EU Regional Development Funds - Interreg Central Europe AWAIR

Strategies and operational tools to support adaptation actions in vulnerable population groups during the Severe Air Pollution Episodes (SAPEs)

Parma - APE Parma Museo, via Farini 32a, November 6th, 2019

Air pollution and Endocrine Disruptors (EDCs)

SERGIO BERNASCONI

Full Prof. of Pediatrics, University of Parma (Italy)

OUTLINE

1) DEFINITION

2) IMPACT on HUMAN HEALTH

3) EDCs and AIR POLLUTION

OUTLINE

1) DEFINITION

DEFINITION

Definition of EDCs (IPCS, 2002)

*"An **endocrine disruptor** is an exogenous substance or mixture that alters function(s) of the endocrine system and consequently causes adverse health effects in an intact organism, or its progeny, or (sub) populations."*

A 2012 Endocrine Society statement define endocrine disruptors as :

"an exogenous chemical, or mixture of chemicals, that can interfere with any aspect of hormone action"

DEFINITION

Science of the Total Environment 612 (2018) 1516–1531

Emergent contaminants: Endocrine disruptors and their laccase-assisted degradation – A review

Carlos Barrios-Estrada [a], Magdalena de Jesús Rostro-Alanis [a], Blanca Delia Muñoz-Gutiérrez [a], Hafiz M.N. Iqbal [a,*], Soundarapandian Kannan [b], Roberto Parra-Saldívar [a,*]

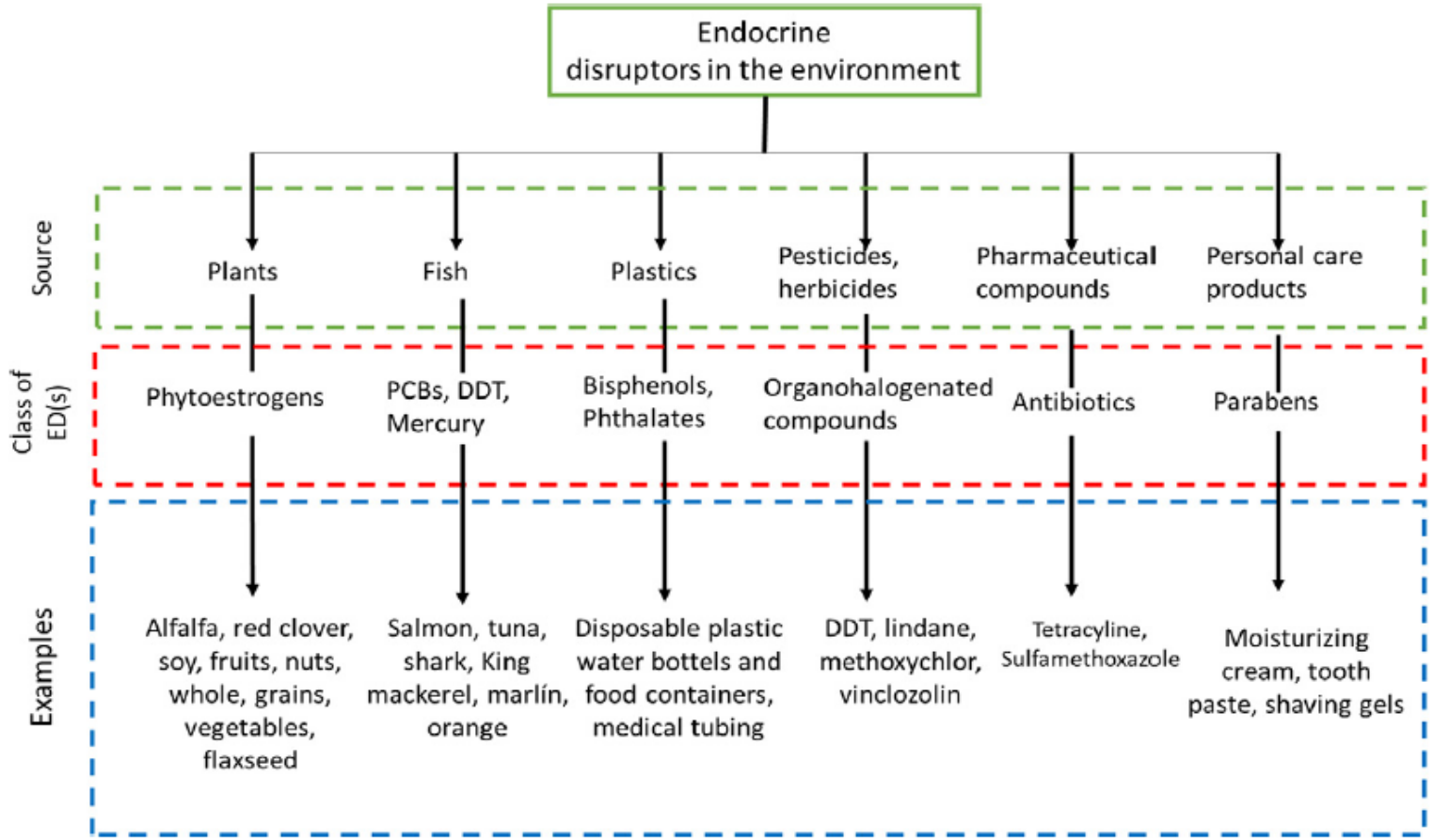
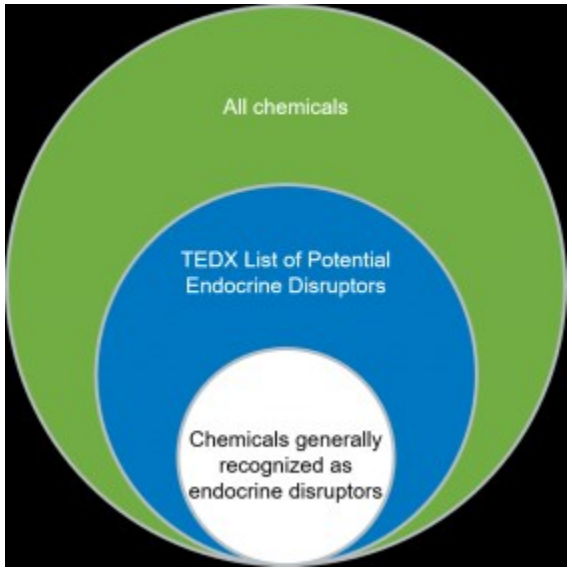


Fig. 2. Common sources of EDs in the environment.

DEFINITION



The TEDX List of Potential Endocrine Disruptors identifies chemicals that have shown evidence of endocrine disruption in scientific research. TEDX researchers evaluate chemicals by searching the publicly available scientific literature and identifying peer-reviewed research showing effects on endocrine signaling.

