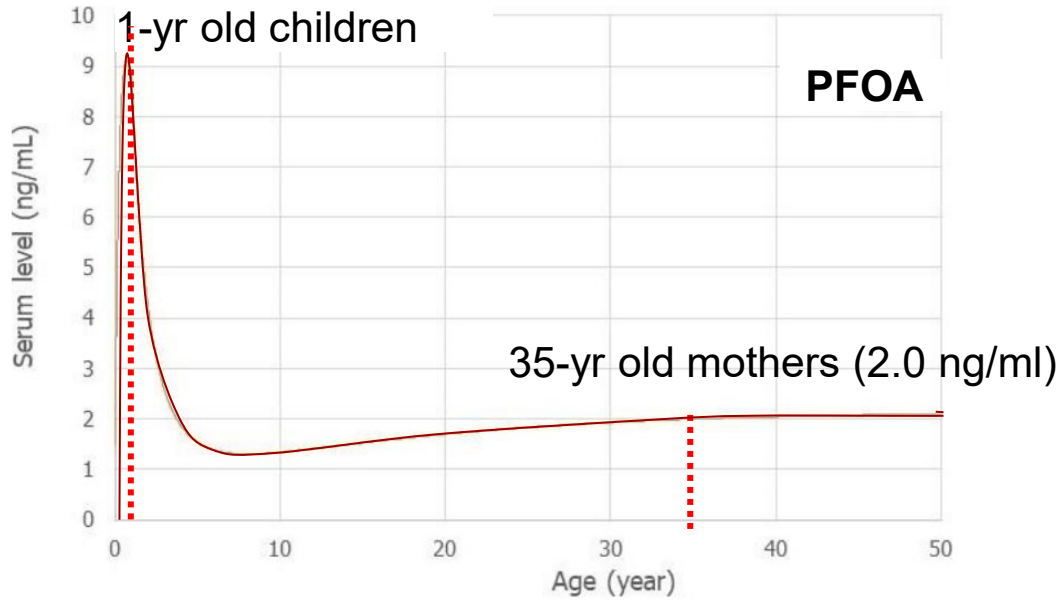


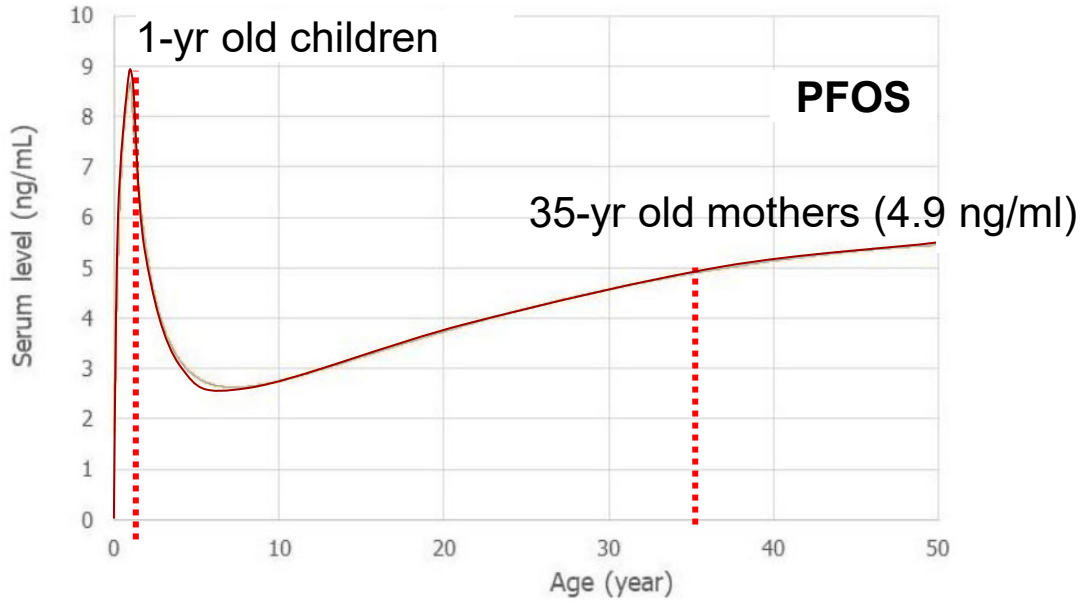
Tolerable Weekly Intake of Σ4PFAS (PFOA, PFOS, PFNA, PFHxS):

