

Preventing Early-life Exposure to Endocrine Disrupting Chemicals: Rationale and Design of the Belgian National Awareness Campaign.

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Non-communicable diseases in childhood

Non-communicable diseases (NCDs) are now the leading causes of morbidity and mortality in children, with incidence and prevalence increasing markedly over the past five decades (1). For example, childhood cancer incidence has risen by approximately 35%, male reproductive congenital anomalies have doubled, and neurodevelopmental disorders affect an estimated 10-15% of births worldwide. Likewise, the prevalence of paediatric obesity has nearly quadrupled, contributing to a sharp rise in type 2 diabetes among children and adolescents (1,2). Accumulating evidence indicates that environmental stressors during gestation, infancy, and early childhood play a critical role in the development of these NCDs across the life course. Epidemiological studies highlight that disruption of sensitive biological processes via early life environmental exposures can increase the risk of adverse health outcomes that may manifest even years or decades after exposure (2,3).

Endocrine disrupting chemicals

According to the International Program on Chemical Safety and the World Health Organization (WHO), endocrine-disrupting chemicals (EDCs) are defined as “an exogenous substance or mixture that alters the function of the endocrine system and consequently causes adverse effects in an intact organism, its progeny, or subpopulations” (4). EDCs can interfere with normal endocrine function by altering hormone synthesis, metabolism, transport, or action. In addition, they are even shown to affect

epigenetic regulation of endocrine and nervous system pathways (3-5).

Sources of exposure in childhood

EDCs consist of several heterogeneous chemical classes originating mainly from industrial processes but may also occur naturally in certain plant-based products and foods (4,6). Unfortunately, human exposure to EDCs is ubiquitous and occurs from various environmental sources, including household products as food packaging and containers, baby bottles, clothing, toys, cosmetics and personal care products – such as liquid soap, sanitary wipes and nappy creams –, as well as furniture and construction materials (4,5,7). It should also be noted that specific usage practices, such as heating food in plastic containers, can increase the migration of EDCs and subsequent exposure.

Children can be exposed to EDCs through inhalation, ingestion, and dermal contact (4). Compared with adults, infants and children experience proportionally higher exposures owing to physiological, anatomical, and behavioural differences. First, their intake of air, food, and water per unit body weight is substantially higher than that of adults. Second, they have a larger body surface area-to-mass ratio and increased skin permeability, resulting in enhanced dermal absorption of toxicants. Third, immaturity of the blood-brain barrier increases susceptibility to neurotoxic effects. Finally, children spend much of their time indoors – in homes, childcare centres, and schools – where multiple sources of EDCs coexist, further increasing cumulative exposure risk. Toddlers, in particular, frequently come into contact with soil and floors and commonly engage in hand-to-mouth and object-mouthing behaviours that

FIGURE 1: Examples of visuals of the new Belgian awareness campaign targeting young children's exposure to endocrine-disrupting chemicals. « A diaper blowout? Classic! Use a washcloth, water and neutral soap. Avoid disposable impregnated wipes. » (LEFT). « Mashed veggies or modern wall art? Mess is part of the game. Choose plates made of porcelain, glass, or stainless-steel. Preferably no plastic. » (RIGHT).



may involve materials containing EDCs (2,4,5,7,8). Consequently, biomonitoring studies consistently report higher concentrations of several EDCs in infants and toddlers than in adults (7).

Health risk of childhood exposure

Although humans are continuously exposed to these chemicals, accurately quantifying their health effects remains challenging, particularly given the complexity of exposure patterns (5). Beyond higher exposure, fetuses, infants, and children are also biologically more vulnerable to the effects of EDCs. Differences in toxicokinetic, due to renal and hepatic immaturity, may result in higher circulating or tissue concentrations for a given dose compared with adults (3,4).

Moreover, early life comprises a series of critical windows during which organs and biological systems undergo rapid growth, maturation, and epigenetic programming. Perturbation of hormonally regulated processes during these periods can lead to long-lasting or irreversible effects, even at exposure levels that would have little or no impact later in life (2,7). The developmental origins of health and disease (DOHaD) hypothesis recognizes the long latency of EDCs effects, whereby early exposures program metabolic, neurological, and endocrine functions and increase disease susceptibility across the lifespan (1,7). Recent research has shown that even very low-dose exposures to EDCs during vulnerable developmental periods are associated with an increased risk of disease and disability across the life course (5). These findings, which illustrate the absence of a linear dose-response relationship, challenge the Paracelsian notion that “the dose makes the poison” and support a new paradigm in which the timing of exposure is at least as important as the dose, particularly during early human development (1,7). Furthermore, children are rarely exposed to a single chemical. Simultaneous exposure to multiple EDCs may result in additive or synergistic effects, a phenomenon commonly referred to as the “cocktail effect”, while bioaccumulation – particularly in adipose tissue – can amplify long-term risks (4).