Government agencies, non-profit groups, scientists, and businesses have different criteria for labeling a chemical as an endocrine disruptor. We provide a master list of potential endocrine disruptors, defined as chemicals with at least one study demonstrating endocrine disrupting properties, in order to serve a broad array of needs.

September 2018
Chemicals in plastic packaging were reviewed in this update. Twenty-six new chemicals were added to the list, along with 1 chemical based on user requests and 1 other chemical, bringing the total number of chemicals to 1,484.

DEFINITION

(*J Clin Endocrinol Metab* 100: 0000–0000, 2015)

Table 3. Criteria for Evaluating Toxicological Evidence

Quality of Evidence	Interpretation	Study Design
Strong, group 1 (endocrine disruptor)	There is a strong presumption that the chemical has the capacity to cause the health effect through an endocrine disruptor mechanism.	The animal studies provide clear evidence of the ED effect in the absence of other toxic effects, or if occurring together with other toxic effects, the ED effects should not be a secondary nonspecific consequence of other toxic effects. However, when there is, eg, mechanistic information that raises doubt about the relevance of the effect for humans or the environment, group 2 may be more appropriate. Substances can be allocated to this group based on: Adverse in vivo effects where an ED mode of action is plausible ED mode of action in vivo that is clearly linked to adverse in vivo effects (eg, by read across)
Moderate, group 2a (suspected endocrine disruptor)	There is some evidence from experimental animals, yet the evidence is not sufficiently convincing to place the substance in group 1.	The health effects are observed in the absence of other toxic effects, or if occurring together with other toxic effects, the ED effect should be considered not to be a secondary nonspecific consequence of other toxic effects. Substances can be allocated to this group based on: Adverse effects in vivo where an ED mode of action is suspected ED mode of action in vivo that is suspected to be linked to adverse effects in vivo ED mode of action in vitro combined with toxicokinetic in vivo data (and relevant non-test information such as read across, chemical categorization, and QSAR predictions)
Weak, group 2b (potential endocrine disruptor)	There is some evidence indicating potential for endocrine disruption in intact organisms.	There is some in vitro/in silico evidence indicating a potential for endocrine disruption in intact organisms or effects in vivo that may, or may not, be ED-mediated.

Abbreviations: ED, ●●●●; QSAR, quantitative structure–activity relationship. Adapted from Ref. 36.

OUTLINE

1) DEFINITION

2) IMPACT on HUMAN HEALTH

Adipocytes under assault: Environmental disruption of adipose physiology ☆

Shane M. Regnier [a], Robert M. Sargis [a,b,c,*]

Biochimica et Biophysica Acta 1842 (2014) 520–533

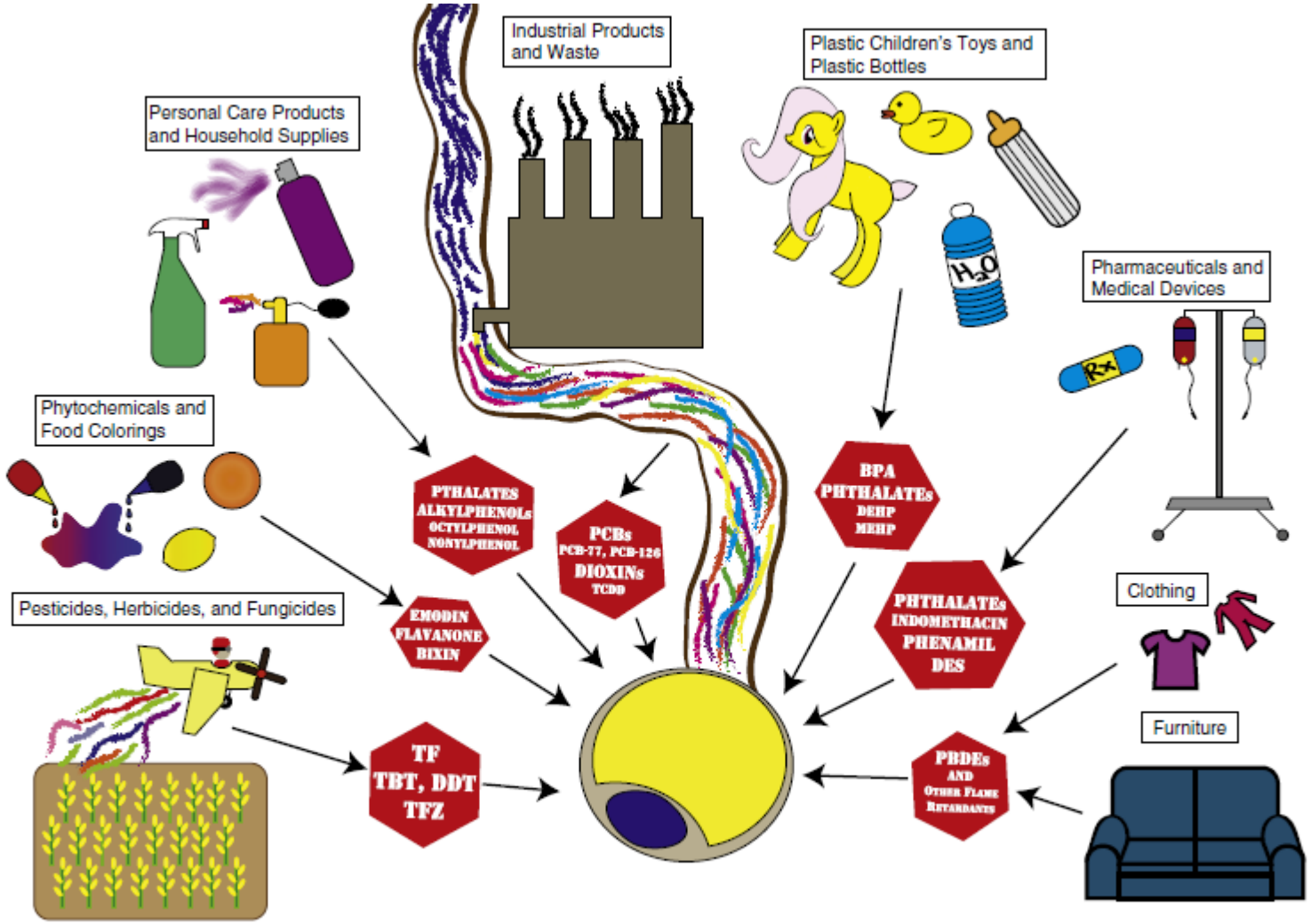
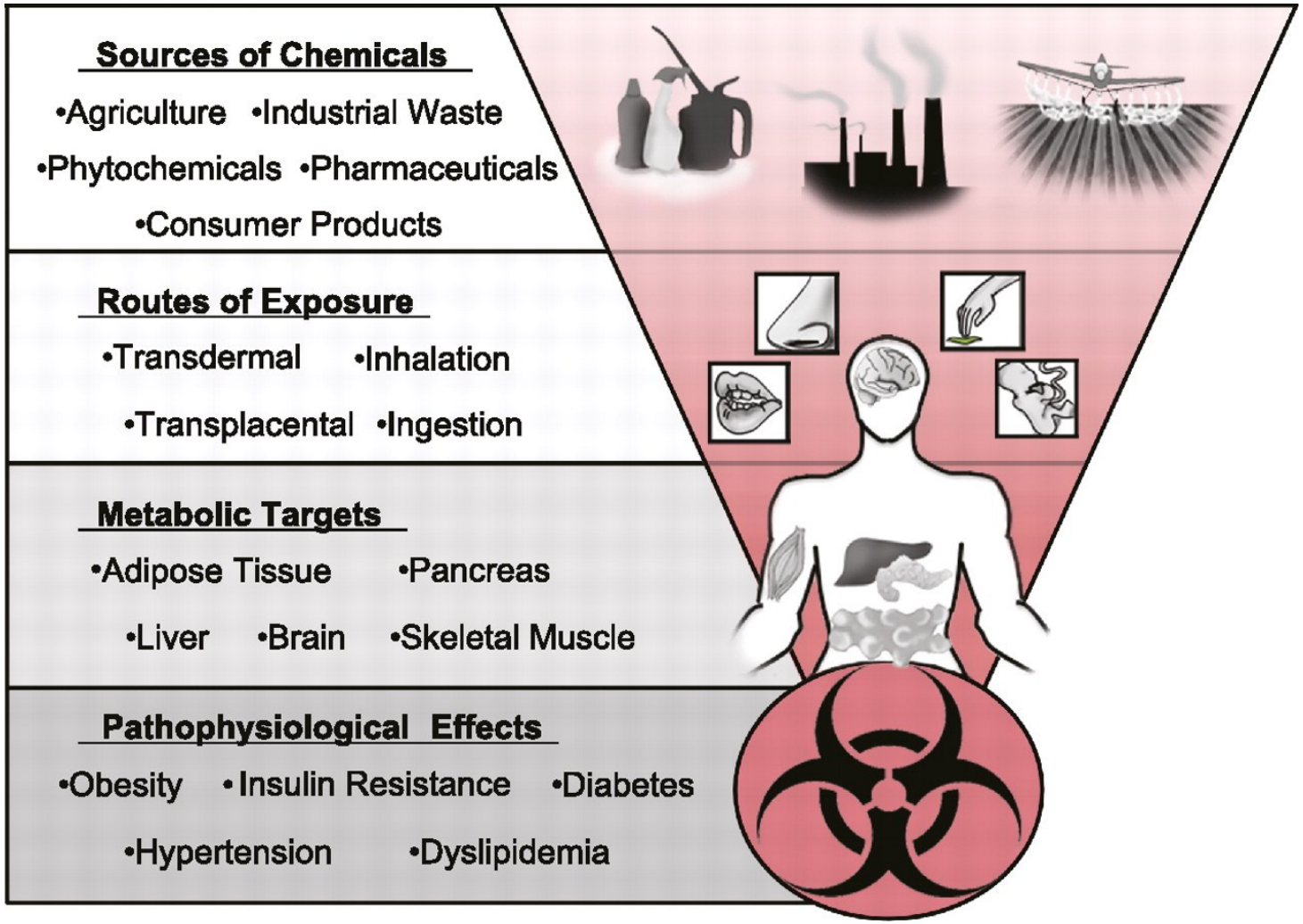


