Rencontres de Santé publique France 2026
9 novembre 2026 à 14h30-17h

Les laboratoires au cœur des innovations en biosurveillance

Vers une caractérisation plus représentative des mélanges en population générale

Arthur David

Prof. French School of Public Health

Research Institute for Environmental and Occupational Health (**Irset**) (ELIXIR Team)

« Cette intervention est faite en toute indépendance vis-à-vis de l'organisateur de la manifestation.

Je n'ai pas de conflit d'intérêt avec le sujet traité »

Arthur David

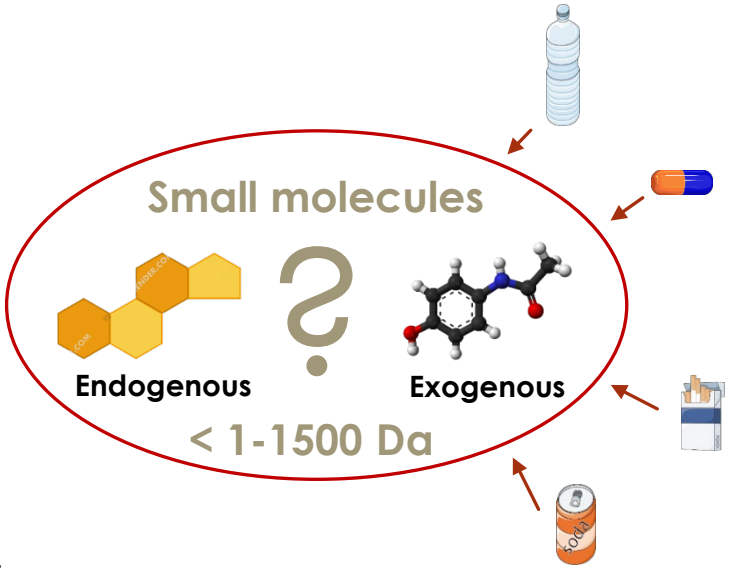
Les molécules présentes dans notre corps restent incomplètement décrites

HUMAN GENOME PROJECT

Reference sequence

>19,000 reference proteins
>90% detected

Deutsch et al., 2026.J. Proteome Res. 25 (2): 539–555.



Internal chemical exposome

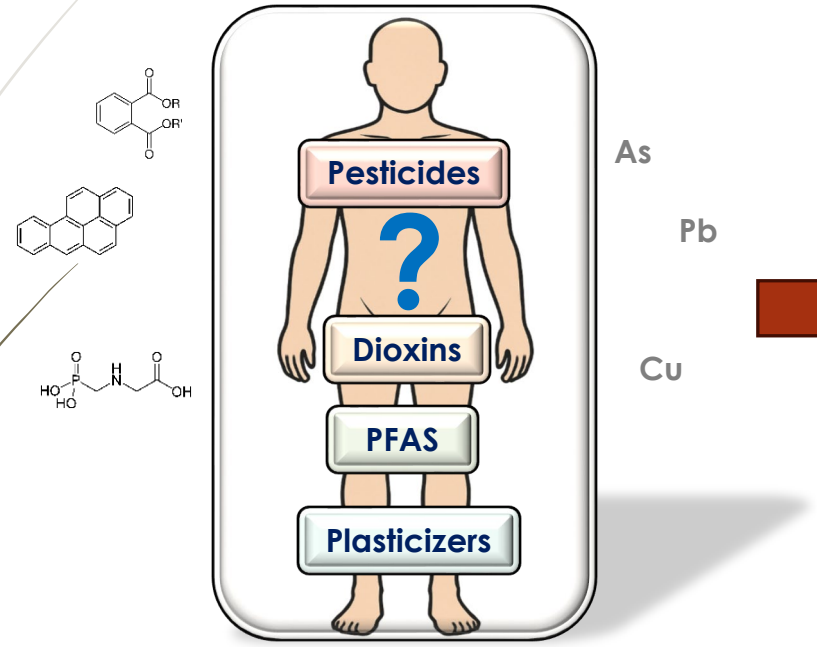
Exogenous chemicals and their transformation products present in human biospecimens

David et al., 2021. Environ. Int.156,106630,

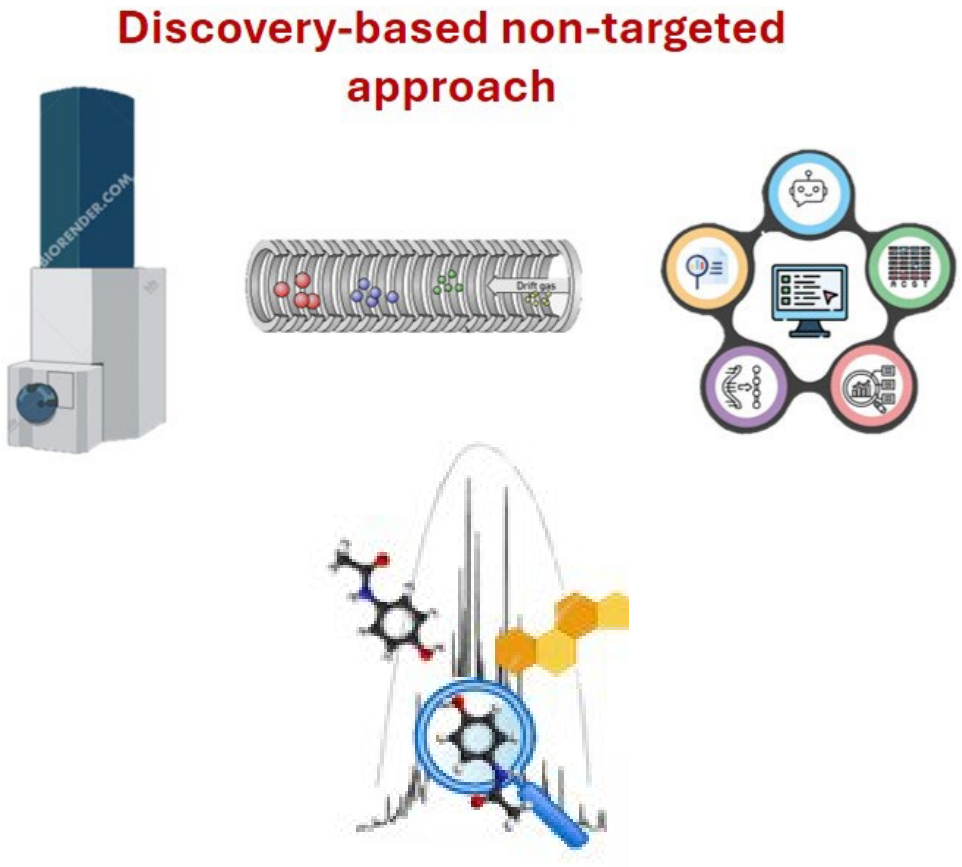
- **Host metabolism**
- **microbiome**
- **diet**
- **pharmaceuticals**
- **environment**

⇒ Nous ne disposons pas encore d'un inventaire expérimental complet de ces substances chez l'humain.

