

EDITORIAL

Unraveling the exposome: towards a model of planetary health



Desenredando el exposoma: hacia un modelo de salud planetaria

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The concept of health is evolving as environmental, social and technological challenges redefine our priorities. Climate change, pollution, the loss of biodiversity, the depletion of resources, unsustainable costs, the disconnection from nature and the rise of chronic diseases are closely linked to the Anthropocene era. We face a global crisis with a particularly strong impact on vulnerable populations, especially children. Pollution is currently responsible for one in six deaths worldwide.¹ To guarantee a healthy future, we must radically reconsider our approach to paediatric health.

Environmental medicine proposes a multidimensional, wide-ranging and holistic approach that extends beyond genomic advances and expands the principles of precision medicine by integrating the genome, the environment, lifestyle and social determinants in clinical decision-making (Table 1). This novel approach posits that health should be

understood as a dynamic process of adaptation and equilibrium in synchrony with the natural and social environment.²

Anthropocene related-disease, a global manifestation

The Anthropocene related-disease refers to the deep and generalised impact of human activity on the health of people and the planet. Since the mid-twentieth century, this era has been characterised by environmental degradation, climate change, overexploitation of resources and the culture of waste tied to the massive use of fossil fuels. In this context, the chronic diseases involving multiple organs and systems (cardiovascular, renal, respiratory, endocrine, neurodegenerative, malignant. . .) and emerging pandemics, like the one caused by SARS-CoV-2, are clear manifestations of this environmental crisis. All these diseases share risk factors that are intimately associated with the destruction of ecosystems and modern lifestyles. Approaching them as expressions of the Anthropocene related-disease offers a unique opportunity to integrate human and planet health. If we want to treat the sick among us, we must also cure the planet.

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Table 1 Key elements for ambiomic medicine in a Planetary Health model.

Genome	Genome and all omics. Genomics, epigenomics, proteomics, metabolomics and transcriptomics, among other omics that study molecular interactions and functions in health and disease.
Exposome	<p>Physical and chemical pollutants. All environmental exposures throughout the lifespan, such as air pollution, chemicals and radiation.</p> <p>Lifestyle. Physical activity, sleep, use of technology, contact with nature, digital environments, other addictions and behaviours that have an impact on health.</p> <p>Mental health. How stress, anxiety, emotions and other psychosocial factors affect health.</p> <p>Social determinants of health. Beliefs, values, culture, spirituality and socio-economic factors with an impact on planetary health.</p> <p>Socio-ecological interactions. Impact of the natural environment, climate change, biodiversity, natural disasters, meteors, emerging pandemics and ecosystem quality on human and planetary health.</p> <p>Microbiome. Community of microorganisms that inhabit the human body and other ecosystems and their role in digestion, immunity and general health.</p> <p>Metabolism and nutrition. Nutrition for optimal development and health.</p>

Environmental pollution and climate change have a common origin and share many of its effects with human health. The introduction of the *Global Burden of Disease* indicator in the evaluation of pollution has succeeded in stirring public opinion and achieved significant advances in its control.³ If we were to implement such an indicator for climate change, it would be possible to join efforts to improve planning and strategies for the protection of human and ecosystem health.

Redefining health: an ecosystems approach

Since 1948, the World Health Organization (WHO) defines health as “a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity.” Although this definition was groundbreaking at the time, today it is often perceived as overly static. We propose a new definition of health based on the “skills” that enable individuals and communities to achieve the optimal physical, mental, and social wellbeing possible “in harmony with Nature.” This definition establishes health as a dynamic and participatory process in which individuals are proactive agents in pursuing their wellbeing, which is tightly associated to the condition of ecosystems. This model will be sustainable and cost-effective only if individuals actively engage in its maintenance and improvement.²

While historical sources of pollution have decreased, the mortality attributable to contaminants such as lead, air pollution and chemicals products has increased drastically.¹ The core challenge in this approach is to “renaturalize health” in order to “rehumanize” our practices, restoring the connection of human beings to nature. Rooting child health in this way will give meaning to health care practices and promote a public health model that focuses on protective factors rather than just avoiding risk.

