EXECUTIVE SUMMARY

Interim roadmap focused on exposome research in Europe

Funded by the European Union

April 2026

The exposome concept, introduced by Christopher Wild in 2005, refers to the totality of environmental exposures experienced over a lifetime. It was a call to better understand the non-genetic drivers of disease, which account for over 80% of the burden of non-communicable diseases and therefore represent major opportunities for improving population health, reducing inequalities, and strengthening health system sustainability.

Since its inception, numerous programmes and studies have advanced the development and integration of the exposome into the broader health research paradigm. These early efforts have demonstrated the value of the exposome approach across diverse domains, including child health, climate, chemical safety, occupational health (career), citizen empowerment, clinical practice, and urban health (cities).

We are now entering a scale-up stage in exposome research where tools and insights from exposomics are expected to be translated into large and sustainable actionable frameworks that help societies tackle key health and environmental challenges, from health promotion and disease prevention to improved clinical care.

At the same time, accelerating global changes—including climate change, biodiversity loss, and pollution—are reshaping exposure patterns, increasing the urgency to move from fragmented approaches towards integrated, life-course strategies. This new phase requires a clear roadmap for exposome research, detailing both the research as well as the programme needs.

IHEN partners worked together and spoke with stakeholders to develop this interim roadmap for research, innovation (including social innovation) and competitiveness. We identified five major goals. Goal 1 and 2 address the fields that are constantly shaping the complexity of the exposome (fig.2). Goal 3 and 4 address how engaging with the exposome will allow us to transform how we study and advance population health, moving from the biomedical model to an exposome model that integrates environmental and social factors into precision medicine and policy. Finally, we strongly advocate the need to support and maintain exposome infrastructures (Goal 5).

Goal 1
To understand and anticipate how global changes modify the exposome

The major impact of global change, including climate change, biodiversity loss, and global pollution, is its ability to alter key components of the exposome and thereby influence human health directly or indirectly. While the full causal pathways between global change and the exposome are not yet fully understood, this connection is increasingly evident and urgently requires further investigation. In particular, the combined effects of different aspects of global change and various components of the exposome remain unclear and call for the development of new methodologies to assess these interactions. In parallel, the role of social inequalities, major determinants of both exposure and health vulnerability, must be a central focus. A deeper understanding of these links is essential to better anticipate future challenges and to guide more effective and equitable public health strategies.

Goal 2
How do transitions affect the exposome

Because of the drastic effects of global changes, transitions are underway in a variety of sectors such as the energy, mobility, food, work, urban, circular economy sectors, and globally with the green transitions. The actual impacts of these societal and economic changes on the exposome and consequently on health are still unclear. The question here is the balance between delaying adaptation to such transitions and accelerating them. This goal calls for better characterization of both intended and unintended consequences, including emerging risks such as novel chemical exposures linked to circular economy practices. Understanding these dynamics is essential to ensure that transitions lead to health-positive outcomes.

Goal 3
How can the exposome support public health policy and regulation

As the exposome field matures, its integration into public health policy becomes increasingly important. Traditional frameworks—such as burden of disease models and health economic assessments—must be revisited considering the exposome's multifactorial, cumulative, and life-course perspective on exposure and health. Research is also needed to guide how policies in sectors like urban planning, housing, and workplace design can incorporate emerging exposome insights.

Similarly, chemical and physical exposure regulations, as well as public health recommendations and risk communication, should reflect a more comprehensive and nuanced understanding of health determinants—balancing both beneficial and harmful exposures. This represents a significant shift for public health practice and will require a reorientation of priorities within health safety agencies and policy agendas.

Goal 4

How can the exposome improve medicine

Exposome research is increasingly demonstrating its relevance for patient care and public health. The next challenge lies in scaling up its application and embedding its use into routine prevention, clinical practice, and decision-making. This includes developing more tailored and effective health interventions for specific sub-populations, supported by advances in technologies such as sensors, advanced analytical platforms, imaging, and data science. In therapeutic settings, exposomics can improve drug safety and effectiveness by identifying environmental factors that influence variability in treatment susceptibility and response, in combination with gene factors. More broadly, exposome-informed approaches are expected to advance our understanding of disease onset and progression across a wide range of medical fields. To support this integration, education on exposome science should become a core component of training for healthcare and public health professionals.

Goal 5

Development of methods, tools, infrastructures

Analytical platforms—such as sensors, mass spectrometry, and other advanced technologies—must be further enhanced to improve the granularity, reliability, and applicability of exposure data, especially across diverse populations and real-world settings. Equally important is the development of robust, interoperable data infrastructures. A FAIR-compliant exposome data ecosystem should link electronic health records, cohort data, and other relevant sources to support secure data integration, advanced analytics, and actionable insights. Strengthening causal inference also remains a priority, calling for the advancement of toxicological research through next-generation new approach methodologies (NAMs) and AI-powered tools for data mining and toxicity prediction. This vision will require strong transdisciplinary collaboration, sustained capacity building, and institutional support to fully embed the exposome paradigm into health policy and decision-making. Targeted collaboration with the private sector—spanning pharma, MedTech, environmental monitoring, and digital health—will enable exposome insights to be embedded directly into products, services, and decision-support systems, creating competitive European offerings with international reach.

The proposed agenda aligns with the Sustainable Development Goals (SDGs), the European Green Deal, and the Competitiveness Compass, and is fully embedded within key EU policy frameworks. It supports strategic domains including cities (e.g. European Strategy for Housing and Construction, Sustainable Transport Investment Plan, European Climate Adaptation Plan, New European Bauhaus), chemicals (e.g. REACH Regulation, Chemicals Strategy for Sustainability, Clean Industrial Deal), climate (e.g. 2040 European Climate Law, European Climate Adaptation Plan, One Health Strategy), child health (e.g. European Child Guarantee, WHO Child and Adolescent Health Strategy), and clinical practice (e.g. EU Mental Health Plan, Health Promotion and Disease Prevention Initiative, EU Mission on Cancer).

By generating actionable knowledge on environmental and lifestyle determinants of health, the exposome agenda helps translate research into more effective regulatory decisions, fosters clean innovation, and empowers European citizens to benefit from healthier living environments. The roadmap highlights a set of cross-cutting priorities to ensure impact. These include the need to move from fragmented to integrated approaches to health and exposure, to embed exposome science into EU policy and regulatory frameworks, to ensure that major societal transitions are health-positive and equitable, and to strengthen data infrastructures, capacity building, and citizen engagement. Together, these priorities provide a clear pathway for translating exposome research into tangible benefits for public health, sustainability, and innovation.

To fully realize this vision, Europe should establish a long-term European Human Exposome Initiative, bringing together research, infrastructure, policy, private sector and innovation efforts under a coordinated framework. This includes the development of large-scale, population-based exposome cohorts, sustained investment in interoperable data systems, integration with European infrastructures (e.g. EHDS, EOSC, ESFRI), and strengthened science–policy interfaces to accelerate the translation of exposome research into public health, environmental regulation, and clinical practice.

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