Epidemiological research is inherently complex owing to delayed health effects, non-linear dose-response relationships, mixture effects, and gaps in toxicity testing. As a result, the developmental toxicity of many EDCs will likely remain unidentified (2,7).

Strategies to reduce harmful exposure

Despite growing evidence linking early-life chemical exposures to disease, regulatory responses remain slow and fragmented. Only a fraction of the approximately 5,000 high-production-volume chemicals in widespread use have been adequately tested for developmental toxicity, and even fewer have been regulated (8). Regulatory frameworks typically assess chemicals individually, failing to account for mixture effects, and insufficiently consider children's heightened vulnerability, leading to delayed protection or even, in some cases, “regrettable substitution” of restricted substances with structurally similar compounds of uncertain safety (1,7,8).

Given this heightened sensitivity in early childhood, prenatal and early postnatal life must be prioritized for exposure reduction. Alongside regulatory action, environmental hygiene strategies aimed at reducing everyday

exposures represent a pragmatic and immediately implementable approach to protect vulnerable pregnant women, infants, and children (8). Although it is currently impossible to eliminate exposure to EDCs, paediatricians play a critical role in providing precautionary guidance to families. Increasing awareness of EDCs' sources and promoting cautious behavioural changes may help minimize exposure during vulnerable developmental periods. Considering the mounting evidence that even low-dose exposures can be harmful, clinicians should remain informed, vigilant, and actively engaged in prevention efforts (4,5).

The Belgian Awareness Campaign

In this context, the Federal Public Service (FPS) Health, Food Chain Safety and Environment prepared a national awareness campaign aimed at reducing young children's exposure to EDCs. This initiative follows an awareness campaign targeting pregnant women that was launched in May 2024 and forms part of the Belgian National Action Plan on Endocrine Disruptors (NAPED), adopted in June 2022, which explicitly includes communication strategies directed at vulnerable populations. This awareness campaign was co-designed with field stakeholders from Belgium's three communities and involves a wide range of institutional and professional partners – including the FPS Health, Food Chain Safety and Environment; the Walloon Agency for Health, Social Protection, Disability and Families (AVIQ); SPW Environment and Brussels Environment (IBGE); the Office de la Naissance et de l'Enfance (ONE); Kind en Gezin / Opgroeien (K&G); the FPS Employment, Labour and Social Dialogue; the FPS Social Integration; Sciensano; mutual health insurance funds; as well as midwives, gynaecologists, and paediatricians.

This new campaign, specifically targeting young children, will highlight four key preventive messages: [1] limiting the use of plastic tableware and food containers and favouring glass, earthenware, or stainless-steel alternatives; [2] opting for glass baby bottles rather than plastic ones, while emphasizing that breastfeeding

always remains the first option; [3] performing nappy care using a washcloth and neutral soap instead of disposable impregnated wipes and perfumed nappy creams; and [4] removing toys, comforters, and clothing from their packaging and washing them before first use. In addition, comprehensive prevention advice will be made available on the official campaign website. These four key messages were selected because they illustrate simple, practical actions that are easy to understand and implement, involve no major economic cost, and can meaningfully reduce exposure to EDCs. They were also designed to be complementary to the 2024 awareness campaign targeting pregnant women, thereby ensuring continuity and coherence across critical windows of early-life exposure.

This new campaign will be launched in March 2026 and will include postcards and posters distributed to healthcare

professionals and institutions (Figure 1), informational pages and articles published in several Belgian journals and magazines, as well as short video clips disseminated via social media platforms. Postcards and posters will be available free of charge and may be ordered via the official campaign website of the FPS Health, Food Chain Safety and Environment.

Given their central role in preventive counselling during early childhood, paediatricians are uniquely positioned to ensure the effective dissemination of these messages. By integrating this prevention guidance into routine clinical practice, paediatricians can act as trusted intermediaries, supporting parents in making informed choices and addressing concerns regarding exposure to EDCs. Their active involvement is therefore essential to maximize the impact of this national awareness campaign during critical windows of child development.

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