*Review*

# Cardiovascular and Metabolic Health: Endocrine Disrupting Chemicals and Biomaterials

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**Abstract:**
Endocrine and metabolic dysfunctions may be related to environmental endocrine disrupting chemicals (EDCs), which can alter hormone-related organs and are thus associated with different health problems. Medical biomaterials, devices and all implants must be biocompatible to reduce the risk of adverse effects. Biocompatibility has applications in a variety of biomedical fields, including orthopedic implants and devices, dental implants and materials, and cardiovascular devices. Although most medical biomaterials are rigorously tested for biocompatibility and safety, including toxicity and endocrine disruption, the risk may derive from known or suspected endocrine disruptors; the material is implanted or used for long time; or the material may break down or degrade into smaller, active compounds during the aging process.
The article presents the insight into common environmental chemicals and theoretical concerns about the potential consequences of the long-term presence of artificial materials in the body. Future research directions in the field of biocompatibility should include developing a better understanding of the interactions between biomaterials, their molecular mechanisms and the endocrine system. Clinical experimental studies are needed to examine endocrine associations and ensure that the industry requires identification of products containing potentially harmful materials.

**Keywords:** Cardiovascular health; Metabolic syndrome; Endocrine disrupting chemicals; Obesity; Obesogens; Implants

## 1. Environmental pollutants and health

### *1.1. Environmental chemicals*

There is growing interest in the possible health threat posed by endocrine disruptors as different chemicals which are substances in our environment, food, and consumer products and interfere with hormone biosynthesis, metabolism, or action resulting in a deviation from normal homeostatic control or reproduction. There is substantial evidence that endocrine disruptors have effects on reproduction, breast development and cancer, prostate cancer, neuroendocrinology, thyroid, metabolism, and cardiovascular endocrinology during aging (Diamanti-Kandarakiset et al., 2009; Moroni et al., 2020; Fan et al., 2023; Huang et al., 2024; Liang et al., 2025).

### *1.2. Toxicology of endocrine disruptors*

Cardiometabolic disorders and aging-related diseases are a growing public health problem. Among the known cardiometabolic risk factors are compounds that may induce endocrine and metabolic dysfunctions, such as endocrine disrupting chemicals (EDCs). Those EDCs can alter hormone-related organs and thus be linked to a wide range of non-communicable cardiometabolic diseases. EDCs are chemicals which contribute to health problems by interfering with the physiological production and target effects of hormones with proven impact on a number of endocrine systems. EDCs are natural or synthetic compounds present in the environment which can interfere with hormone synthesis and normal physiological functions. Most EDCs tend to bind to steroid hormone receptors including the oestrogen receptor, progesterone receptor and androgen receptor and disrupt the actions of endogenous hormones; they may also induce abnormal physiological functions of different systems (Lee et al., 2013). Over the past 20 years, scientific knowledge about endocrine disruptors has increased exponentially, particularly about bisphenols such as BisPhenols A (BPA), and it is now accepted that low doses of BPA can alter the function of hormone-related organs and thus be linked to a wide range of non-communicable cardiometabolic diseases (Chen et al., 2025).

### *1.3. EDCs and obesity*

The etiology of the obesity epidemic has been partly attributed to high caloric uptake, a lack of physical activity and sedentary lifestyle. However, beside a genetic predisposition and lifestyle modifications, scientific research implies the impact of environmental substances in the generative roots of obesity, explained as "obesogens" – molecules which inappropriately regulate lipid metabolism and adipogenesis to promote obesity (Grün & Blumberg 2006; Tabb & Blumberg, 2006; Jaskulak et al., 2025).

The excessive weight is one of the top ten health risks in the world and the number of overweight people in the world is now greater than the number of undernourished. The prevalence of obesity defined as body fat greater than 25% in men or greater than 30% in women, has risen dramatically in wealthy, developed countries, and it is also on the rise in poor nations. The rise in the incidence of obesity matches the rise in the use and distribution of different chemicals that may be playing a role in generation of obesity (Baillie-Hamilton 2002; Diamanti-Kandarakis et al., 2009; Jaskulak et al., 2025), suggesting that EDCs may be linked to this epidemic. Obesity has deleterious effects on human health by increasing the risk of associated metabolic abnormalities such as insulin resistance, hyperinsulinemia, hypertension, and dyslipidemia—all components of the metabolic syndrome—which constitute, in turn, major risk factors for the development of diabetes mellitus type 2 and coronary heart disease.

The obesity phenotype may lead to a dysmetabolic state with atherogenic, inflammatory, prothrombotic abnormalities which not only accelerate the progression of cardiovascular diseases but also create favorable "subsoil" for an acute myocardial infarct (Poirier & Després, 2003; Assenza et al., 2025). Therefore, the cardiovascular system is also a target of environmental chemicals which interfere with intracellular signaling of hormonal and inflammatory pathways. A link between exposure to EDCs and the occurrence of cardiovascular diseases, myocardial infarction, hypertension, and altered cardiac electrophysiology was demonstrated (Fu et al., 2020).