Le non-ciblé peut élargir le champ des substances recherchées

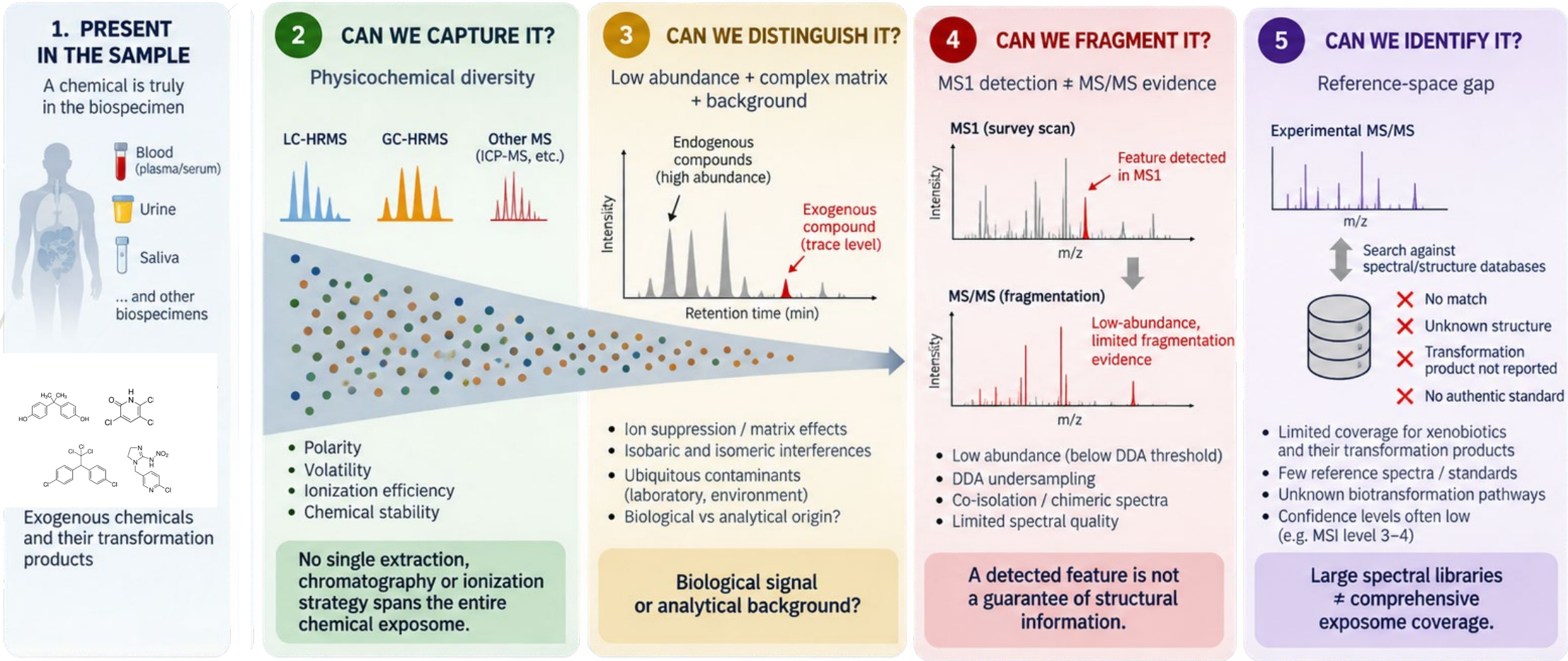


≈ **350,000 chemical substances** registered for production over the past 30 to 40 years (Wang et al., 2020. ES&T Vol 54)



Mais plusieurs limitations doivent être considérées

Etat de trace, très grande diversité chimique et données spectrales incomplètes

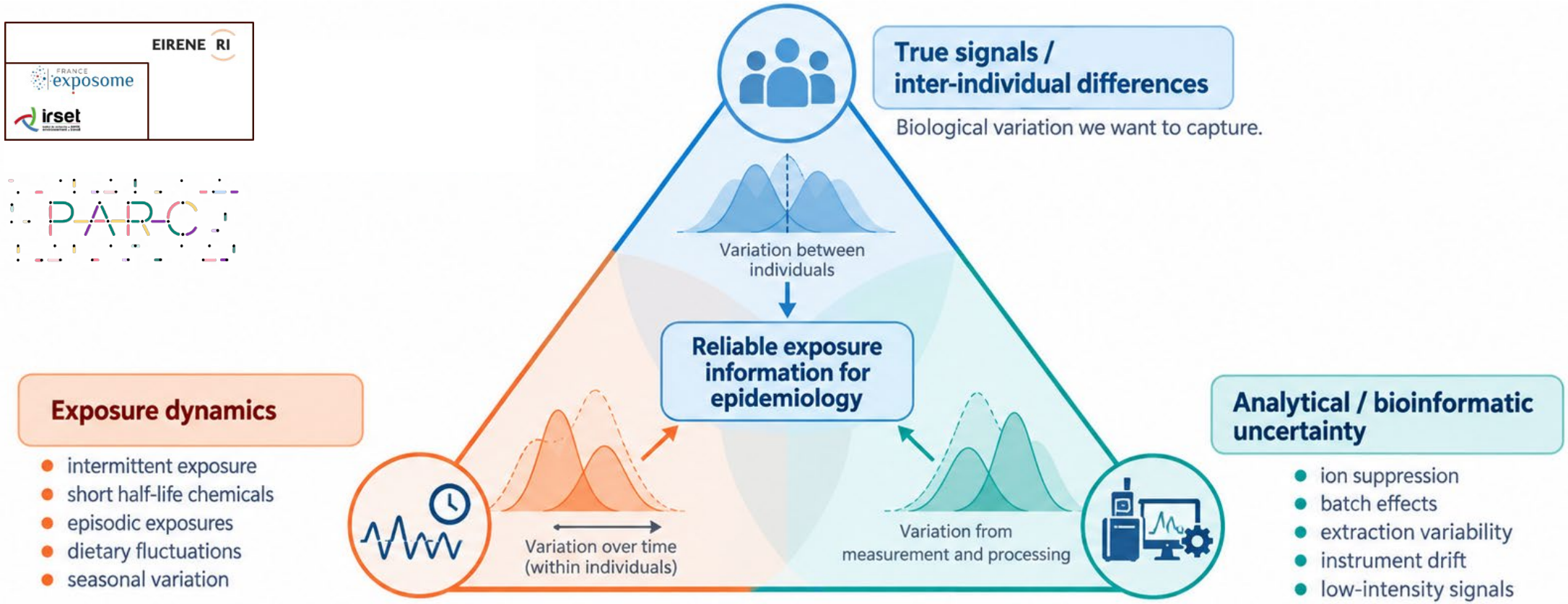


⇒ **De nombreuses molécules peuvent disparaitre à chaque étape analytique**

AI-assisted illustration generated with OpenAI ChatGPT, scientific concept and content by the author

La fiabilité des mesures conditionne leur interprétation

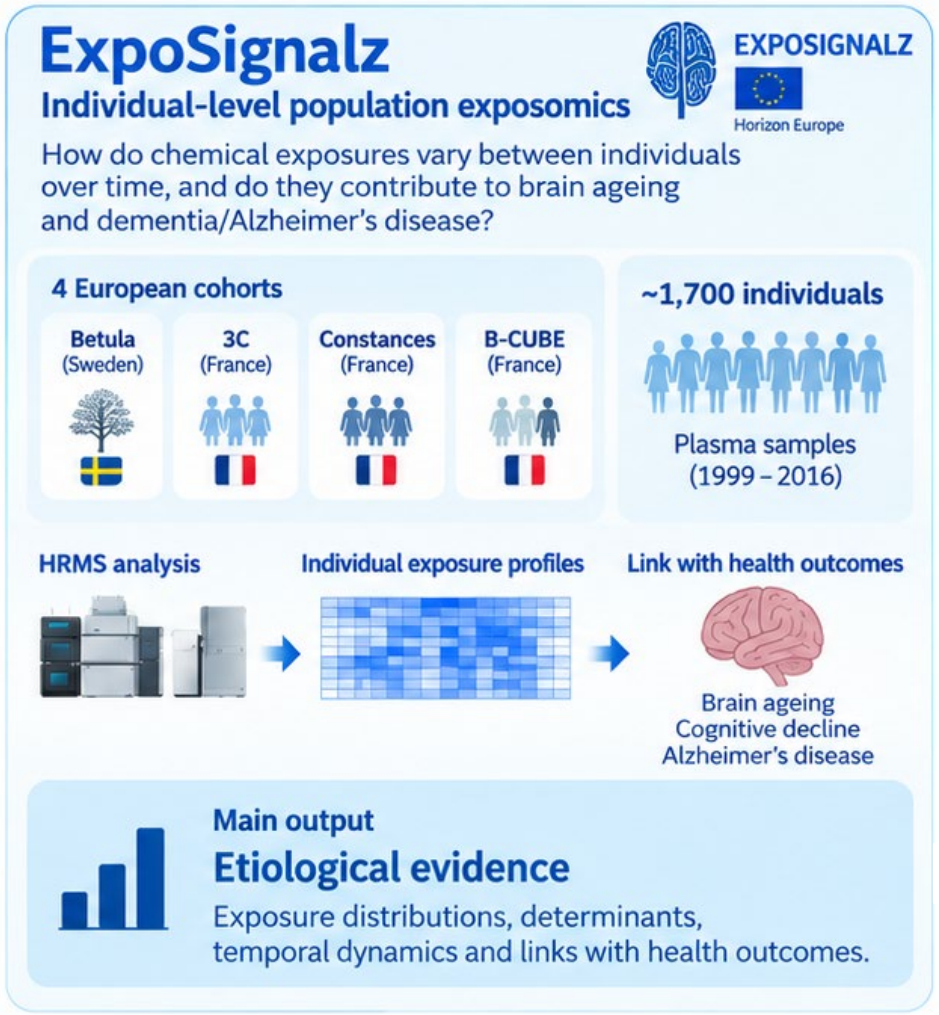
Comparer les individus exige de distinguer plusieurs sources de variation

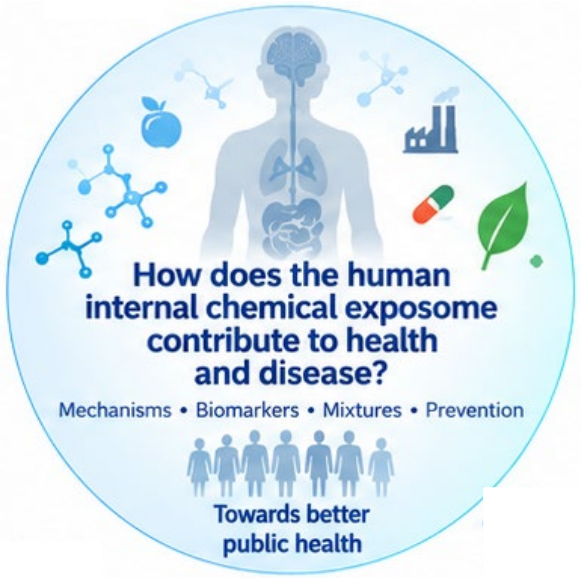


1 Chaker… David, 2022. Analytical Chemistry, Vol 94/ 2
2 Chaker… David, 2021. Analytical Chemistry, Vol 93/ 3
3 Chaker… David, 2023. Environmental Science & Technology, Vol 57/48
4 Lennon… David, 2024. TrAC, Vol 174

AI-assisted illustration, scientific concept and content by the author

ExpoSignalz : caractériser les expositions dans des cohortes de vieillissement





ExpoSignalz

AI-assisted illustration generated with OpenAI ChatGPT, scientific concept and content by the author

Case study: large-scale HRMS exposomics in aging cohorts



ExpoSignalz: a 5-year research project funded by the Horizon EU

11 Partners and 14 teams located in 6 EU countries

FUNDING
€9.3m from Horizon Europe

PROJECT DURATION
Jan 2025 – Dec 2030

PROJECT COORDINATOR
Veronique Perrier, INSERM

1

Identify environmental pollutants likely to have **neurotoxic effects** and pro-amyloidogenic properties, potentially contributing to a **neurodegenerative trajectory** related to Alzheimer's disease.