Fig. 1. Adipocytes Under Assault: endocrine disrupting chemicals and their sources. BPA, bisphenol A; DDT, dichlorodiphenyltrichloroethane; DEHP, di-2-ethylhexyl phthalate; DES, diethylstilbestrol; MEHP, mono-ethylhexyl phthalate; 4-NP, 4-nonylphenol; PBDEs, polybrominated diphenyl ethers; PCB, polychlorinated biphenyl; TF, tolylfluanid; TBT, tributyltin; TCDD, 2,3,7,8-tetrachlorodibenzo-*p*-dioxin; TFZ, triflumizole.

Sources and targets of metabolic disruptors.



Brian A. Neel, and Robert M. Sargis Diabetes 2011;60:1838-1848

American Diabetes Association.

MICROBIOME Research Hub

IMPACT ON HEALTH?

EDC-2: The Endocrine Society's Second Scientific Statement on Endocrine-Disrupting Chemicals

A. C. Gore, V. A. Chappell, S. E. Fenton, J. A. Flaws, A. Nadal, G. S. Prins, J. Toppari, and R. T. Zoeller

Figure 1.

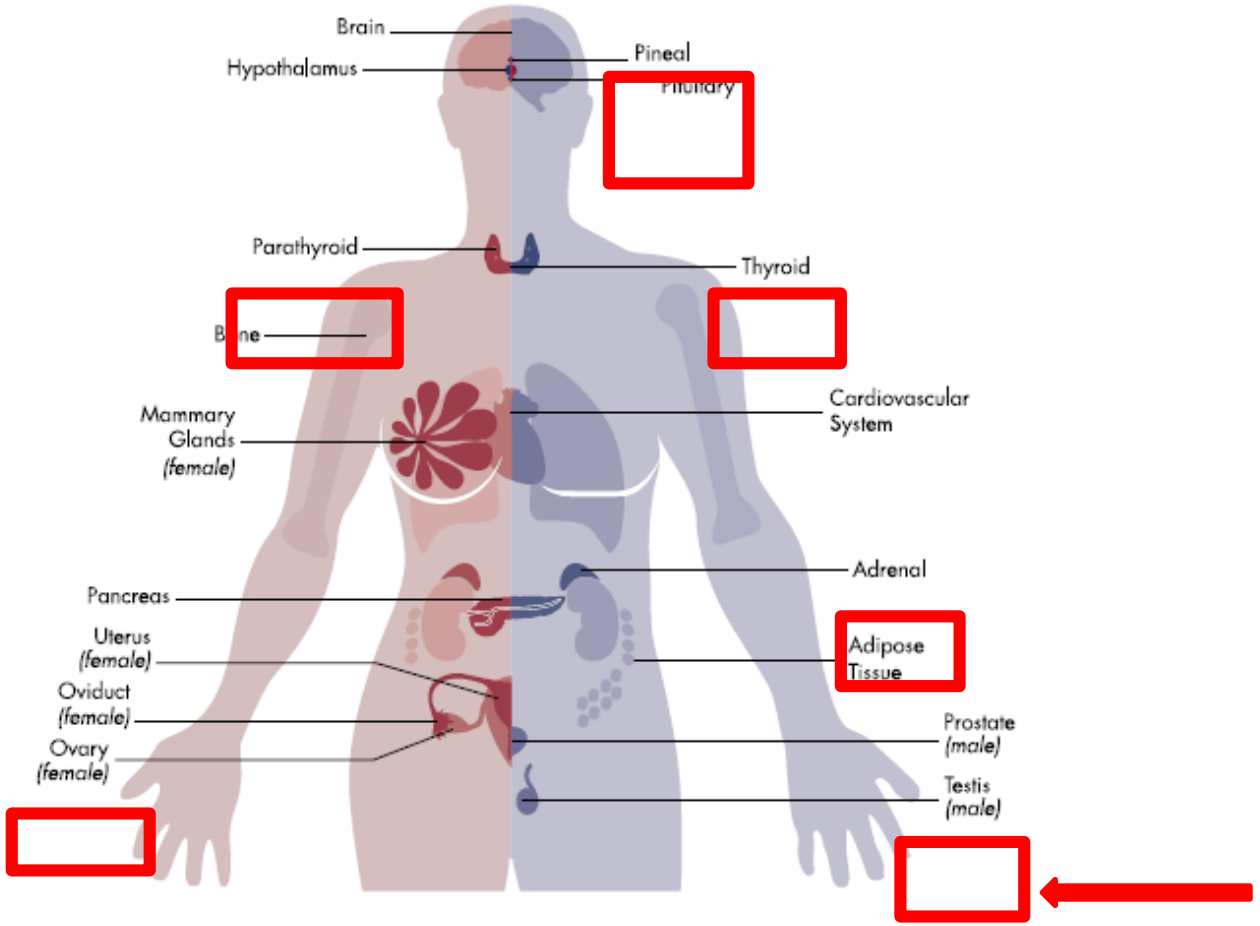
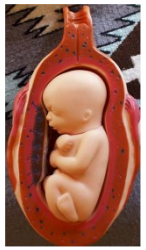


