



science and policy  
for a healthy future

# Health effects of mixtures

Andreas Kortenkamp  
Brunel University London

Is mixture risk assessment feasible with exposure and effect data from the literature?

# Case studies, focusing on human health endpoints of concern

- Endocrine disruption with a focus on disruptions of **male reproductive health**
- **Developmental neurotoxicity**
- **Cancers**, including e.g. lung cancer in occupational settings
- **Nephrotoxicity**

# Declines in semen quality



## Approach

# Sums of risk quotients

$$HI = \sum_{i=1}^n \frac{\textit{Exposure level}}{\textit{Reference dose}}$$

Concern if sum > 1

Specific **reference doses** for deteriorations in semen quality

# Multiple chemicals monitored in the same sample

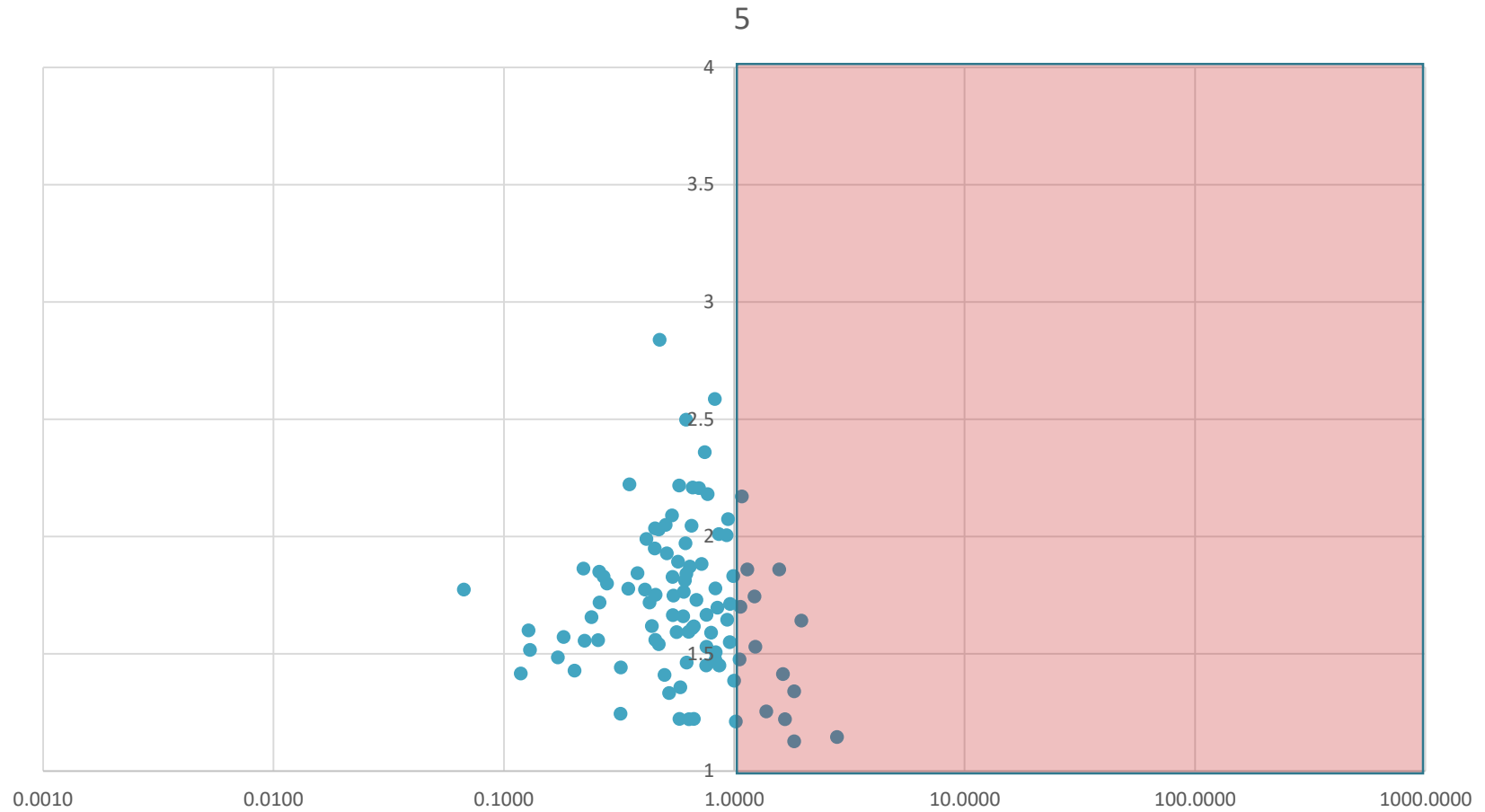


<b>Phthalates</b>	DiBP
	DnBP
	DEHP
	DiNP
	BBzP
<b>Bisphenols</b>	BPA
	BPS
	BPF
<b>Painkillers</b>	Paracetamol



