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Review article

Perspective on pre- and post-natal agro-food exposure to persistent organic pollutants and their effects on quality of life

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ABSTRACT

Background: Adipose tissue constitutes a continual source of internal exposure to organic pollutants (OPs). When fats mobilize during pregnancy and breastfeeding, OPs could affect foetal and neonatal development, respectively.
Scope and approach: The main aim of this review is to deal with pre- and post-natal external exposure to organic pollutants and their effects on health, proposing prevention measures to reduce their risk. The goal is the development of a biomonitoring framework program to estimate their impact on human health, and prevent exposure by recommending some changes in personal lifestyle habits.
Key findings and conclusions: It has been shown that new studies should be developed taking into account their cumulative effect and the factors affecting their body burden. In conclusion, several programs should continuously be developed by different health agencies to have a better understanding of the effect of these substances and to develop a unified public policy.

Contents

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1. Importance of the exposure to OPs

The presence of organic pollutants (OPs) in humans has become subject of intense research for human exposure and health risk assessment (Covaci et al., 2008). This is the reason that, over the years, instruments to regulate and control environmental pollutants to protect human health and environment have been created by the international community. The most ambitious plan is the Stockholm Convention (2013), which aim is to eliminate and, when it is not possible, regulate emissions and discharges of persistent OPs (POPs).

Human exposure to environmental pollutants begins in the uterine life period by trans-placental transfer (Regan et al., 1986; Vizcaino et al., 2014a). In this sense, epidemiologic researches demonstrated the vulnerability of the human foetus, child, and adult to adverse health outcomes from parental or childhood exposures to OPs that disrupt time-specific growth and developed processes (Wigle et al., 2007). Foetuses and infants are particularly vulnerable to the effects of OPs because of their rapid growth and organ development, cell differentiation, and immaturity of metabolism (Vafeiadi et al., 2014). Birth outcomes may be intermediate between prenatal toxic exposures and various health outcomes in later life; hence, the in utero effects of environmental agents on pregnancy outcomes are of great interest (Vafeiadi et al., 2014).

1.1. Common characteristics of OPs

OPs can be defined as a set of highly toxic synthetic organic compounds, which have a long persistence in the environment. All this is because they are resistant to degradation and are bio-accumulative; therefore, they are incorporated in the tissues of living organisms and can increase their concentration through the food chain, and have the potential to be transported over long distances reaching areas where they had never occurred. All this makes them a threat to human health and the environment across the globe. OPs are manufactured either for a specific purpose (e.g. pesticides or flame-retardants) or produced as by-products (e.g. of incinerated waste). They lead to chronic diseases such as male reproductive problems, pregnancy complications, certain cancers, obesity and affect brain development. POPs possess a particular combination of physical and chemical properties (Convention, 2008), since they:

- remain intact for long periods of time (many years);
- become widely distributed throughout the environment as a result of natural processes involving soil, water and, air;
- accumulate in the fatty tissue of living organisms and are found at higher concentrations at higher levels in the food chain; and
- are toxic to both humans and wildlife.

It is then essential to understanding and modelling their environmental transport and transformation. The most important properties for understanding the environmental behaviour of OPs appear to be octanol/water partition coefficient (Kow), octanol/air partition coefficient (Koa), water solubility (Sw), vapour pressure (Pv) and organic carbon partition coefficient (Koc) (Table 1).

1.1.1. Listing of OPs in the Stockholm Convention

The UNEP Stockholm Convention on POPs entered into force in 2001 regulating or banning a preliminary list of twelve chemicals called the "dirty dozen" (including PCBs, dioxins (PCDDs) and furans (PCDFs) and a range of organochlorine pesticides OCPs) and came into effect on May 17, 2004. In August 2009, nine new chemicals were added in an amendment and came into force 1 year later (including other OCPs, hexabromobiphenyl, a range of Polybrominated diphenyl ethers (PBDEs) and perfluorinated chemicals as well as its salts (PFCs)). During the fifth meeting held in 2011 was added endosulfan, in the sixth meeting held in 2013, hexabromocyclododecane became the 23rd POP and at its last meeting, the seventh, in May of 2015, the Stockholm Convention added to the list 3 new compounds: hexachlorobutadiene, pentachlorophenol and the polychlorinated naphthalenes. The Table 1 shows the structures, as well as their main chemical and physical properties, of the selected POPs.

1.1.2. Other related contaminants

The list of substances could be completed with the following pollutants, which are in need of monitoring due their human risk. Structures and main chemical and physical properties are also shown in Table 1.

Polycyclic aromatic hydrocarbons (PAHs) are a group of compounds produced naturally, through emissions from volcanoes, and the incomplete combustion of wood (Yebra-Pimentel et al., 2015). They can be also produced in the industry, via metallurgical processes of production and processing of aluminium but also coke and carbon. The mechanism of toxicity is considered to interfere with function of cellular membranes as well as with enzyme systems, which are associated with the membrane. They have been shown to cause carcinogenic and mutagenic effects and are potent immunosuppressants.

Pyrethrins and *pyrethroids* are insecticides included in over 3500 registered products (González-Rodríguez et al., 2008). The use of