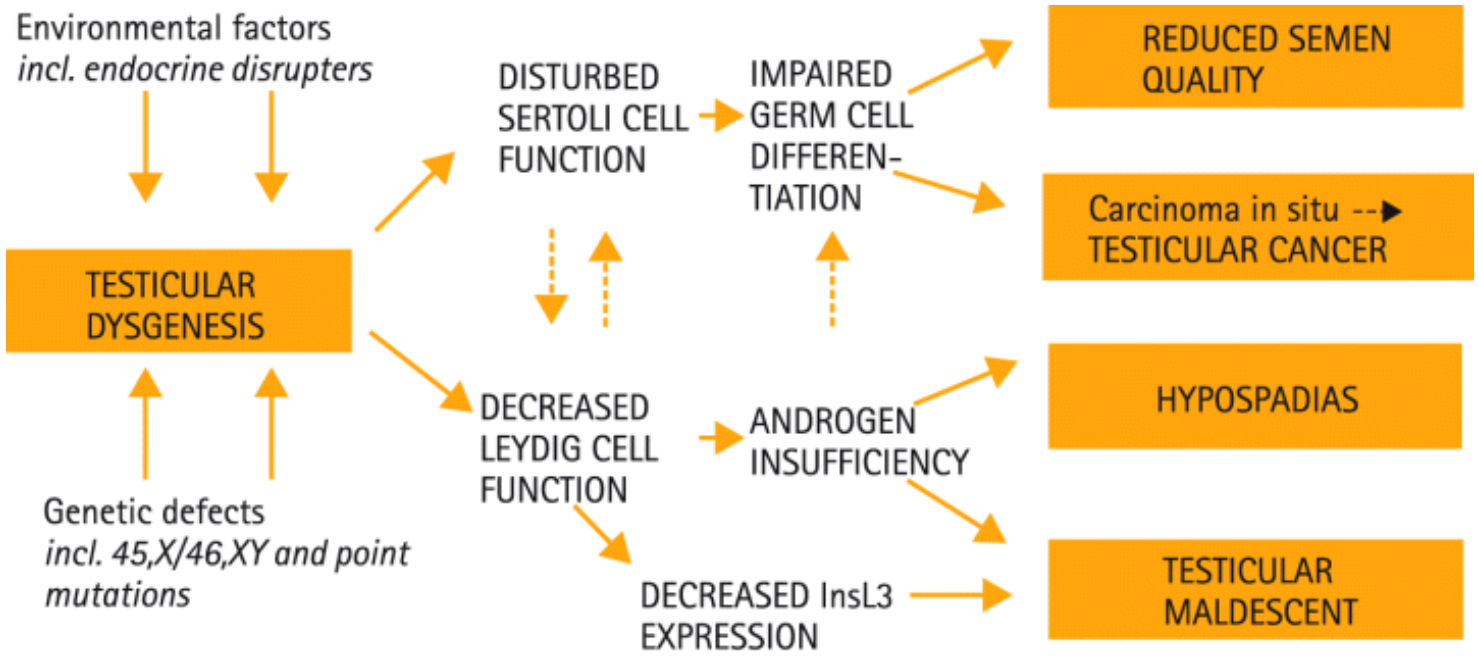
Figure 1. Diagram of many of the body's endocrine glands in females (left) and males (right).

MICROBIOME Research Hub

Genital malformations and the TDS (Testicular dysgenesis syndrome)

