What is the effect of phasing out long-chain per- and polyfluoroalkyl substances (PFAS) on the concentrations of perfluoroalkyl acids and their precursors in humans?

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1. BACKGROUND

Toxicological and refractory properties of PFASs, in combination with their widespread occurrence and bio-availability, have raised concerns about the environment and human health. Consequently, the use of some PFASs have been regulated or voluntarily phased-out by the industry in parts of the World. Here we summarize the findings of a systematic review on global temporal trends of perfluoroalkyl acids (PFAAs) and their precursors in humans.

2. METHODS

A systematic review was conducted in compliance with the guidelines by Collaboration for Environmental Evidence (CEE) and according to a previously published protocol (Land et al. 2015). The systematic review included both human and environmental samples. Temporal data were reanalysed using the same statistical methods across all datasets. As meta-analysis was not feasible, the synthesis is mainly narrative but includes graphic visualizations of study results (examples shown in Figure 1).

Example A. No detected change-point and no significant trend. The power to detect a trend is low which means that a trend may be present, but given the inter-annual variability the dataset is insufficient to detect that.

Example B. A significant change-point (CP) is detected, but the trends are in-significant with low power to detect a trend both before and after the CP. There is a significantly decreasing trend if the entire study period is considered (indicated by green marker).

Example C. A significant change-point (CP) is detected. Before the CP the trend is insignificant and the power to detect a trend is high. It is unlikely that there is a significant (undetected) trend before the CP. After the CP there is a significant decreasing trend.

Example D. No change-point analysis was performed (<7 time-points). There is no significant trend and the power to detect a trend is low.

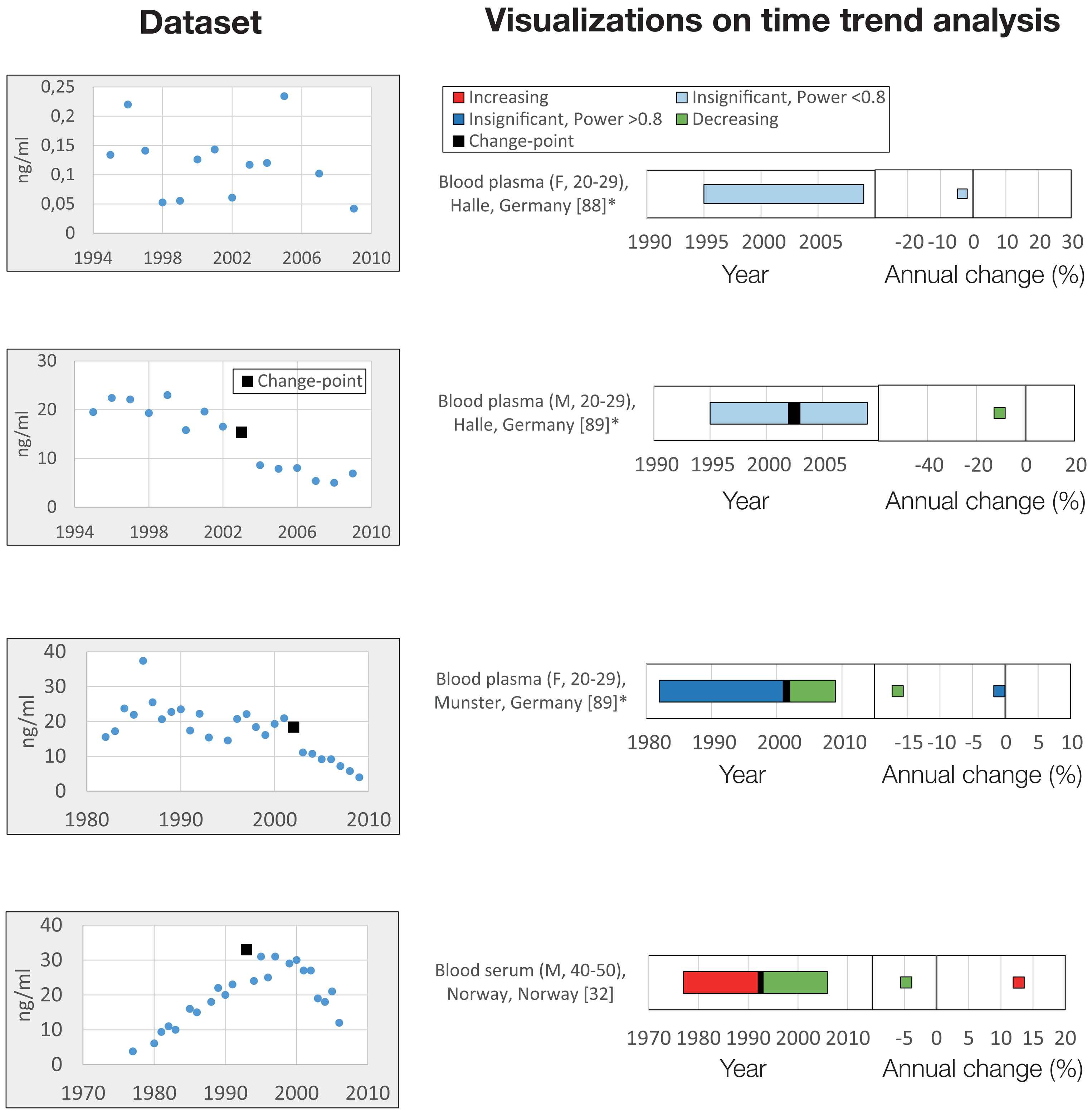

Figure 1. Four examples showing how results obtained in time trend analyses are visualized.

3. RESULTS

The systematic review includes 13 PFASs. Figure 2 shows study results for PFOS in humans.