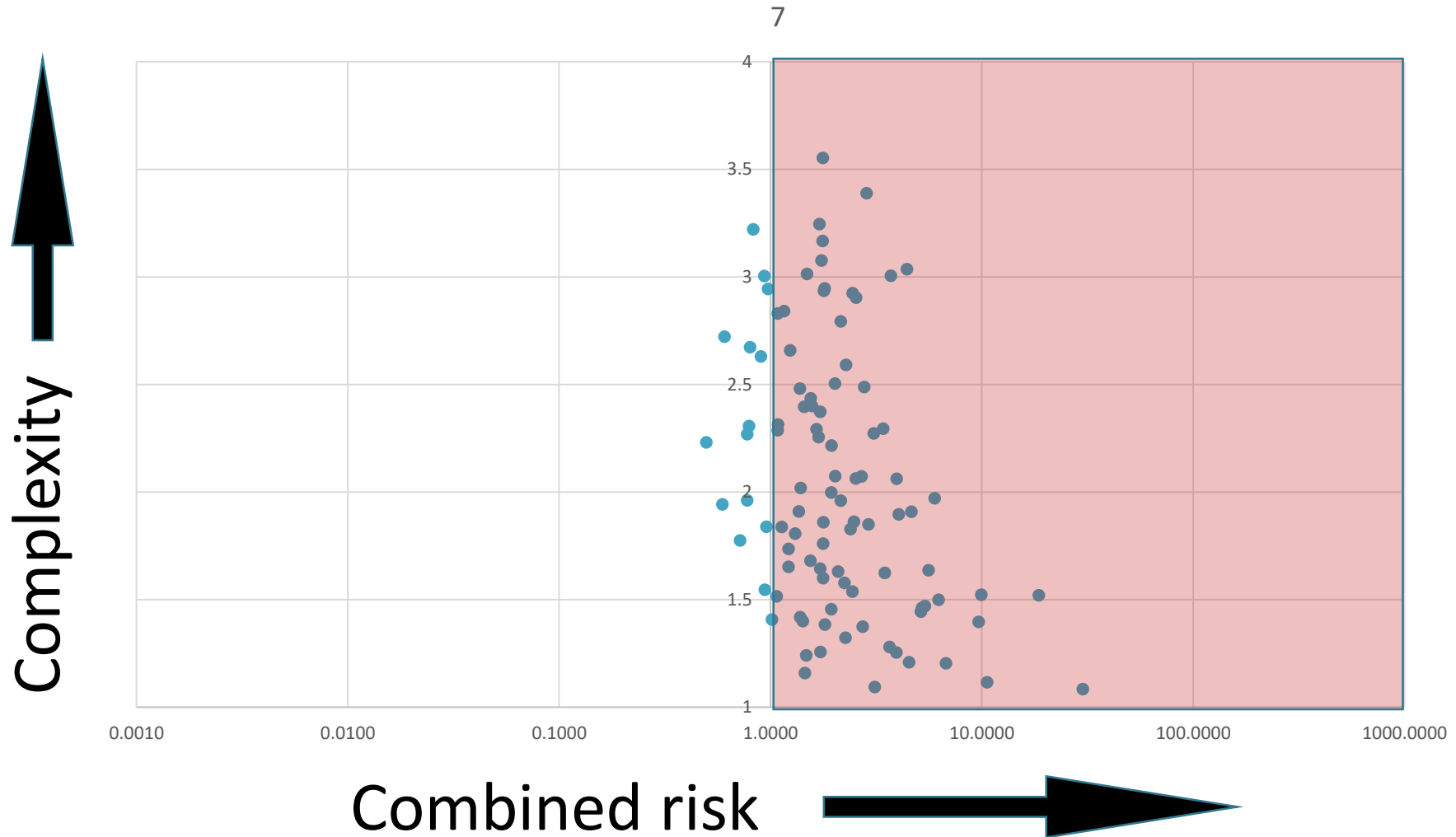
# Phthalates

Complexity ↑



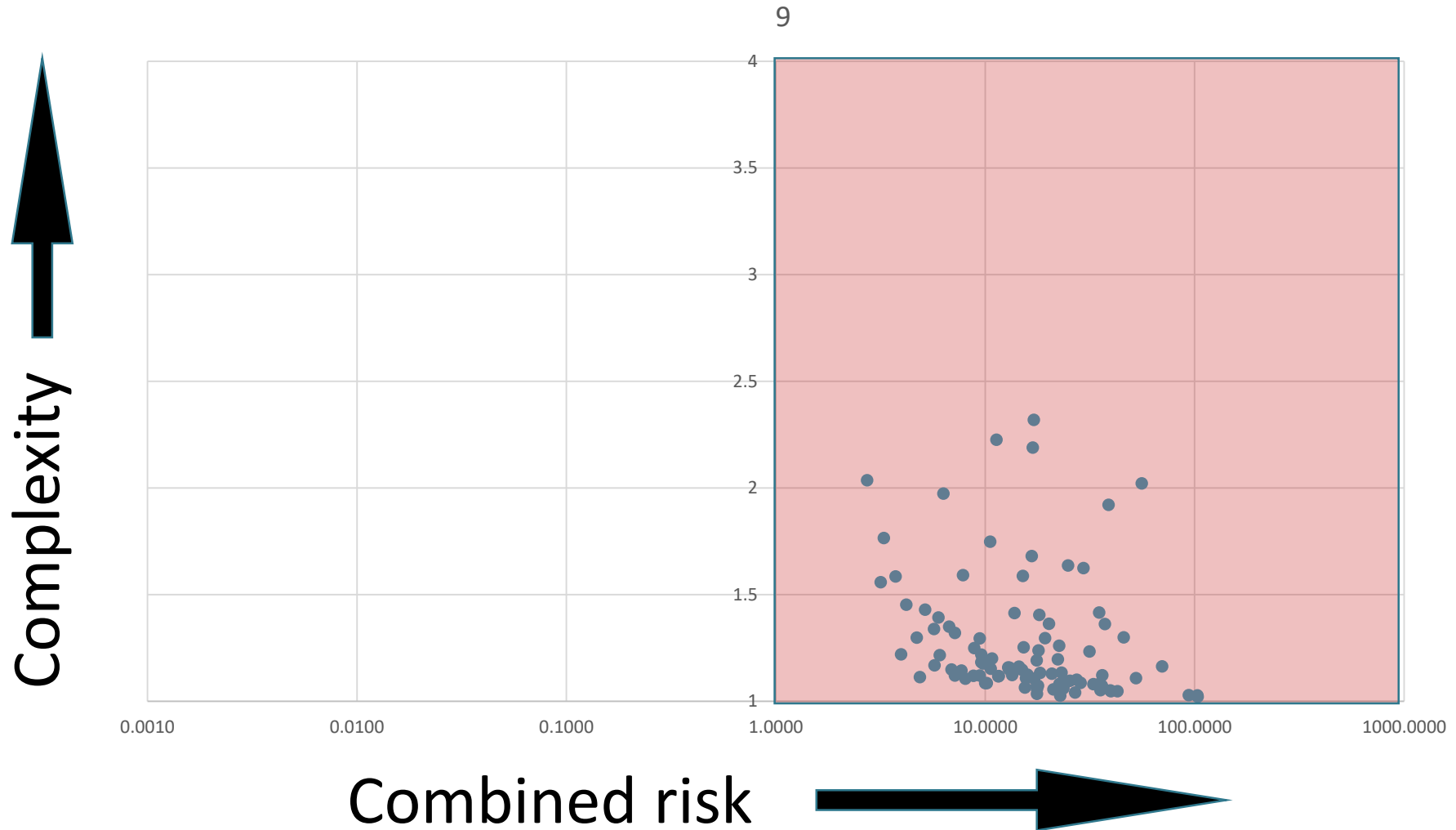
Combined risk →

# Phthalates, bisphenol F, S

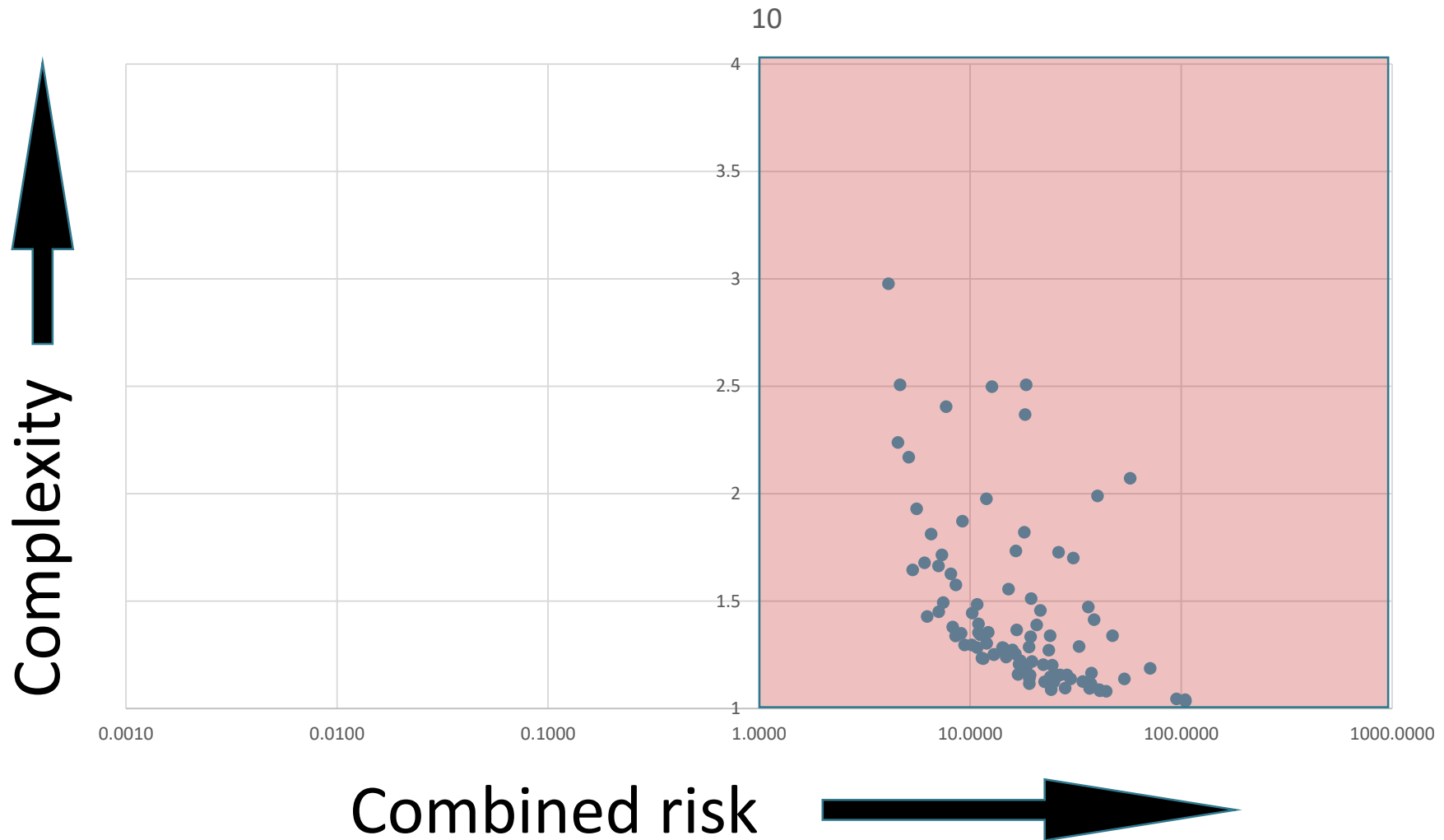