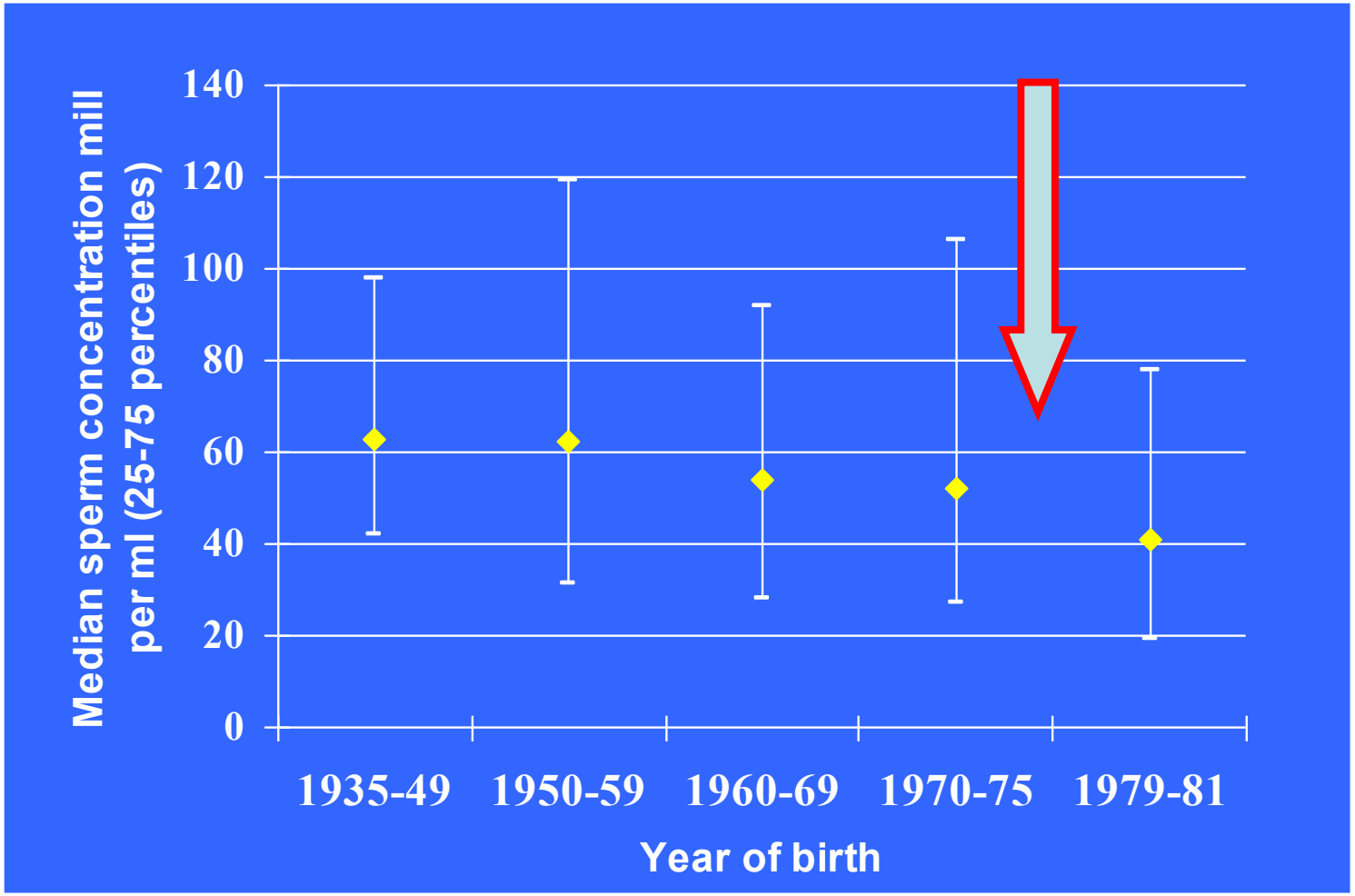
First introduced by Skakkebaek (Denmark)





Reproductive disease in adult men may result from disruption of embryonic programming and fetal gonadal development

Median sperm concentration and 25-75 percentiles according to year of birth from 10 Danish studies of men born between 1935-75 (reconstructed from Bonde) and 708 men from the general Danish population born from 1979-81.



Endocrine Disruptors: Time to Act

Mariana F. Fernández · Marta Román ·
Juan Pedro Arrebola · Nicolás Olea

Curr Envir Health Rpt (2014) 1:325–332

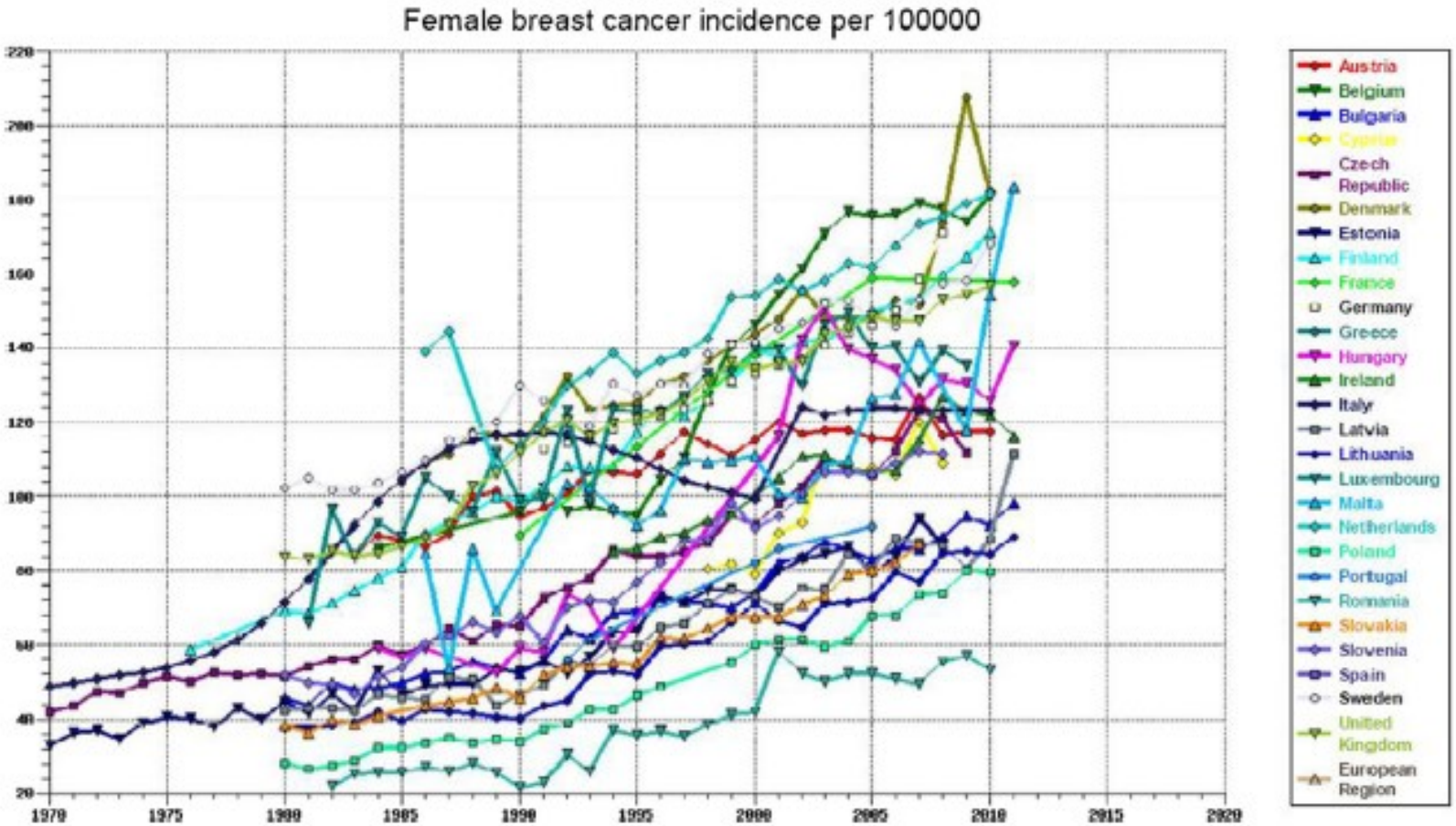


Fig. 2 Trends in breast cancer incidence in 27 European countries. Analysis of the European health for all database (online database). Copenhagen, WHO Regional Office for Europe, 2014 (http://data.euro.who.int/hfadb/)