4.4 ng/kg body weight/week

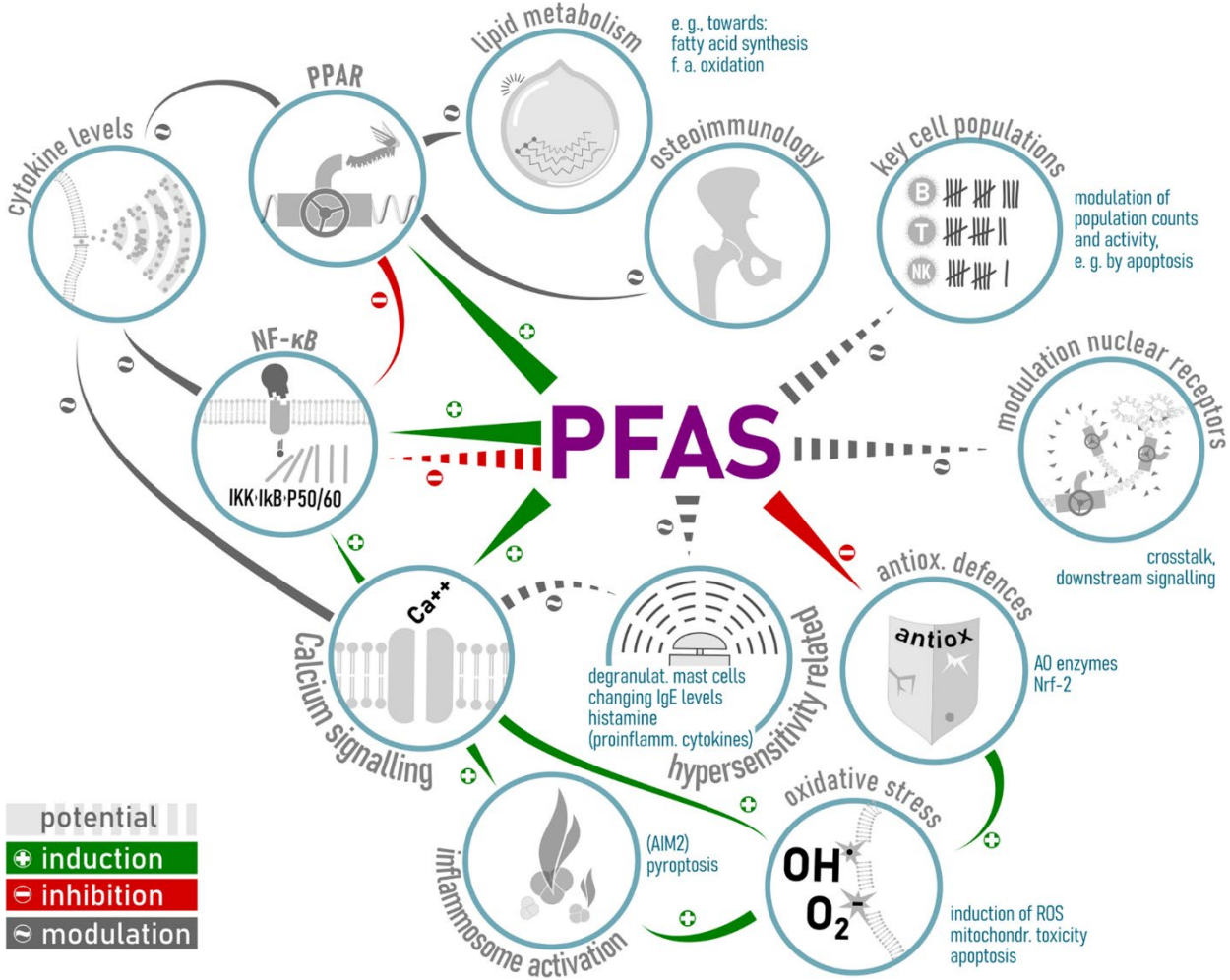
(EFSA, 2020)