# Phthalates, bisphenols and paracetamol



# Phthalates, bisphenols, paracetamol + 20 background chemicals



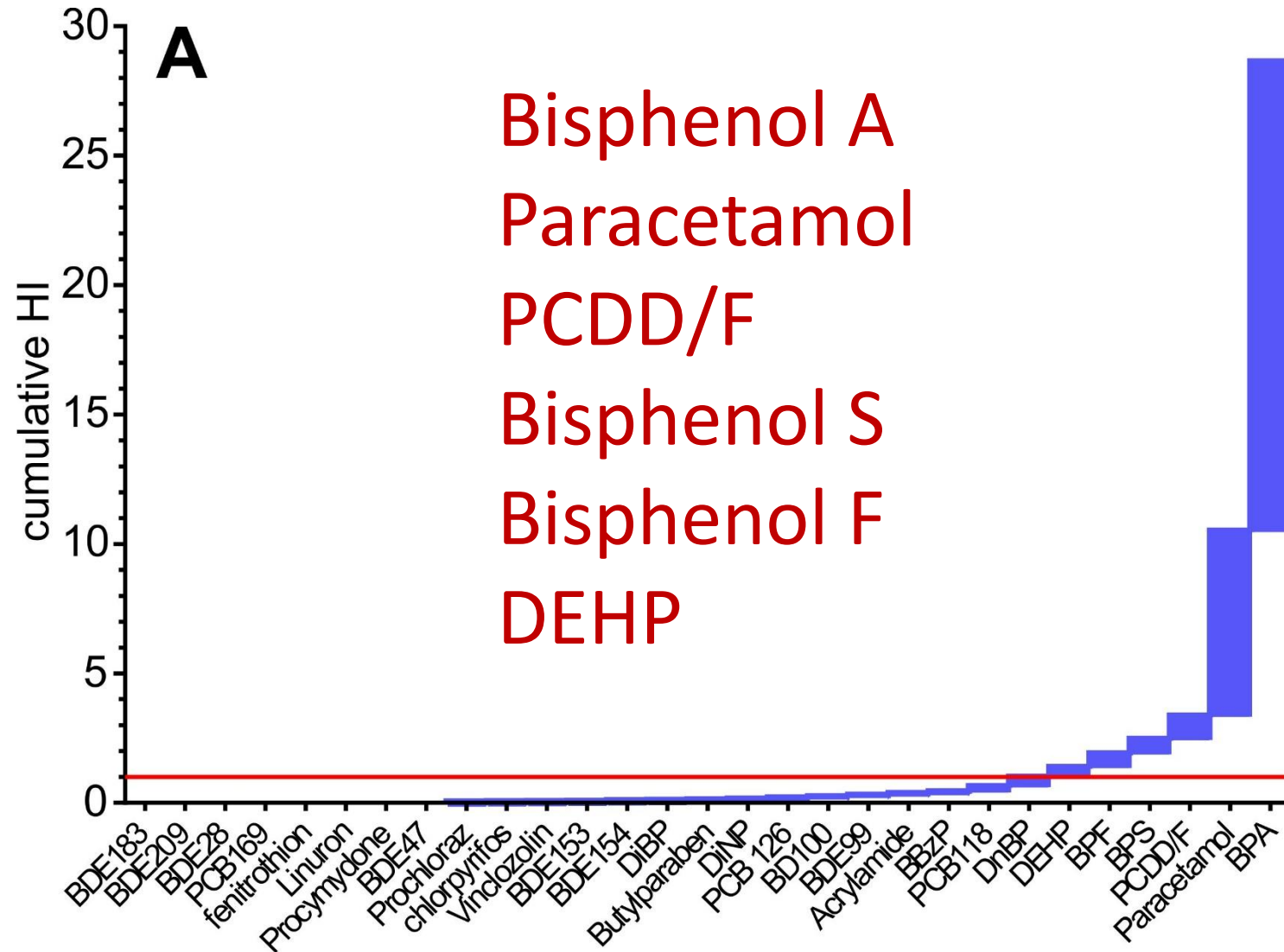
## What this means

Everyone is “over the line”

Safety margins are exhausted

Some approach doses associated with **effects in lab animals**

# Drivers of mixture risks



## Policy implications

There is **no protection** against mixture risks

Single-chemical risk assessments **underestimate risks**

Even consideration of groups of chemicals (e.g. phthalates) is **not enough**

Limits for single chemicals are **too high**



**Brunel**  
University  
London

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