4 in-vitro models

UTRECHT UNIVERSITY, INSERM A, UPPSALA UNIVERSITY

2

Characterisation of pollutant signatures associated with brain ageing and Alzheimer's disease in human populations.

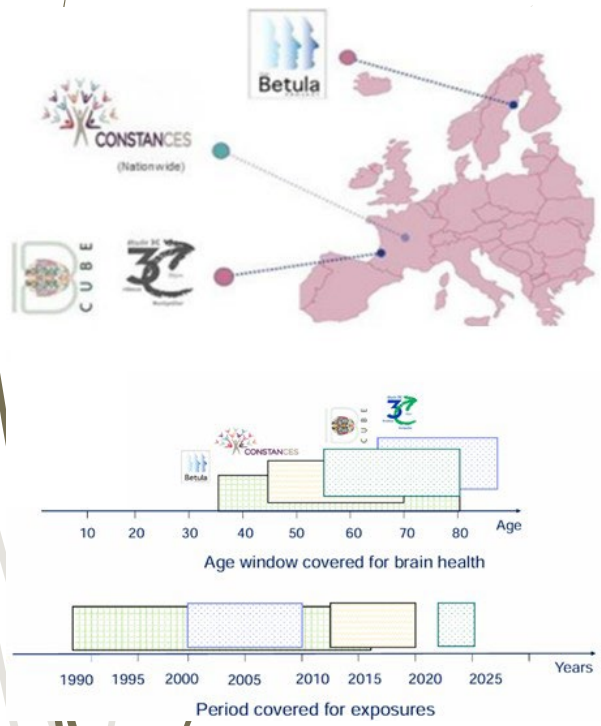
4 human cohorts

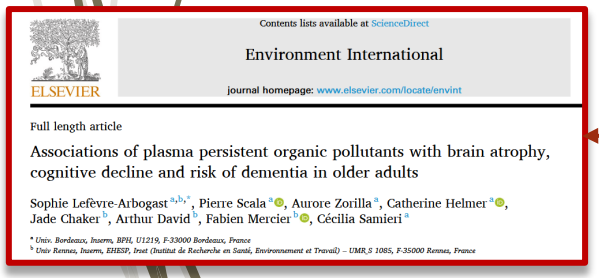
UNIVERSITY OF BORDEAUX, INSERM C / D, UMEÅ UNIVERSITY, LIH, EHESP

ExpoSignalz

Multi-platform chemical exposome characterization strategy

HRMS is part of a broader integrated exposure assessment framework




Contents lists available at ScienceDirect

Environment International

journal homepage: www.elsevier.com/locate/envint

ELSEVIER

Full length article

Associations of plasma persistent organic pollutants with brain atrophy, cognitive decline and risk of dementia in older adults

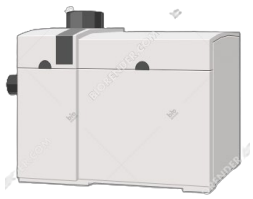
Sophie Lefèvre-Arbogast [a,b,*], Pierre Scala [a], Aurore Zorilla [a], Catherine Helmer [a], Jade Chaker [b], Arthur David [b], Fabien Mercier [b], Cécilia Samieri [a]

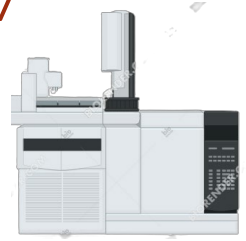
[*] Univ. Bordeaux, Inserm, BPH, U1219, F-33000 Bordeaux, France

[b] Univ Rennes, Inserm, EHESP, Irset (Institut de Recherche en Santé, Environnement et Travail) – UMR_S 1085, F-35000 Rennes, France

Internal chemical exposome assessment

Whole blood	Plasma	Plasma	Pooled urine	
n = 3000	n = 1700	n = 1700	n = 1440	(7840)
Targeted *	Targeted *	Non-targeted	Targeted	
ICP-MS	GC-MS/MS	LC-HRMS	LC-MS/MS	
13 Inorganic elements (metals)	44 POPs (PBDE, PCB, DDT…)	Non-persistant compounds	37 Pesticides (neonics, pyrethroids, anilinopyrimidines)	
Betula, n=1000	Betula, n=1000	Betula, n=250x2	B cube (n=800)	
Constances, n=1000	3C, n=700	Constances, n=250	Constances (n=640)	
B CUBE, n=1000		B CUBE, n=250		
		3C, n=700		