For decades, precision medicine has focused on the human genome, achieving extraordinary advances. However, this approach is insufficient to understand human health as a whole. The challenge for paediatrics in the next 25 years will be to unravel the exposome (the set of environmental exposures across the lifespan) and its impact on

well-being. This approach will not only enhance prevention and treatment, but will redefine health care, promoting a more holistic and nuanced perspective. Table 2 summarises the differences between models.^{2,4}

In this new model, primary, secondary and tertiary prevention are unified under an anticipatory approach. The earlier we intervene, the greater the health benefits will be. Anticipation prevents diseases, optimises treatments and improves outcomes by engaging individuals in their own wellbeing (Fig. 1).²

A future in which disease will be rare

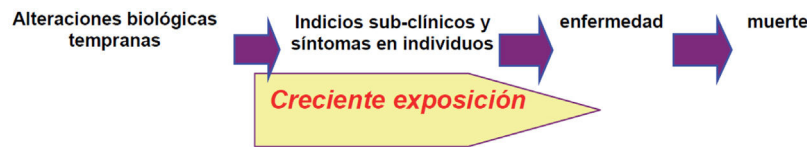
Unravelling the exposome through the integration of open data, citizen engagement, and anticipatory action will transform paediatric care. Instead of reacting to disease, anticipatory care will take the helm, enabling the early detection of abnormalities before they become chronic conditions. This shift entails the delivery of most services outside traditional health care facilities. In this future, disease will be a rare occurrence, and health will be largely maintained through the collaboration of health care professionals, educators and society. “Targeted prevention” programmes for risk groups will be at the core of clinical practice and take up a substantial portion of paediatric care resources. Hospitals will be smaller but extraordinarily sophisticated and technologically advanced. This approach will require a redistribution of resources and the establishment of strategic alliances with universities, international institutions, and the private sector, allowing this health care model to transcend the traditional boundaries of medicine and have an impact on global health.^{2,4}

Toward planetary health

The concept of planetary health proposes a radical integration of human and planetary health. It goes beyond the prevention of diseases, aiming to create environments where children and communities can thrive in harmony with nature. Achieving this goal would require these key actions: (a) to develop new capacities and structures, such as *paedi-*

Table 2 Differences between the classic medicine model based on traditional care delivery and the planetary health model.

	Traditional	Planetary health
Approach	Individual risk factors	Holistic
Role of the sick individual/family	Passive recipient	Central role, partnership
Responsibility	Falls on professional	Shared responsibility
Demanding major changes from the patient	No	Yes, often
Goal	Treatment of disease	Disease eradication and prevention
Treatment	Short-term	Long-term
Most common therapeutic modality	Medication	Changes in environment, lifestyle and social/community factors
Personalization	Precision Medicine. Focus on genetics (genome) and individual characteristics.	<i>Ambiome</i> (genome + exposome), Integrating environmental, social and community factors
Resilience and sustainability	Not contemplated	Focus on patient resilience and the sustainability of health systems and the environment
Main focus	Diagnosis and treatment	Promote and ensure therapeutic adherence
Importance of the environment	Little	Important and transcendent
Use of open data	Limited, focused on the health professional and individuals	Extensive, based on transparency, community participation, and comprehensive monitoring of the environment and social spheres.
Impact on communities	Limited, focused on the individual	Comprehensive, with interventions that impact both individuals and communities as well as the environment.
Use of technology	Expanded in omics sciences for diagnosis and prevention	Extensive, integrating omics and exposome monitoring


Figure 1 Anticipatory medicine and targeted prevention practice.

Note: In the Planetary Health model, disease will become a rare phenomenon. Most pediatric activities will focus on early biological alterations or the subclinical phase to prevent the progression to disease.

atric environmental health specialty units (PEHSUs), which integrate health and environment in clinical practice (the goal would be for each tertiary care/referral paediatrics department in Spain to have a PEHSU by 2030), (b) to establish new professional profiles, such as environmental physicians and nurses, ecotherapists and environmental health technicians and managers, (c) to promote education on environmental health, from before undergraduate education through postgraduate education, to prepare professionals to face environmental health challenges.⁵

Global and multisectoral action is urgently needed to protect children's health from the growing harmful effects of pollution and climate change through policies targeting both mitigation and adaptation. These changes will not be easy. Strong opposition from powerful vested interests will have to be overcome. Fortunately, the necessary policies, technological advances, and institutions are already in place to initiate this transformative change. It is only through our col-

lective effort that we will be able to progress towards a more sustainable and equitable model of health, where science, ethics, nature and spirituality converge. As paediatricians, we will not only act as clinicians, but also as community leaders building bridges between medicine, ecology and technology. The active engagement of individuals will be instrumental in co-creating an inclusive, just and resilient model of health for the future of the planet.

Unravelling the exposome is much more than a technical undertaking, it is an act of transformational leadership. As paediatricians, at the forefront of this new era of enlightenment in health, we bear the responsibility for building a planetary health system that not only treat diseases but also prevents them and improves their outcomes through environmental protection. This is the time to be bold, to drive meaningful change, and to prepare future generations to live in a world where the health of humans and the health of the planet are inextricably linked.

Declaration of competing interest

The authors have no conflicts of interest to declare.

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