*1.4. Research problem of EDCs*

The specific health impacts of EDCs remain debated, and their tissue and molecular targets are poorly understood. Shu et al. (2019) identified the association of bisphenols (BPA) molecular signatures with cardiometabolic phenotypes in mice and humans. Their multi-tissue, multi-omics investigation provides strong evidence that EDCs perturb diverse molecular networks in central and peripheral tissues and it offers insights into the molecular targets which potentially link different EDCs to various human health disorders (**Figure 1**).

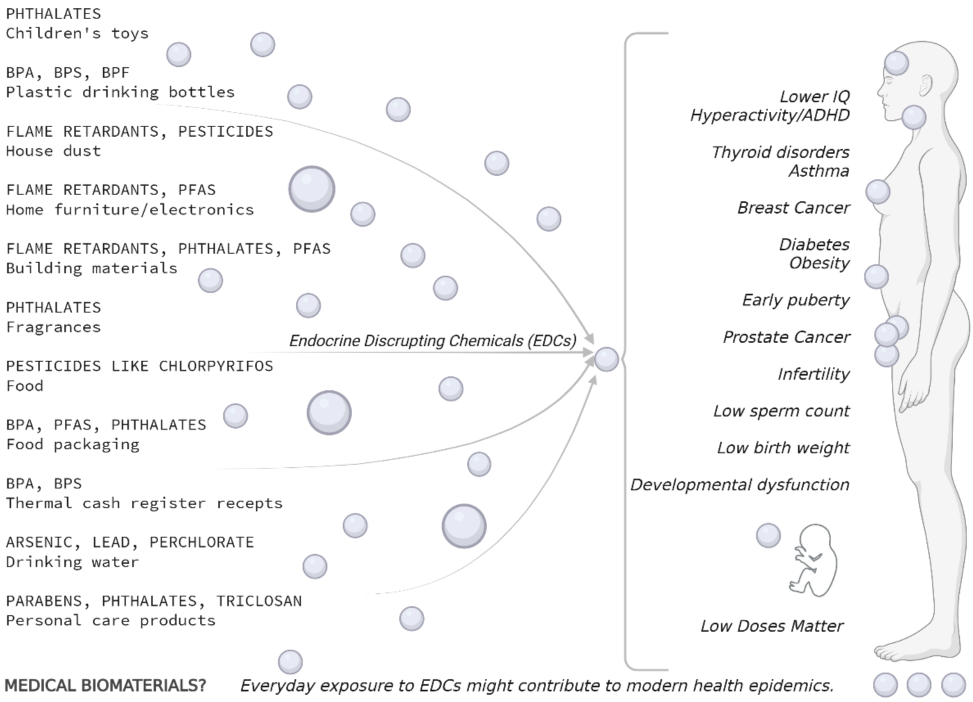


**Figure 1.** Association between different EDCs and potential health disorders.

The mechanism of EDCs influences the molecular level and cardiometabolic risks is not yet to be fully elucidated, especially considering the complexity contributed by species-, chemical-, and dose-specific effects. Moreover, different experimental and analytical methodologies employed by different studies pose challenges when comparing findings across studies.

To explore the molecular mechanisms of EDCs in a systematic manner, Zamora et al. (2024) established a data-driven computational approach to meta-analyze 30 human, mouse, and rat liver transcriptomic datasets for 4 EDCs, BPA, bis(2-ethylhexyl) phthalate (DEHP), tributyltin (TBT), and perfluorooctanoic acid (PFOA). They found that the rat, mouse, and human BPA studies showed highly variable transcriptomic patterns, providing molecular support for the variability in BPA responses. It is important that their bioinformatics workflow will be used in a new toxicogenomic database to study a broad range of environmental toxicants and tissues to better understand their influence on complex human diseases (Zamora et al., 2024). Although EDCs represent a significant public health concern, there are no other standard methods to determine the effect of EDCs on human beings.

To summarize, EDCs represent a broad class of molecules from different environmental industrial chemicals, plastics and plasticizers, fuels, and other chemicals present in widespread use and might be even present in different medical implants, drug delivery systems, or coatings. Biomedical materials are normally biocompatible; however, in long-term contact with body tissues they might potentially cause endocrine issues if implanted or used chronically or if degraded into harmful compounds.

To conclude, the recommendations for a better understanding of the effects of endocrine disruptors are not negligible, including promoting basic and clinical research of different implanted biomaterials and their epigenetic potential in transmitted pathways, which can be modeled in laboratory *in vitro* and *in vivo* models. Therefore, more basic and clinical research is needed to understand the effects of EDCs, invoke the precautionary principles, and advocate involvement of individual and scientific society stakeholders in communicating and implementing changes in public policy and awareness.

## 3. Conclusions

More experimental studies are needed for better insights into differences of molecular mechanisms of various EDCs to elucidate the underlying connections between chemical exposure and disease risks. Furthermore, the long-term impact of various biocompatible biomaterials implanted in the human body may not be a negligible part of the research from an endocrine perspective.

**Conflicts of Interest:** The authors declare no conflict of interest.

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