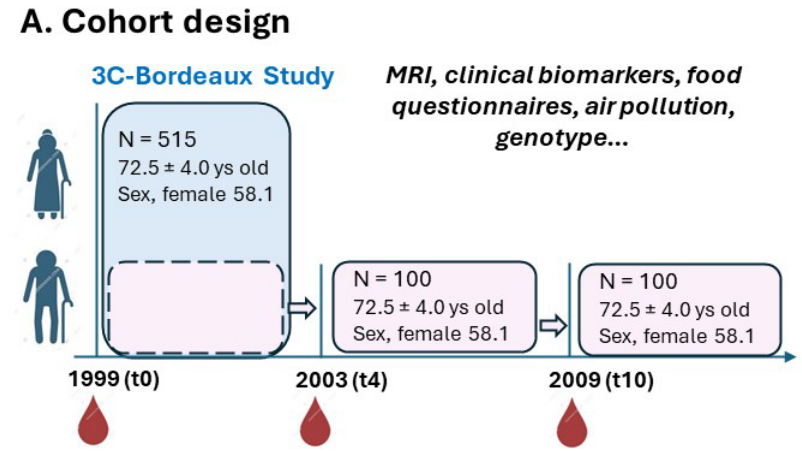


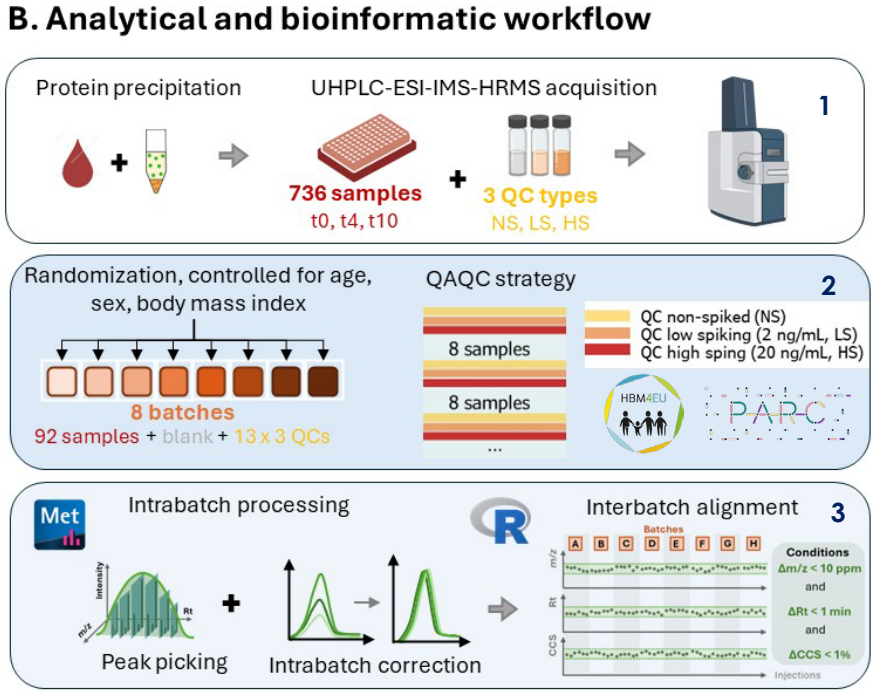


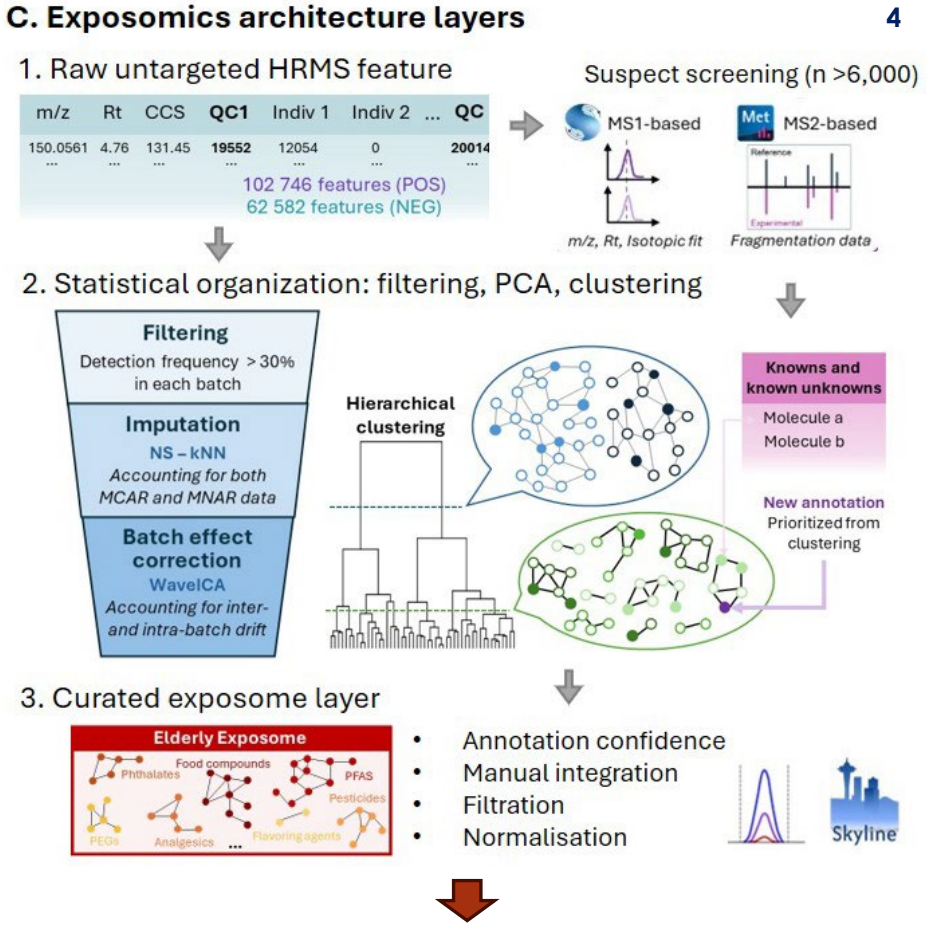


* Cofrac/ISO17025

Les méthodes de retraitement transforment les données en profils interprétables







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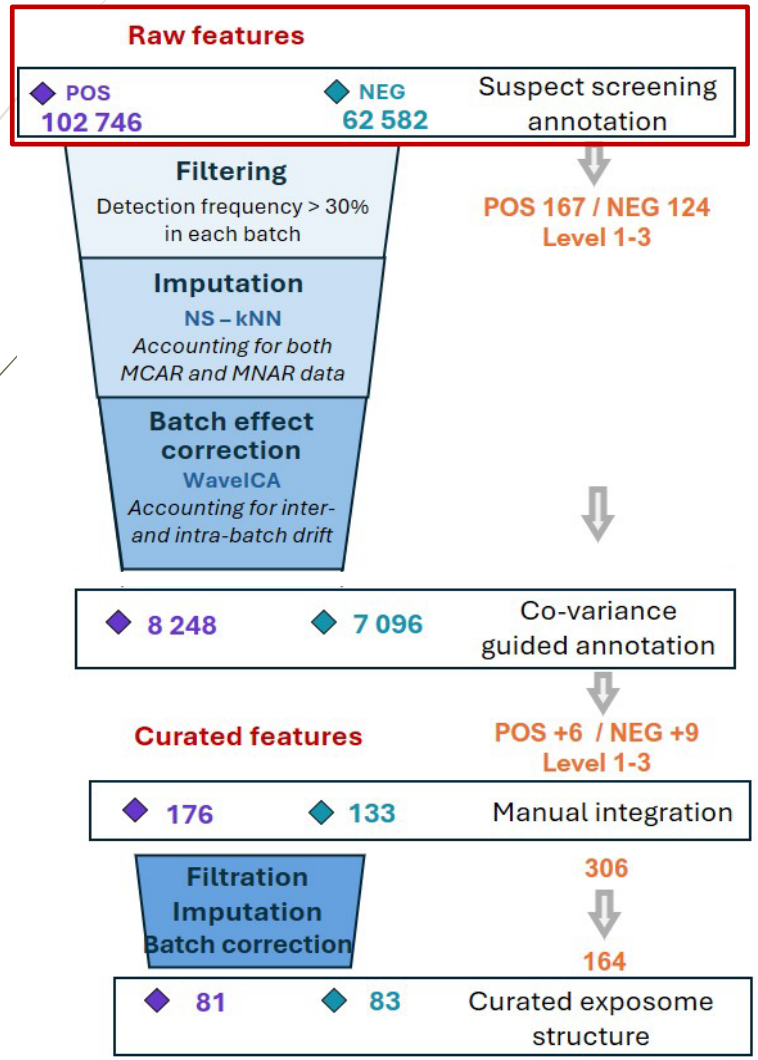
3 Chaker… David, 2021. Analytical Chemistry, Vol 93/ 3
4 Chaker… David, 2023. Environmental Science & Technology, Vol 57/48

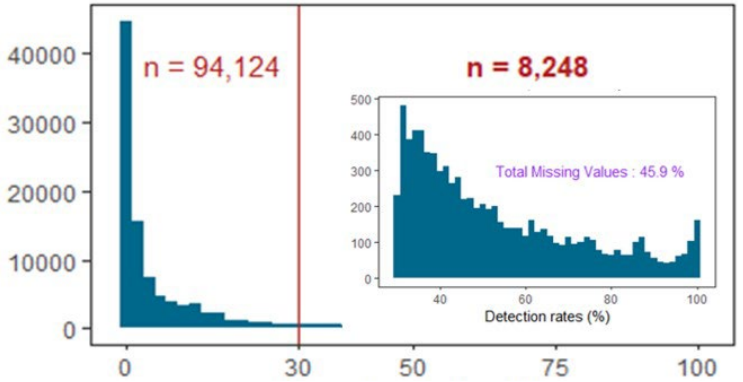
Les méthodes de retraitement transforment les données en profils interprétables

Transformation from exploratory feature space to interpretable statistical structure

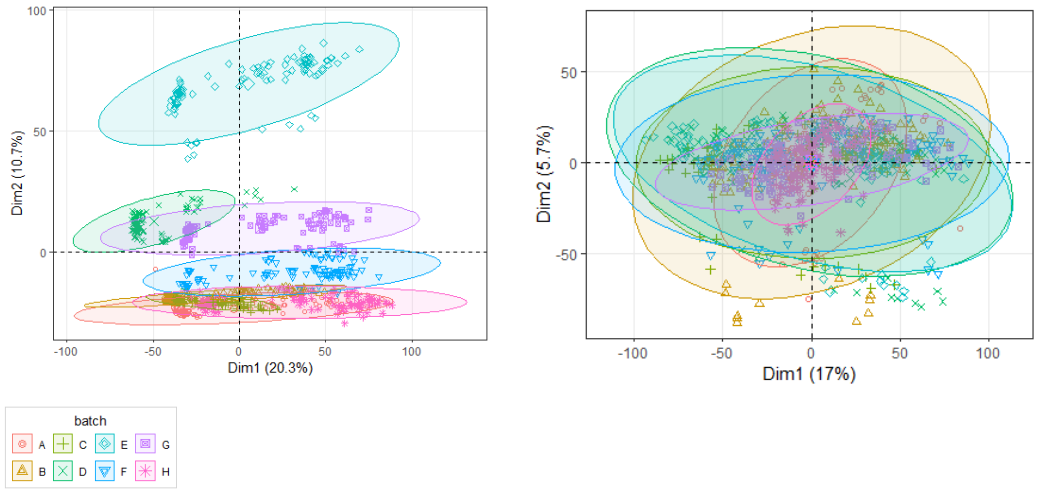
Feature retention waterfall



Feature detection frequency distribution



PCA before and after batch correction (WaveICA)



Le non-ciblé révèle des substances et aide à explorer leurs relations

Perspective | Published: 29 April 2024

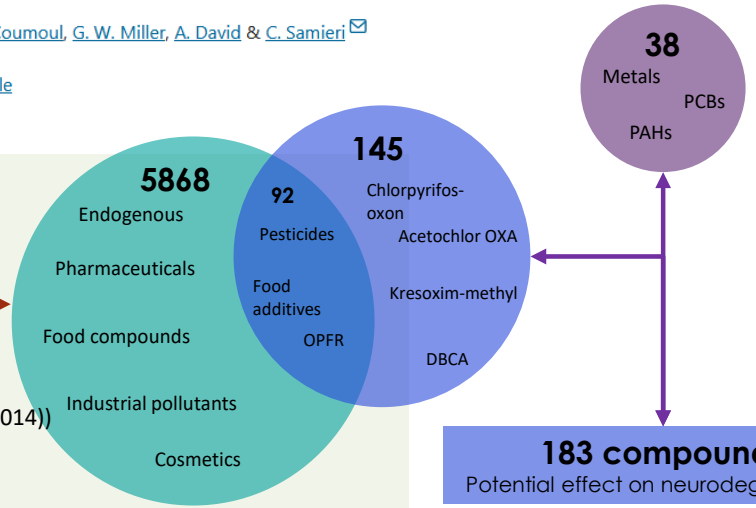
Assessing the contribution of the chemical exposome to neurodegenerative disease