TWI for 4PFAS is established based on a safe intake for women up till 35-yrs of age, so they can breast feed their children without them being affected by an impaired vaccination response





Relevant mechanisms that may underlie the observed effects on the (developmental) immune system



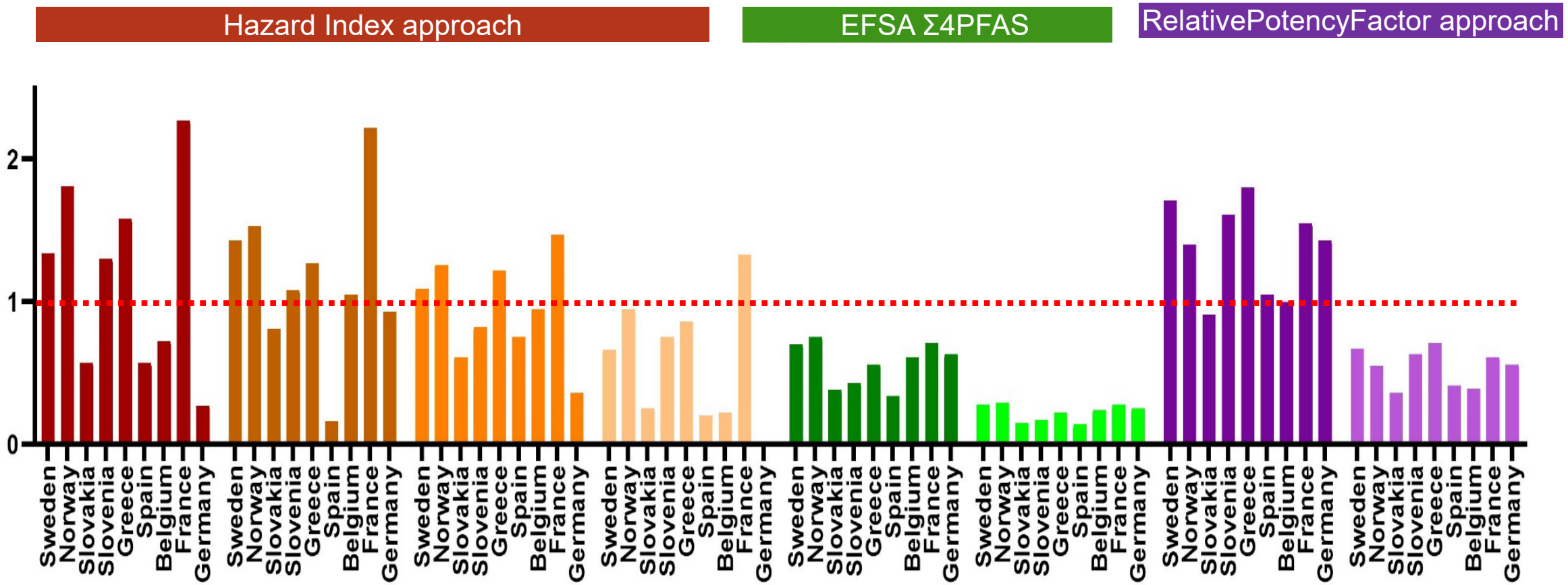
Ehrlich et al. Consideration of pathways for immunotoxicity of per- and polyfuoroalkyl substances (PFAS), Environmental Health (2023) 22:19