International Journal of Gynecology and Obstetrics 131 (2015) 219–225

International Federation of Gynecology and Obstetrics opinion on reproductive health impacts of exposure to toxic environmental chemicals☆

Gian Carlo Di Renzo [a], Jeanne A. Conry [b], Jennifer Blake [c], Mark S. DeFrancesco [b], Nathaniel DeNicola [b], James N. Martin Jr. [b], Kelly A. McCue [b], David Richmond [d], Abid Shah [d], Patrice Sutton [e], Tracey J. Woodruff [e,*], Sheryl Ziemin van der Poel [f], Linda C. Giudice [g]

Box 1

Adverse health outcomes linked with preconception and prenatal exposure to environmental chemicals.[a]

Neurodevelopment

- Impaired cognitive and neurodevelopment, increase in attention problems and attention deficit hyperactivity disorder behaviors at age 5 years, and reduction in working memory capabilities at age 7 years with pesticides [74–77]
- Impaired neurodevelopment in girls and reduction in executive function at age 4–9 years with phthalates [78,79]
- Intellectual impairment with lead [80]
- Reduced cognitive performance, impaired neurodevelopment, and reduced psychomotor outcomes with methyl mercury [81–85]
- Decreased placental expression of genes implicated in normal neurodevelopmental trajectories with increasing in utero exposure to fine particle air pollution [86]
- Reduced intelligence quotient score and a wide range of attention and executive function deficits with PCBs [87–91]
- Impaired neurodevelopment and reduction in sustained attention with polybrominated diphenol ethers [92,93]
- Attention problems at age 6–7 years with polycyclic aromatic hydrocarbons [94,95]
- Aggression and hyperactivity in girls, and reduction in executive functioning skills in girls aged 3 years with bisphenol A [96,97]

IMPACT ON HEALTH?

This article is produced with financial support of the Life+ programme of DG Environment of the European Commission.

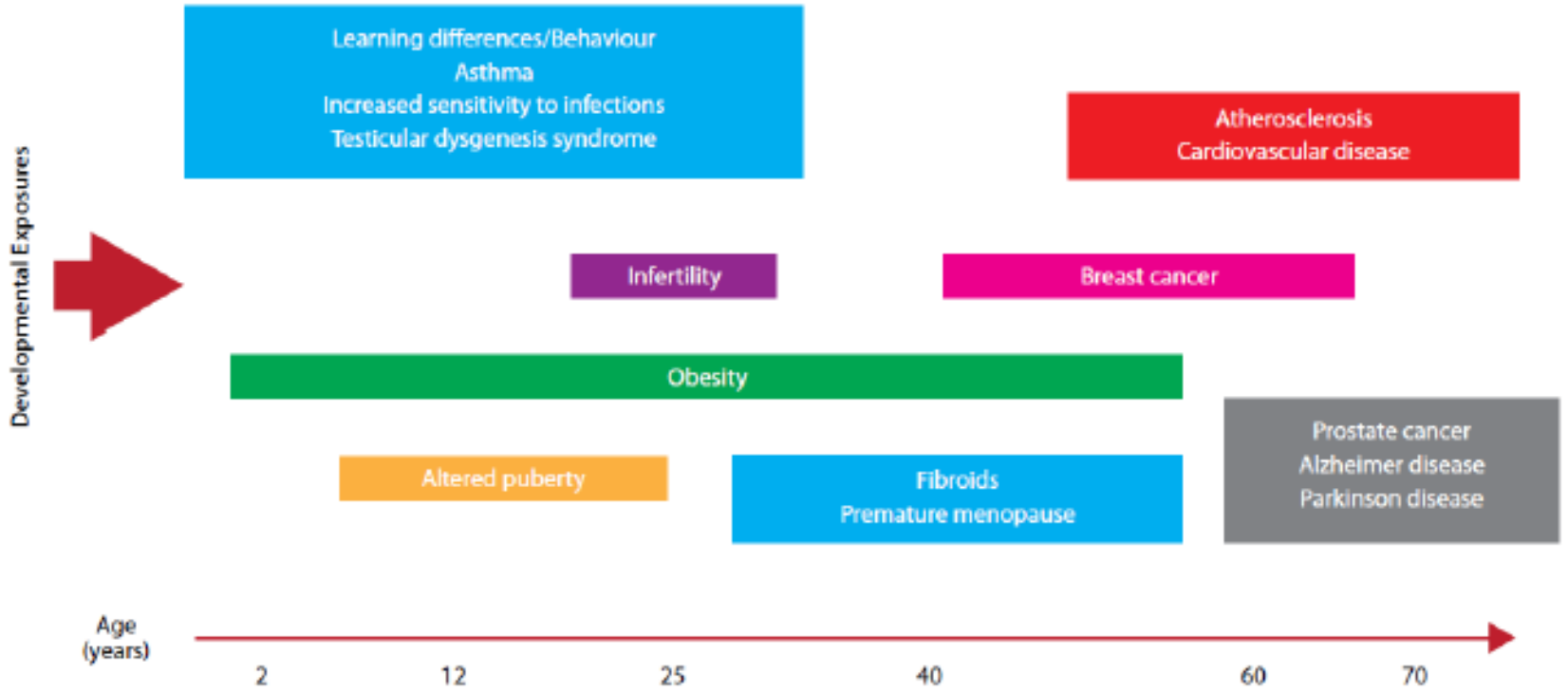


Figure 2: Several diseases and dysfunctions across all ages are linked to early exposure to endocrine disrupting chemicals (source: WHO. (2012). State of Science of Endocrine Disrupting Chemicals).

Limitations of the Evidence

Evidence to Practice
Endocrine-Disrupting Chemicals
Andrea C. Gore, PhD
JAMA Internal Medicine November 2016 Volume 176, Number 11

Several challenges remain in the field of EDCs and endocrine health and disease.

First,
the ability to directly relate an exposure to a disease outcome is virtually impossible, especially when the lag time can be years.

Second,
endogenous hormonal actions at one dosage do not necessarily predict effects at another; such nonmonotic dose-response curves are probably the norm for both physiological systems and for EDC actions.

Third,
EDCs are not pure agonists or antagonists of a single hormone receptor or pathway. This translates to complex and sometimes seemingly inconsistent actions of EDCs in experimental models when trying to compare results to endogenous hormone or pharmaceutical actions.