S. Lefèvre-Arbogast, J. Chaker, F. Mercier, R. Barouki, X. Coumoul, G. W. Miller, A. David & C. Samieri

Nature Neuroscience **27**, 812–821 (2024) | Cite this article

2044 Accesses | **1** Citations | **40** Altmetric | Metrics

nature neuroscience



~ 6000 compounds
Potential presence in plasma/serum

- Described in the literature (e.g. Rappaport (2014))
- The Blood Exposome Database
- Human Metabolome DataBase
- Exposome Explorer
- Food biomarkers (e.g. FoodBall)
- Compounds used in cosmetics (e.g. Skin Deep)
- Norman Suspect List Exchange (Identification of emerging pollutants)

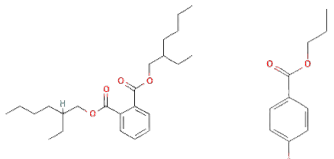
183 compounds
Potential effect on neurodegeneration

- Described in the experimental literature (in vivo/in vitro toxicological studies)
- Described in epidemiological literature

Scannotation
AUTOMATED PRE-ANNOTATION

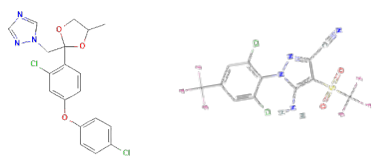
https://github.com/scannotation/Scannotation_software

