



FIGURE 14. The EU Child Cohort Network.

SOURCE: *EU Child Cohort Network*, <https://euchildcohortnetwork.eu/>.

More recently, the International Human Exposome Network (IHEN) Project has been heralded as a ground-breaking endeavour in the realm of exposome research, insofar as it seeks collaboration and coordination at the global scale. This initiative, comparable to the Human Genome Project (1990-2003) in its scope and ambition, aims to map and understand the full breadth of environmental exposures encountered by individuals throughout their lives, akin to the genome's role in decoding genetic information.

## 7.2. EXPOSOME IN THE GLOBAL SOUTH

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While much of exposome research has been conducted in the Global North, there is a growing expectation that the concept will have to be increasingly applied to the Global South, a term coined by the UN Conference on Trade and Development (UNCTAD) to designate countries of low socioeconomic status and, while not strictly geographical (Australia and New Zealand, for example, lie

in the Southern Hemisphere but are considered high-income), it is increasingly being used to refer to low- and middle-income countries.

Unlike the Global North, many countries of the Global South have to face the challenges of poverty, restricted access to education and services (including piped water, waste disposal, and electricity), and weak health systems, among others. These factors – recognised drivers of health – have yet to be addressed fully in exposome research, which has tended to focus its interest on the challenges faced by high-income countries. This research gap is even more significant if we consider the social environment, a domain that has attracted very little research interest (both in the Global North and South), but which is of enormous significance for populations in the Global South who find themselves frequently exposed to adverse life events.

Global South populations also face environmental and socioeconomic exposures that are less prevalent in (or absent altogether from) the Global North (see Figure 15). Limited access to clean water, sanitation facilities, and proper hygiene practices (all of which are associated with waterborne diseases) in combination with restricted access to clean household fuels and technology (responsible for household air pollution) pose significant health challenges. Children living in these conditions are particularly vulnerable as they typically have a higher pre-existing burden of chronic infections and nutritional deficiencies, exacerbating the challenges to their health and development.

In some countries of the Global South, rapid environmental changes, including those associated with urbanisation and industrialisation, hinder both the monitoring and understanding of these changing exposures. In India, for example, an increase in urbanised land use (and the associated reduction in green spaces) in residential areas between 1995 and 2009 has been associated with higher cardiometabolic risk factors due to reduced physical activity and increased air pollution exposure (Milà et al., 2020).

The methodological challenges encountered by exposome research in the Global North are magnified in the Global South by prevailing socioeconomic conditions, insufficient infrastructure and limited resources, all of which undermine both data availability and data quality. Inadequate health infrastructure, for instance, frustrates the ability to conduct large-scale longitudinal epidemiological studies and to collect quality clinical data. The coverage provided by environmental monitoring is also scant. For example, in the case of air quality monitoring, 60% of countries (the majority in Africa), representing 18% of the world's population, conduct no regular PM<sub>2.5</sub> monitoring (Martin et al., 2019).

Despite these challenges, there are instances that point to the feasibility of conducting exposome research in the Global South based on collaborative efforts and the use of advances in technology. One notable example is the study conducted



FIGURE 15. Environmental and socioeconomic factors affecting populations in the Global South.

SOURCE: Created by Ariadna Curto.

on 100 South African children, who were provided with wearable samplers (Koelmel et al., 2022). In this way, 637 environmental exposures could be identified, some of which had never previously been measured in children. The study identified 50 airborne chemical exposures of concern, including pesticides, plasticisers, organophosphates, and combustion products, among others. Primary monitoring campaigns can also serve as an effective means to obtain environmental data in these contexts. An illustrative example here is provided by a study involving

50 adults in South India, where comprehensive ambient and personal monitoring was carried out (Milà et al., 2018). This study exemplifies advanced data integration techniques in resource-limited settings by combining personal and ambient air pollution concentrations with questionnaires, GPS, and wearable camera data, which allowed identification not only of activities associated with increased exposure but also of the times of day and the locations where these exposures occurred.

To further exposome research in the Global South and enhance global collaboration in the field, various initiatives have been taken. Most notably, the International Human Exposome Network (IHEN) Project, funded by the European Commission, seeks to unite stakeholders from various sectors at the global scale. Such a collaborative approach is crucial for maximising the impact of future exposome research, particularly in the many Global South countries where research has historically been limited or undervalued.

### 7.3. EXPOSOME AND PLANETARY HEALTH

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The exposome concept has evolved to encompass not only the chemical exposures but also the broader environmental factors affecting human health (Price et al., 2022). This holistic view of the exposome, especially as regards the external exposome, assesses the links between human health and the intricate web of interactions within ecosystems, including the impacts of lifestyle, social determinants, and natural environments. In considering the interconnectivity between an individual's exposures and these broader ecological and environmental factors, the exposome framework can be aligned with that of *One Health*, which advocates for a unified health perspective across humans, animals, and their shared environments. Furthermore, study of the exposome could also contribute to considerations of the importance of safeguarding *planetary health* as a means of preventing disease and of promoting well-being, insofar as it highlights the exposure-related challenges and opportunities for mitigating global environmental changes derived from environmental degradation.

Although the three concepts highlighted converge, they can be distinguished from each other in certain respects:

- Exposome and studies conducted in this field are concerned with mapping individual environmental exposures and their health effects.

- One Health framework emphasises the interconnected health of humans, animals, and the environment, particularly the links between zoonotic diseases and ecosystem health (Erkyihun & Alemayehu, 2022; Wilcox & Steele, 2021).