Limitations of the Evidence

Evidence to Practice
Endocrine-Disrupting Chemicals
Andrea C. Gore, PhD
JAMA Internal Medicine November 2016 Volume 176, Number 11

Several challenges remain in the field of EDCs and endocrine health and disease.

Fourth,
humans are typically exposed to EDCs at low dosages and in diverse mixtures.
While some have questioned whether low-dose EDCexposures are relevant, the facts that

(1) hormone receptors have exquisitely high sensitivity to endogenous hormones,
(2) most EDCs do not interact with binding proteins, and
(3) EDCs may be resistant to metabolic breakdown means that EDCs have greater bioavailability and persistence, causing very low dosages to have biological effects.

OUTLINE

1) DEFINITION

2) IMPACT on HUMAN HEALTH

3) EDCs and AIR POLLUTION

ATMOSPHERE

Environment International 76 (2015) 78–97

Endocrine disrupting chemicals in the atmosphere: Their effects on humans and wildlife

Jayshree Annamalai *, Vasudevan Namasivayam

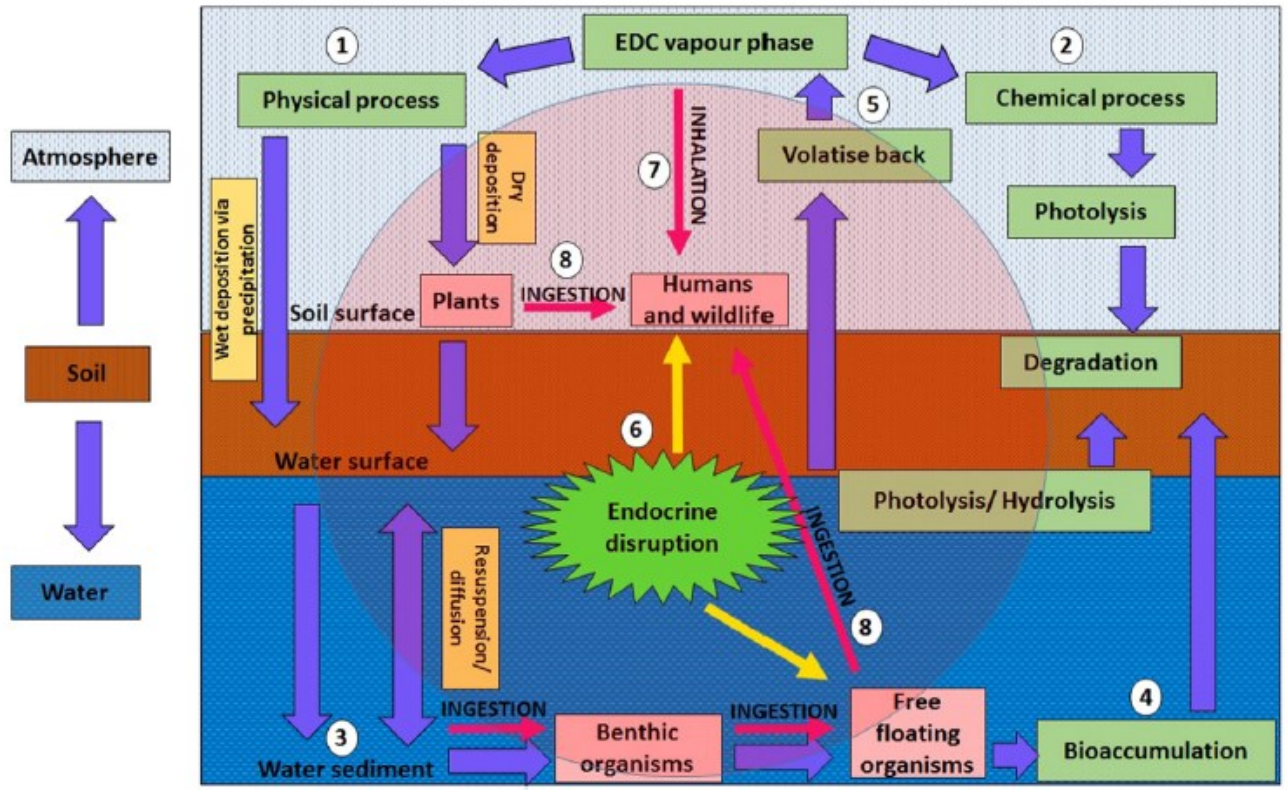


Fig. 2. Fate of EDCs in the environment and interaction with biota: From the atmosphere, EDCs in the vapor phase are transferred to soil surface either by physical process (1) or by chemical process (2). Physical process involves wet deposition and dry deposition while chemical process involves photolysis. Both of the process may ultimately lead to degradation or further transfer of EDC to water bodies (3) where resuspension or diffusion occurs; certain EDCs are adsorbed to the sediments. Bioaccumulation of persistent EDC among aquatic organisms occurs (4) and certain EDCs are volatilized back to the atmosphere (5). In this cycle, human and wildlife exposure are threatened to endocrine disruption (6) via inhalation of EDC from the atmosphere (7) and consumption of EDC deposited primary producers and bioaccumulated tissues of secondary consumers (8).

ATMOSPHERE

Environment International 76 (2015) 78–97

Endocrine disrupting chemicals in the atmosphere: Their effects on humans and wildlife