Phthalates
Parabens
PFAS
…



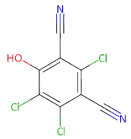
DEHP **BP**

Fungicides
Herbicides
Insecticides



Difenoconazole **Fipronil sulfone**

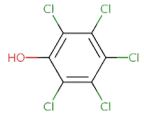
Other biocides



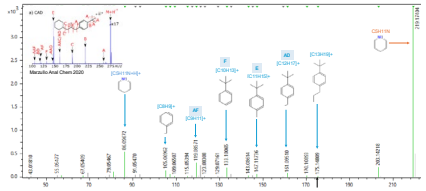
FD: 76%

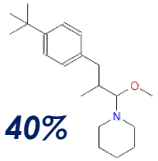
4OH-chlorothalonil

FD: 64%



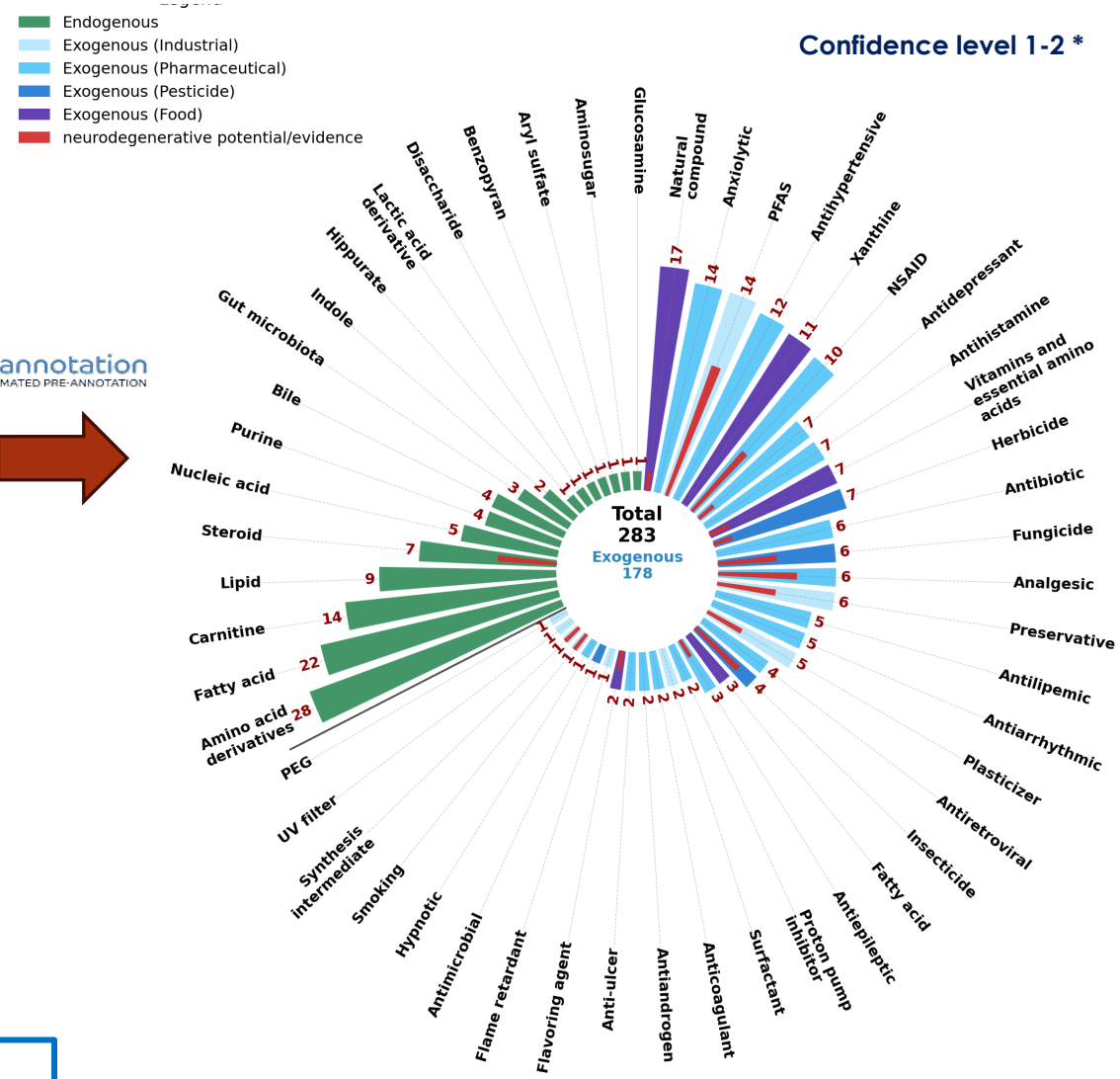
Pentachlorophenol





FD: 40%

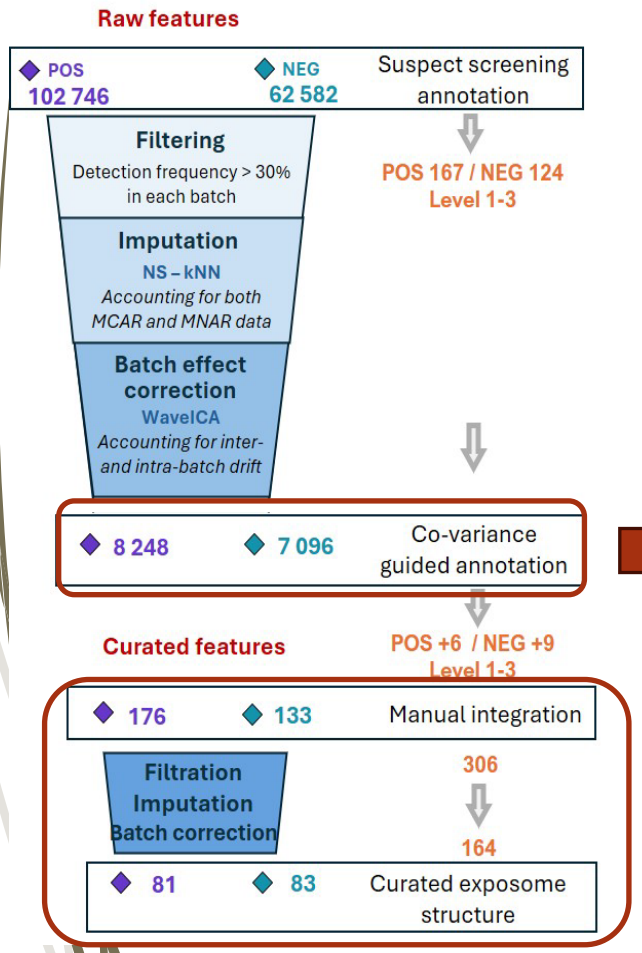
1-methoxyfenpropidine

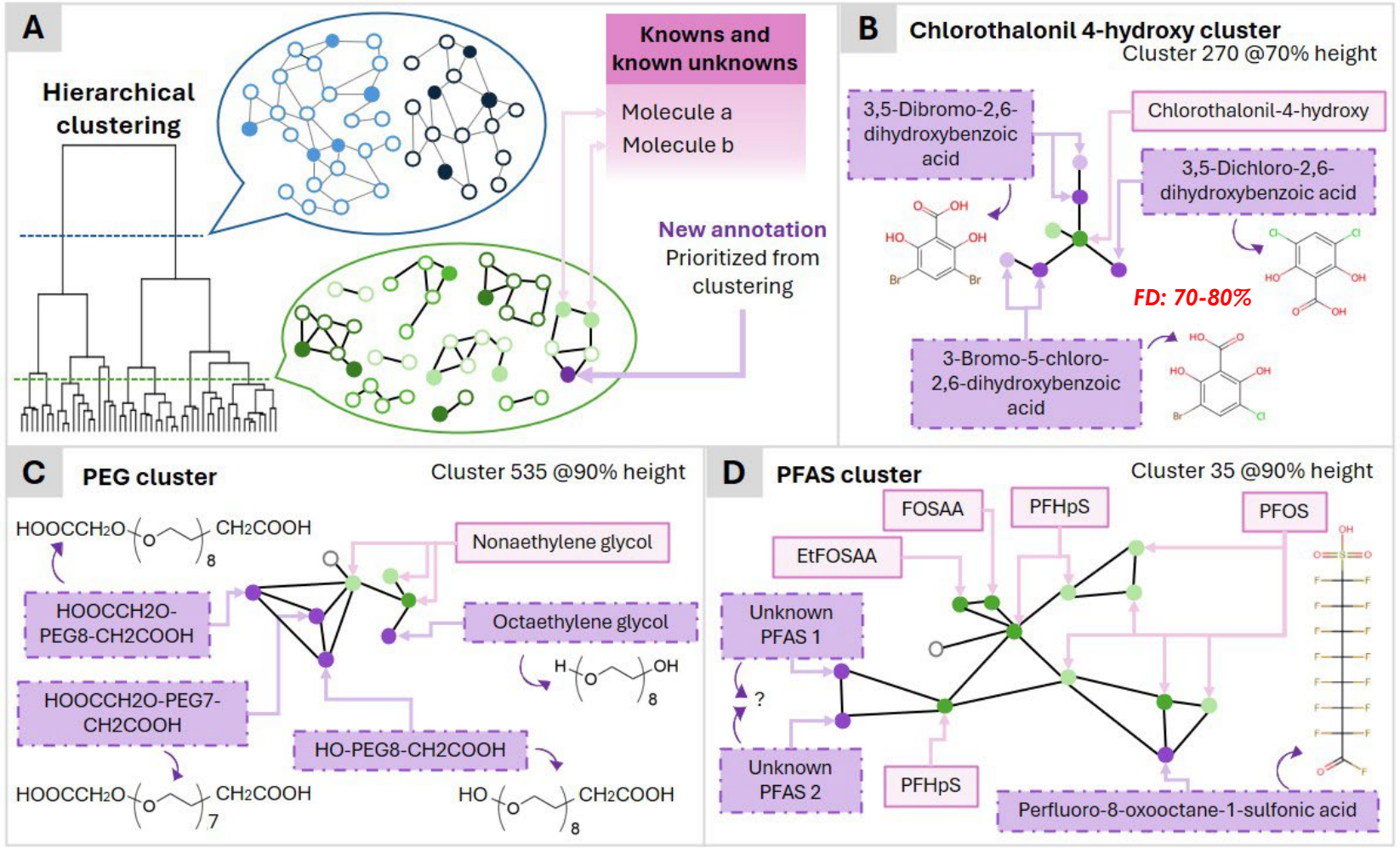


283 **unique compounds** annotated
40 unique **« priority compounds »**

* Schymanski et al., Environmental Science & Technology, Vol 48/4

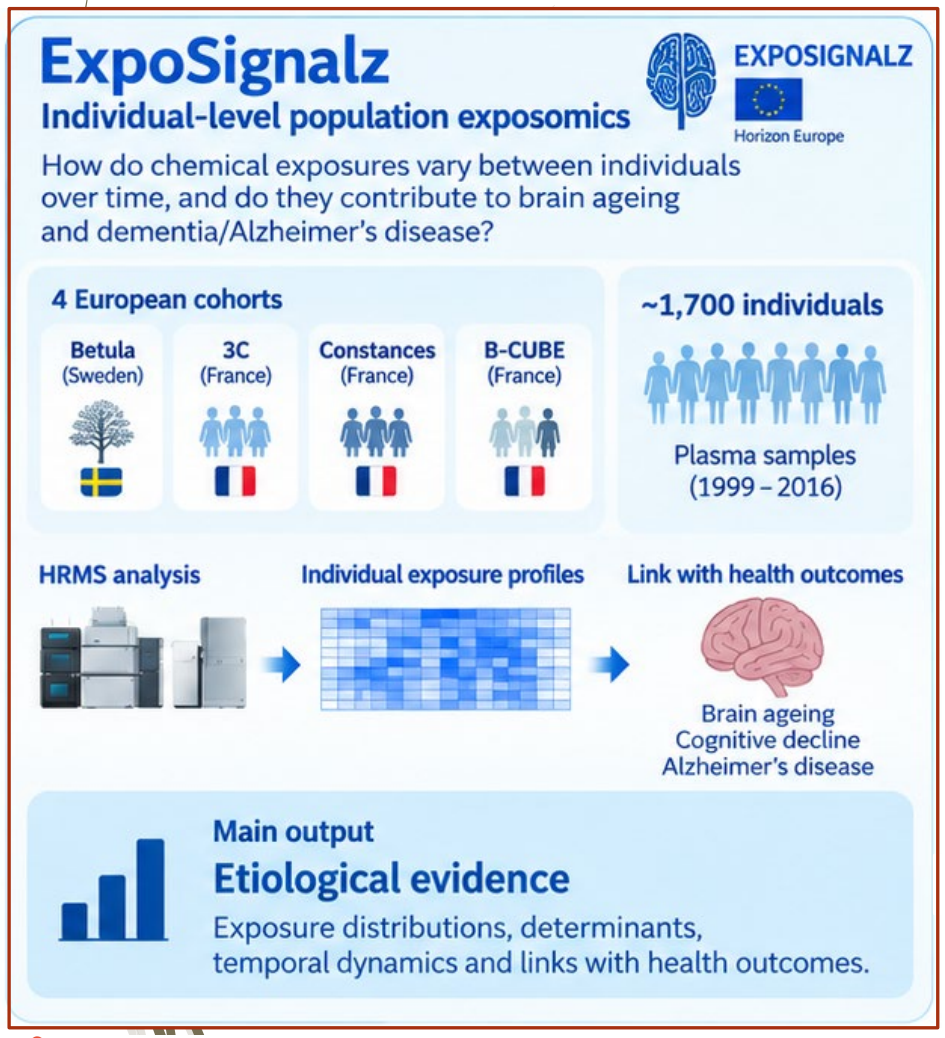
Le non-ciblé révèle des substances et aide à explorer leurs relations