Human PFAS intake via foods in the EU is generally too high and must be reduced

Total intake of ∑4PFAS in the European population: **0.91 ng/kg/day**

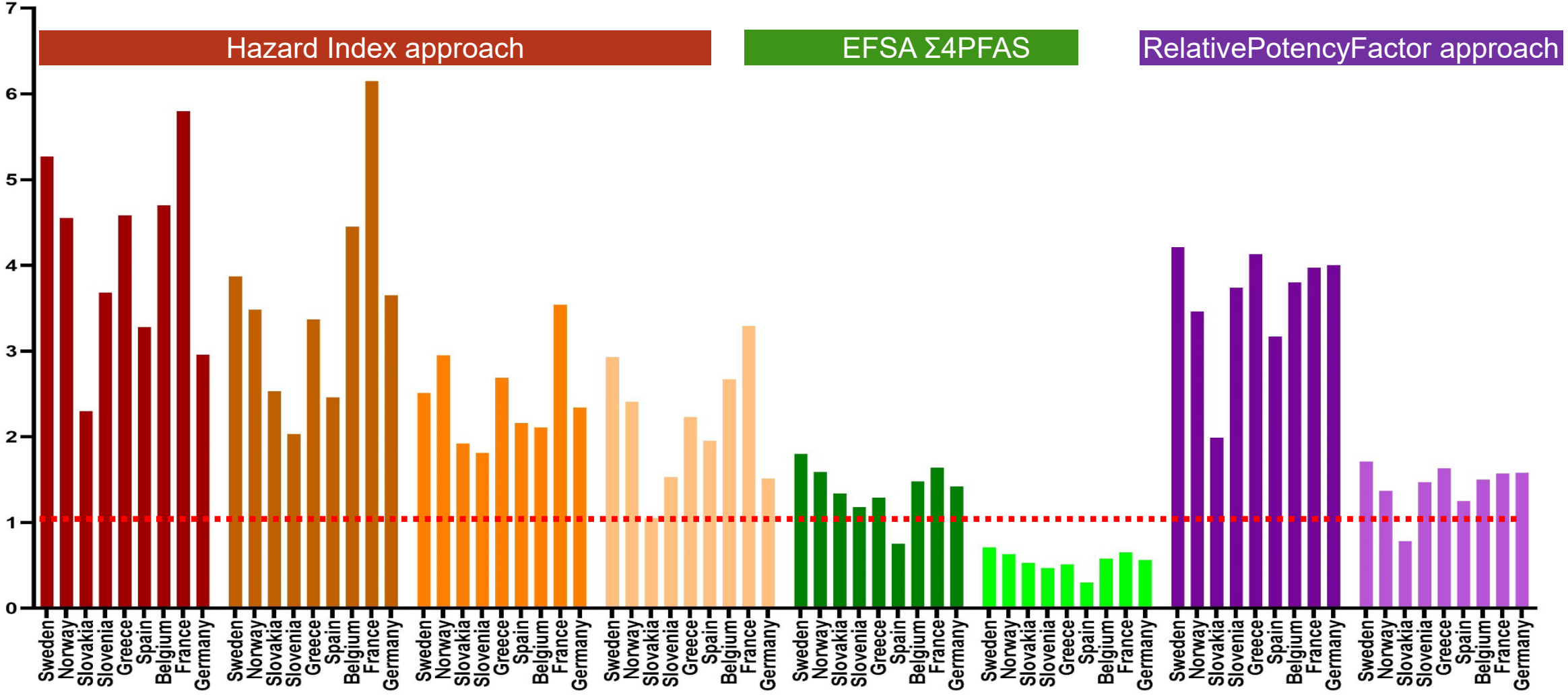
Tolerable intake of ∑4PFAS established by EFSA, 2020: **0.63 ng/kg/day**

Risk assessment of PFAS mixtures based on human biomonitering data from teenagers (P50)



Bil et al. Approaches to mixture risk assessment of PFASs in the European population based on human hazard and biomonitoring data. Int J Hygiene Environ Health. 247, 114071, 2023

Risk assessment of PFAS mixtures based on human biomonitering data from teenagers (P95)



Bil et al. Approaches to mixture risk assessment of PFASs in the European population based on human hazard and biomonitoring data. Int J Hygiene Environ Health. 247, 114071, 2023

Conclusions based on existing knowledge

- Some legacy PFAS have decreased in humans during the last 20 years in the Western countries, whereas **new PFAS increase**. In other parts of the World, legacy PFAS increases as well
- **Foods** are the primary source of PFAS exposure in the normal population
- PFAS exposure in the normal population is generally **too high and must be reduced**
- **Impaired vaccination response**, reduced birth weight, and increased cholesterol levels are the critical effects
- Risk assessments are undertaken to protect the entire population. There is **not necessarily a risk for highly exposed individuals**
- However, from a societal perspective **it is NOT acceptable being exposed to PFAS to a degree that affect the unborn child**