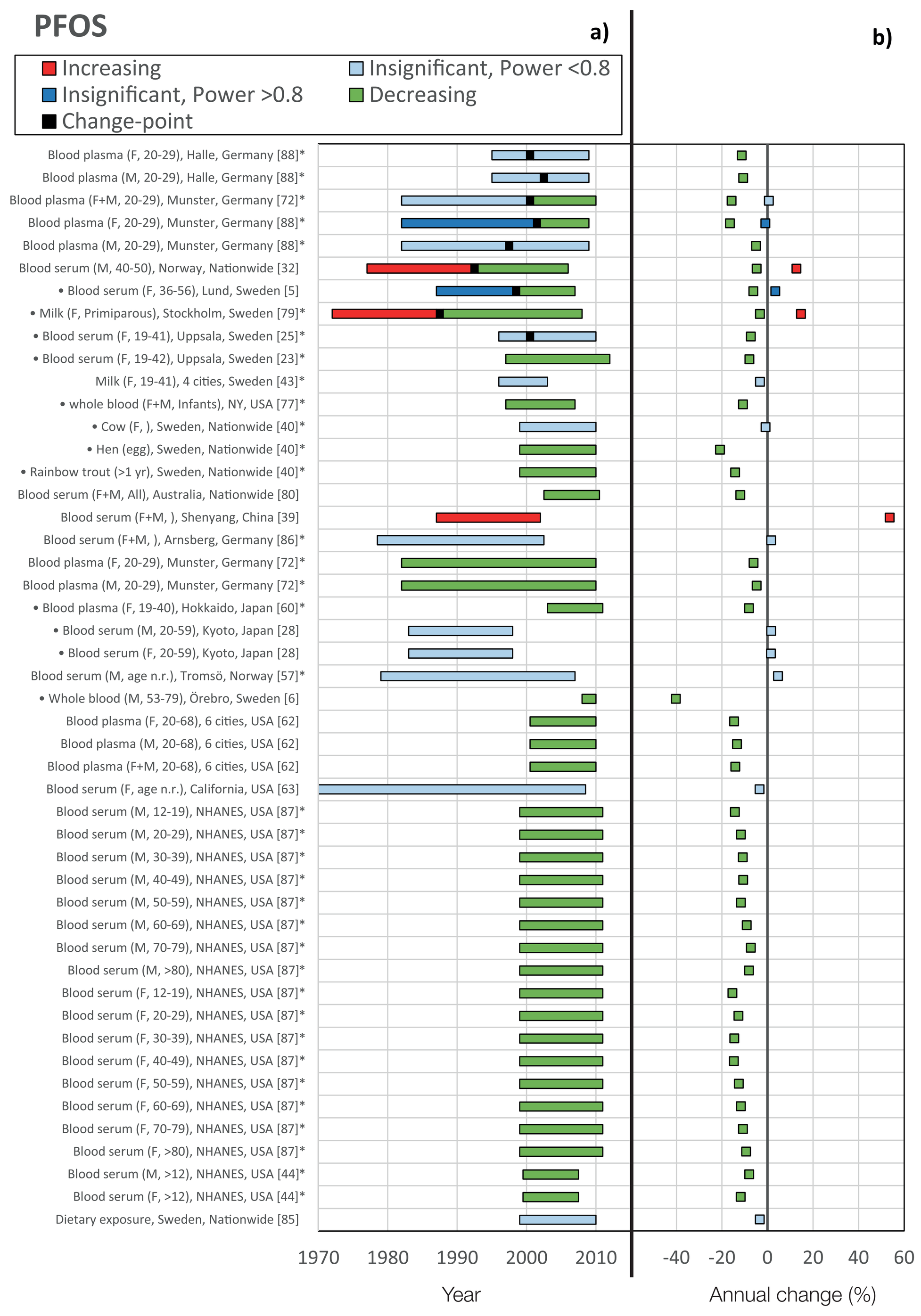

Figure 2. Temporal trends of PFOS in humans and dietary exposure.

4. CONCLUSIONS

In regions where regulations and phase-outs have been implemented, concentrations of **PFOS**[1], **PFDS**[2], and **PFOA**[3] in humans are generally declining, as are some **PFOS-precursors** (e.g. **PFOSA**[4]).

In contrast, limited data indicate that concentrations of PFOS and PFOA are increasing in China where the production of these substances has increased.

Concentrations of perfluorinated carboxylic acids (**PFCAs**) with 9-14 carbon atoms are generally increasing or show insignificant trends with low power to detect a trend.

Declining **PFOS**, **PFOS-precursor** and **PFOA** concentrations in humans likely resulted from removal of certain PFASs from commercial products or from food packaging. Increasing concentrations of **long chain PFCAs** (C9-C14) in most matrices, and in most regions, is likely due to increased use of alternative PFASs.

	PFAS acronym	Chain length	Group	PFAS full name	Chemical formula
1)	PFOS	C8	PFSA	Perfluorooctane sulfonic acid	$C_8F_{17}SO_3H$
2)	PFDS	C10	PFSA	Perfluorodecane sulfonic acid	$C_{10}F_{21}SO_3H$
3)	PFOA	C8	PFCA	Perfluorooctanoic acid	$C_7F_{15}COOH$
4)	PFOSA	C8	Precursor	Perfluorooctane sulfonami de	$C_8H_2F_{17}NO_2S$

Reference

Land, M., de Wit, C.A., Cousins, I.T., Herzke, D., Johansson, J., Martin , J.W., 2015. What is the effect of phasing out long-chain per- and polyfluoroalkyl substances on the concentrations of perfluoroalkyl acids and their precursors in the enironment? A systematic review protocol. Environmental Evidence 4, 1-13.

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