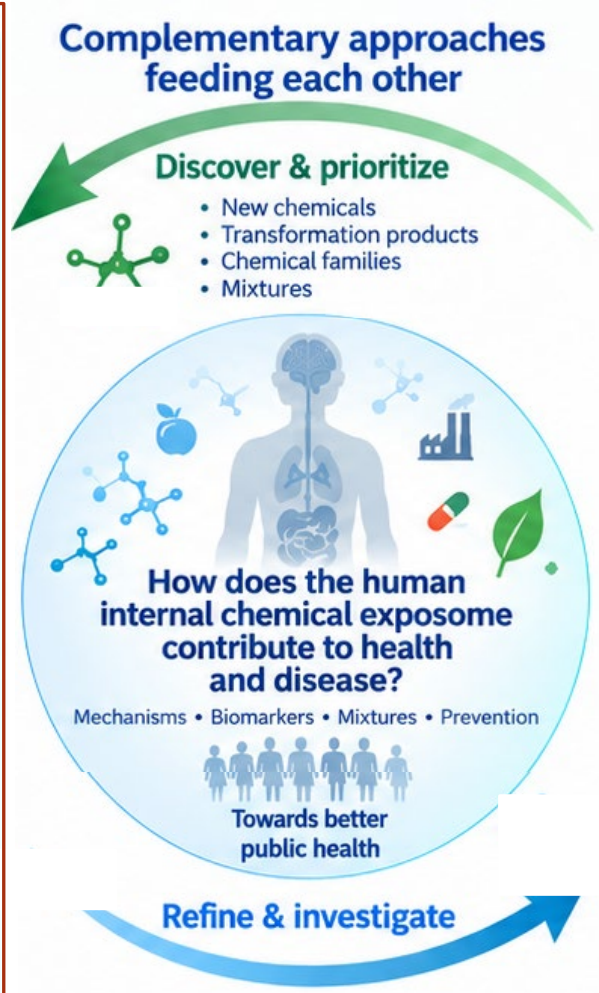


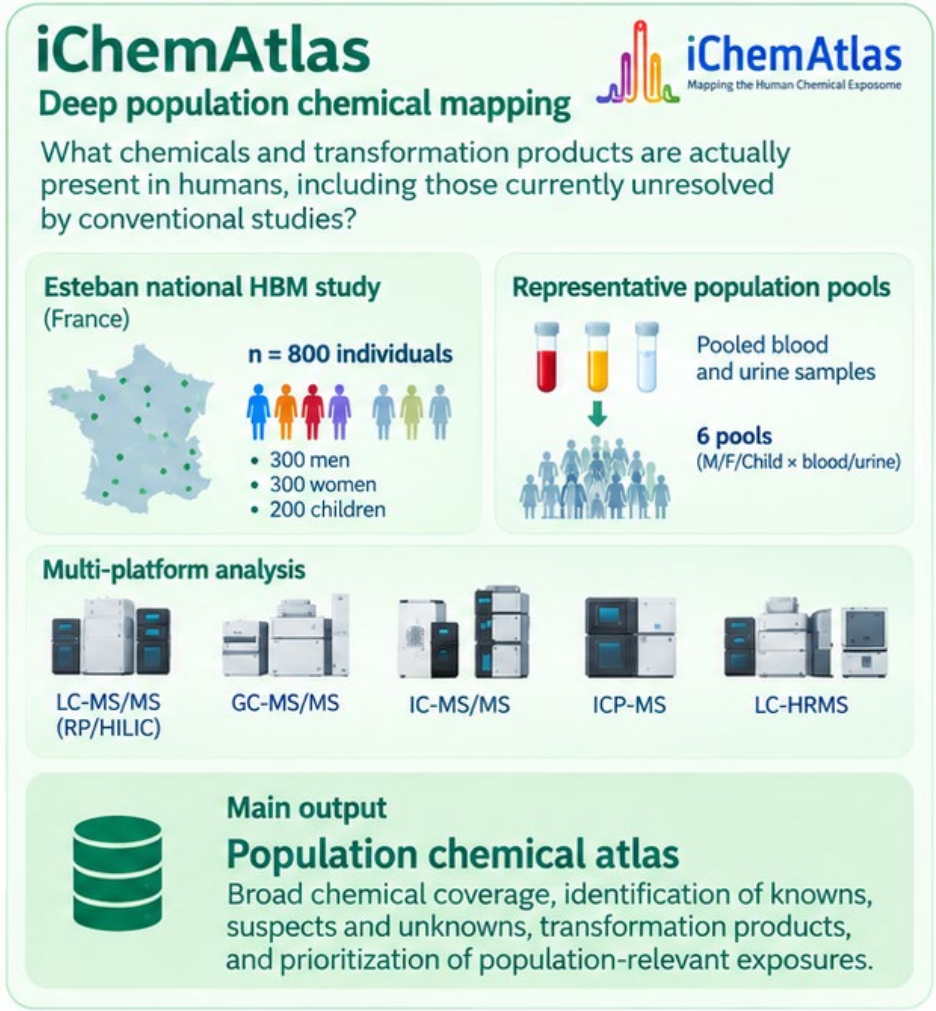


Unpublished data

Les études populationnelles ne sont pas adaptées pour explorer toute la diversité chimique







ExpoSignalz

AI-assisted illustration generated with OpenAI ChatGPT, scientific concept and content by the author

iChemAtlas : mutualiser les échantillons pour approfondir l'inventaire

Existing resources are essential but informations is not yet available experimentally

1 What we already have

Valuable and complementary resources

1.1 Global chemical inventories

- >350,000 chemicals registered or on the market
- Shows what may exist outside humans
- Not evidence of occurrence in humans

1.2 Exposure / metabolome databases

HMDB

Blood Exposome Database

Exposome-Explorer

- detected
- expected
- predicted
- reported in literature

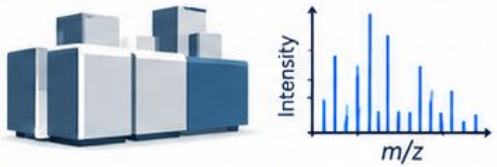
- Valuable curated knowledge bases
- Contain detected, expected or literature-reported compounds / biomarkers
- Often aggregated from literature or database fusion
- Not a standardized experimental population atlas

1.3 Human biomonitoring programs

NHANES (US)
HBM4EU / PARC (EU)
CHMS (Canada)
CNHBM (China)
Esteban (France)
...

- Real human measurements
- Strong for selected priority analytes
- Usually targeted panels rather than exhaustive mapping

1.4 Targeted and non-targeted studies



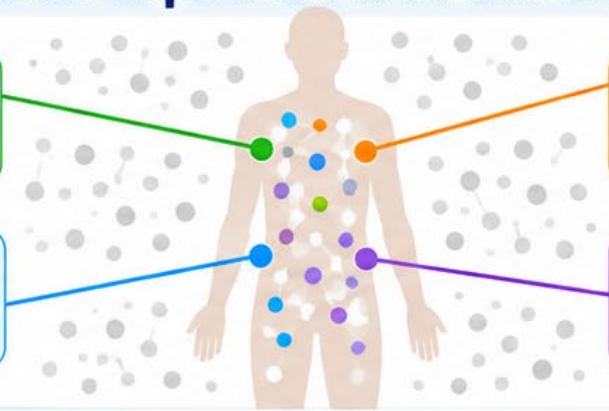
- Important study-specific evidence
- Different matrices, methods and analytical windows
- Partial and fragmented views of the chemical space

2 The internal chemical exposome remains mostly unresolved

... only a small fraction of the human chemical exposome is currently characterized

Known chemicals
Detected and identified in humans

Transformation products
Metabolites and biotransformation products



Unknown features
MS features without confirmed identity

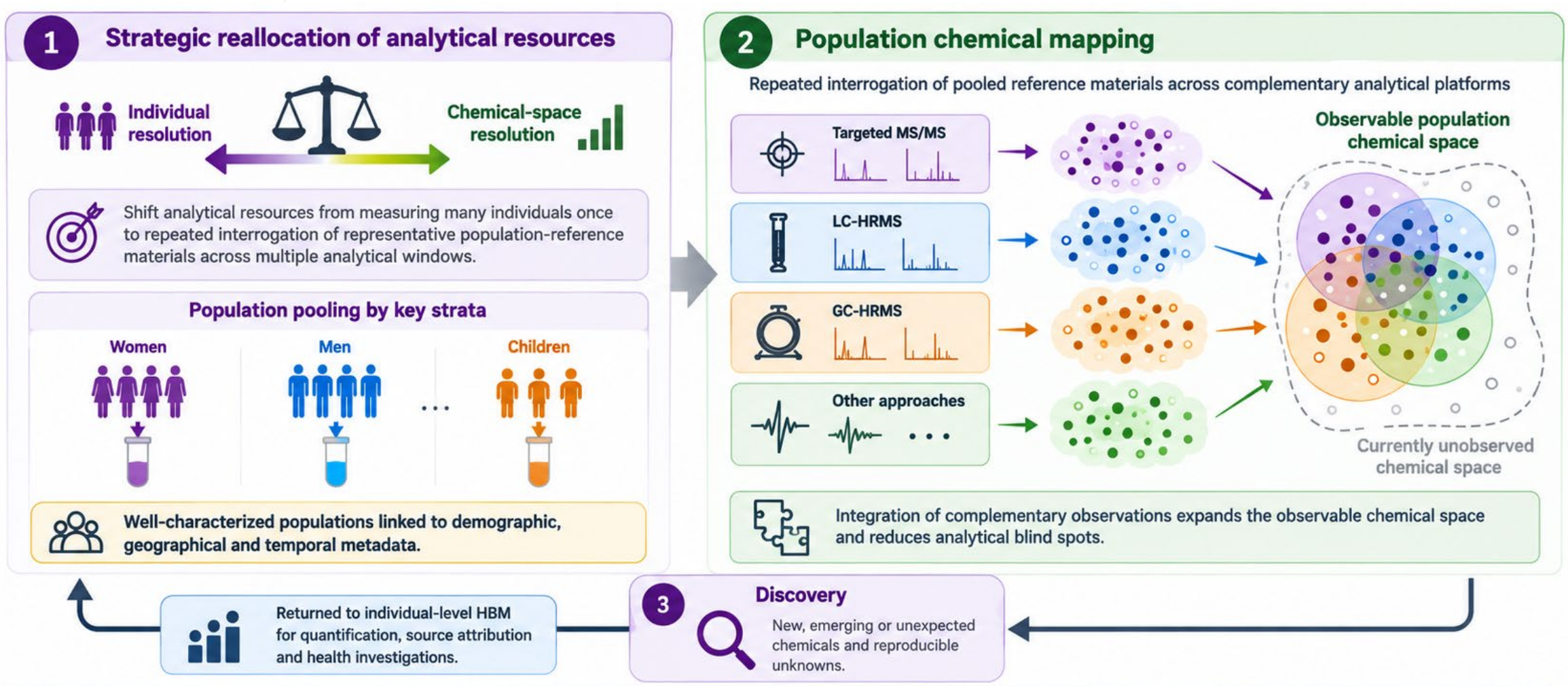
Mixtures / co-exposures
Complex chemical combinations

Current resources tell us what is known, reported or targeted — but not yet a harmonized experimental map of the chemistry actually present in representative human populations.