Jayshree Annamalai *, Vasudevan Namasivayam

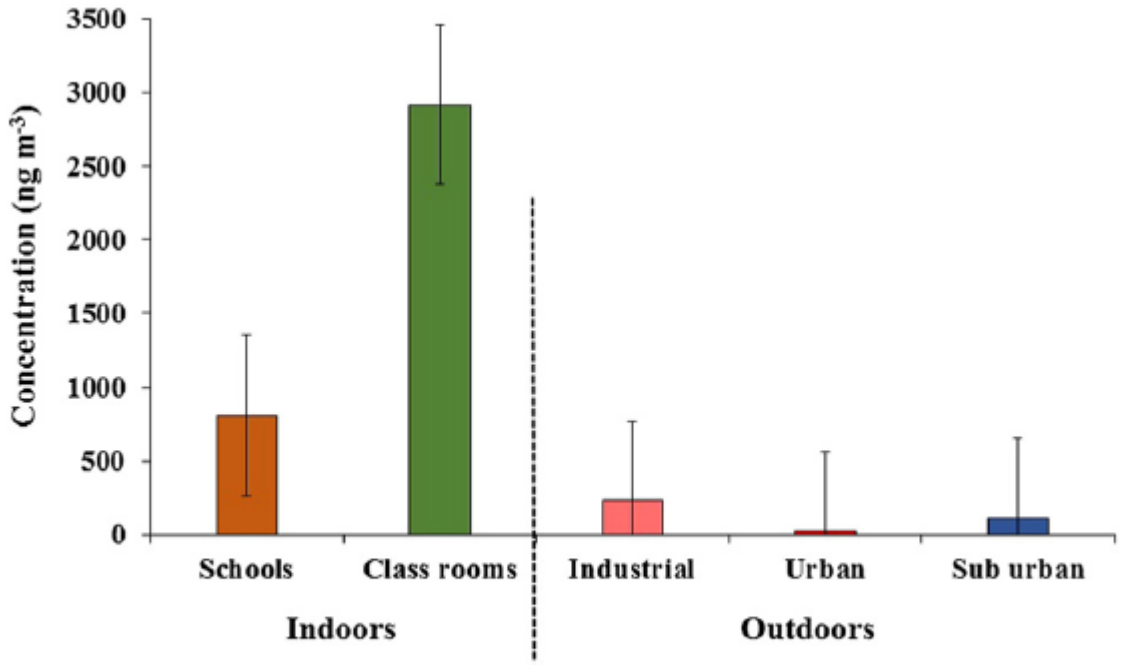


Fig. 5. Graphic illustration of indoor PCBs measured in the Schools of New York City (Thomas et al., 2012); outdoor PCBs at industrial region of Aliaga, Turkey (Elife et al., 2012); and urban and sub-urban areas of Izmir, Turkey (Demircioglu et al., 2011).

ATMOSPHERE

International Journal of General Medicine 2018:11 191–207

Overview of air pollution and endocrine disorders

Philippa D Darbre

Table 2 Sources of endocrine disrupting chemicals measured in air

Chemical	Use	Source of air pollution
Phthalates	Plasticizers to increase flexibility and transparency of plastic products	Plastics, personal care products, air fresheners
Bisphenol A	Manufacture of polycarbonate plastic and epoxy resins	Plastic consumer goods, bottles, sports equipment, CDs, DVDs, coating pipes and food cans, thermal paper
Parabens	Preservatives to prevent microbial action	Personal care products, pharmaceuticals, paper products
Triclosan	Antimicrobial	Hospital scrub, personal care products, kitchen utensils, toys
Alkylphenols	Detergents	Cleaning products, personal care products
Synthetic musks	Fragrance	Personal care products, household cleaning agents, air fresheners, candles
Polybrominated diphenyl ethers	Flame retardants	Soft furnishings
Perfluorooctanoic acid, perfluorooctanesulfonic acid	Stain resistance coatings	Soft furnishings, fabrics
Polychlorinated biphenyls	Industrial lubricants and coolants especially in electrical products	Restricted use since 1970s but ubiquitous persistent organic pollutants
Polychlorinated dibenzodioxins and dibenzofurans	None	By-products of combustion
Polyaromatic hydrocarbons	None	Incomplete combustion of organic materials
Organochlorine pesticides	Pesticides	Agricultural and domestic spraying
Pyrethroids	Pesticide	Agricultural and domestic spraying
Cadmium	Cigarettes	Cigarette smoke
Aluminum salts	Antiperspirant	Aerosol-format personal care products

Review

Current Knowledge on Endocrine Disrupting Chemicals (EDCs) from Animal Biology to Humans, from Pregnancy to Adulthood: Highlights from a National Italian Meeting

International Journal of *Molecular Sciences*

Int. J. Mol. Sci. 2018, *19*, 1647

Maria Elisabeth Street [1,*], Sabrina Angelini [2], Sergio Bernasconi [3], Ernesto Burgio [4], Alessandra Cassio [5], Cecilia Catellani [1], Francesca Cirillo [1], Annalisa Deodati [6], Enrica Fabbrizi [7], Vassilios Fanos [8], Giancarlo Gargano [1], Enzo Grossi [9], Lorenzo Iughetti [10], Pietro Lazzeroni [1], Alberto Mantovani [11], Lucia Migliore [12], Paola Palanza [13], Giancarlo Panzica [14,15], Anna Maria Papini [16], Stefano Parmigiani [17], Barbara Predieri [10], Chiara Sartori [1], Gabriele Tridenti [1] and Sergio Amarri [1]

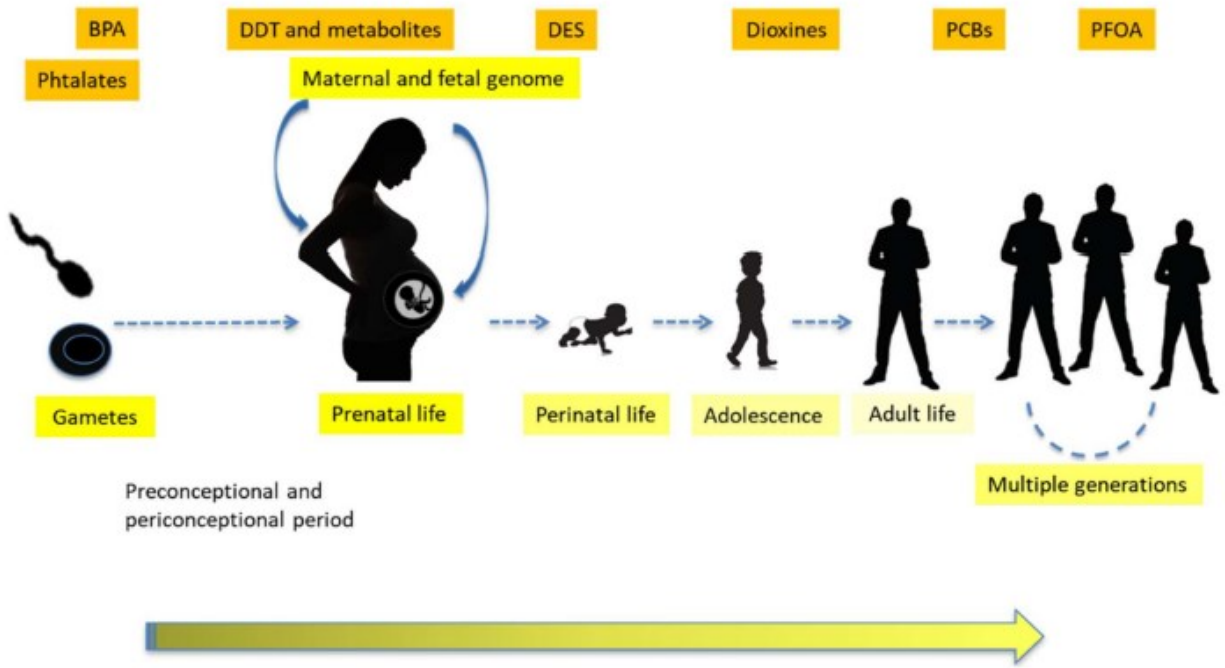


Figure 2. Importance of EDCs driven epigenetic effects during life course and potential consequences across generations according to the Developmental Origins of Health and Disease (DOHaD) theory.

Thank you

sbernasconi3@gmail.com