AI-assisted illustration, scientific concept and content by the author

iChemAtlas : mutualiser les échantillons pour approfondir l'inventaire

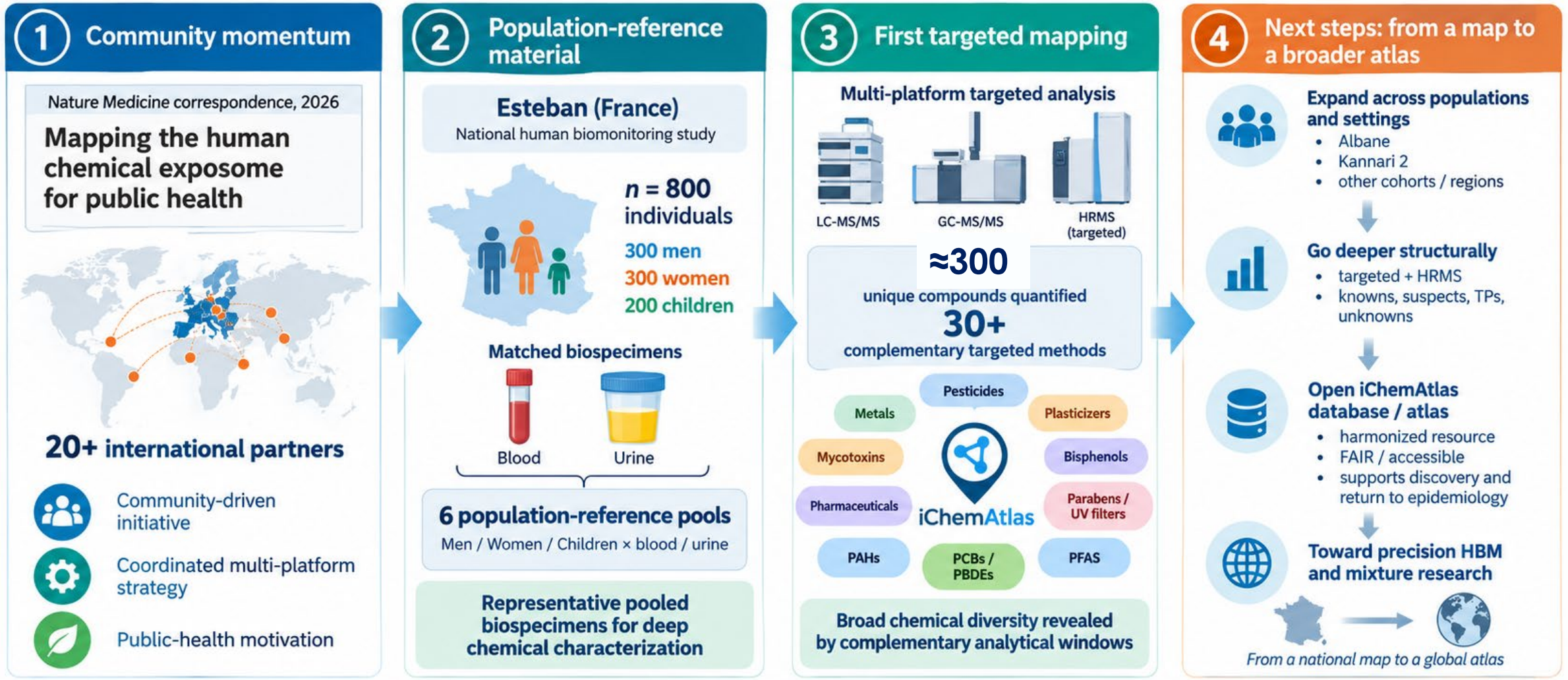
Reallocating analytical resolution from individual to population-reference depth



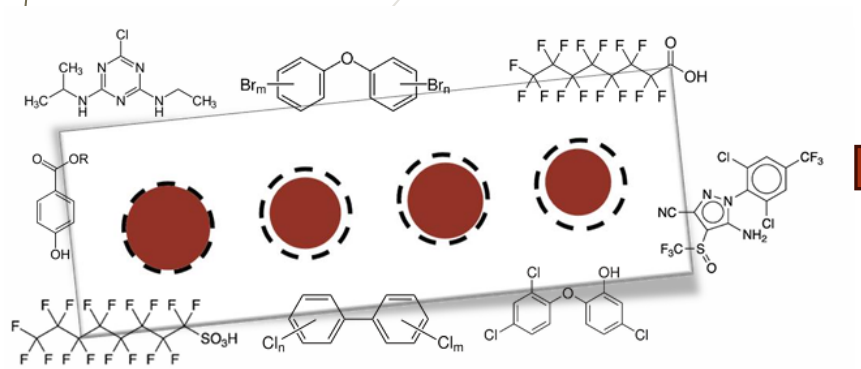
AI-assisted illustration, scientific concept and content by the author

iChemAtlas: iChemAtlas : une première cartographie expérimentale collective

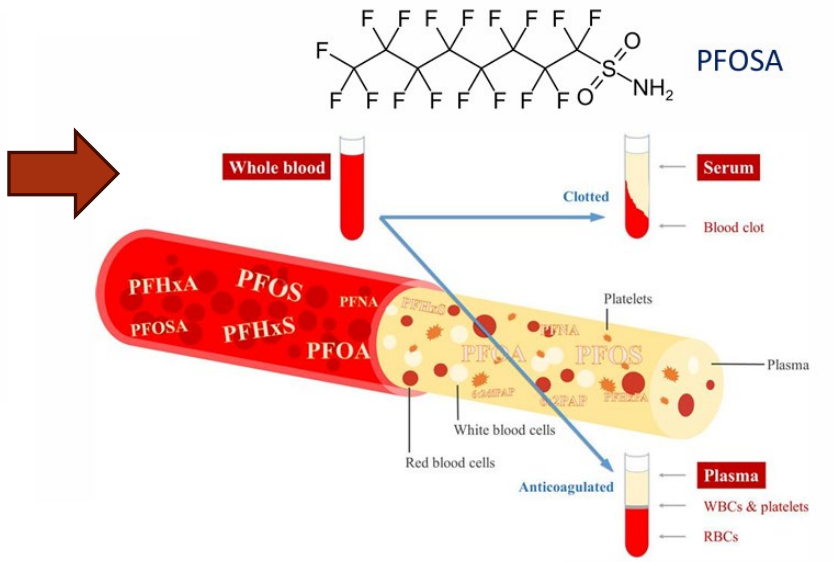
From a French population map to an extensible atlas of the human chemical exposome

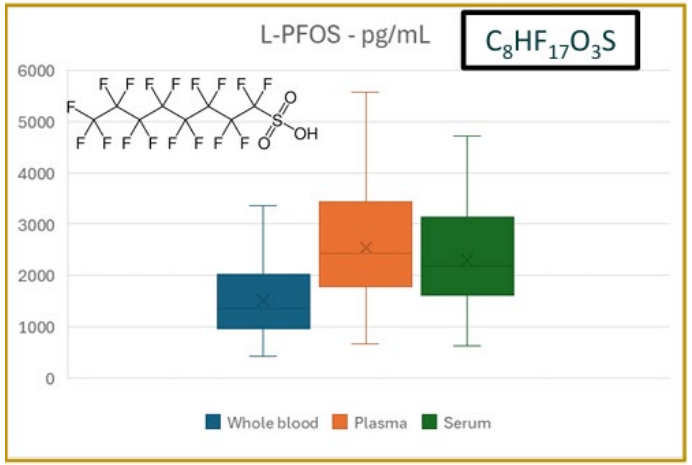


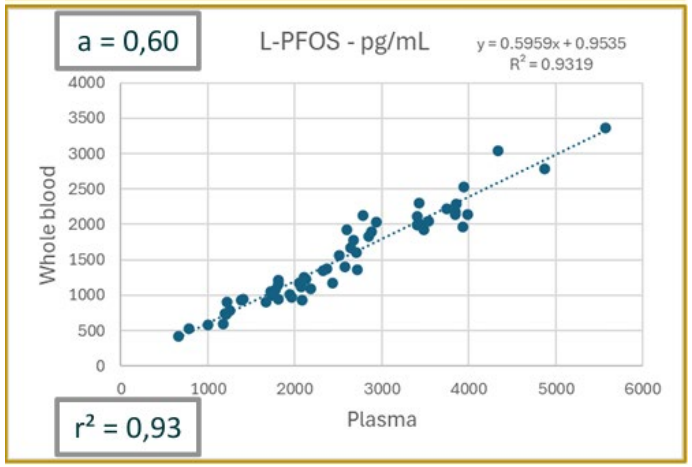
Perspectives: les microprélèvements sanguins pour faciliter la collecte et l'échantillonnage de populations vulnérables















Bordeaux Population Health

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Matteo Gilone
Emmanuelle Orsini



EHESP_IRSET

Thomas Contini
Jade Chaker
Sarah Lennon
Margaux Heurté
Erwann Gilles
Fabien Mercier

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Innover pour sauver

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