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Review Article

An outline of endocrine disrupting chemicals and the influencing hormones: what the human society ought to know?

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Abstract

Endocrine-disrupting chemicals (EDCs) are exogenous chemicals that interfere with hormones action, thereby increasing the risk of adverse health outcomes, including cancer, reproductive impairment, cognitive deficits and obesity. A complex literature of mechanistic studies provides evidence on the hazards of EDC exposure, yet there is no widely accepted systematic method to integrate these data to help identify EDC hazards. Significant advances in research into endocrine-disrupting chemicals (EDCs) and their health effects have elevated concerns in recent years about these chemicals among a number of international scientific and health organizations. The research reviewed here provides knowledge about EDC's that health scientists can use to inform their research and decision-making processes.

Keywords: Endocrine disrupting chemicals, hormones action, cancer, reproductive impairment, cognitive deficits and obesity

Introduction:

The endocrine system consists of glands widely separated from each other with no direct anatomical links. Endocrine glands consist of groups of secretory cells surrounded by an extensive network of capillaries which facilitates diffusion of hormones (chemical messengers) from the secretory cells into the bloodstream. They are commonly referred to as the ductless glands because the hormones are secreted and diffuse directly into the bloodstream.[1] A hormone is formed in one organ or gland and carried in the blood to another organ (target organ or tissue), probably quite distant, where it influences cellular activity, especially growth and metabolism. Most hormones are synthesised from amino acids (amines, polypeptides and proteins) or are cholesterol-based lipids (steroids). Homeostasis of the internal environment is maintained partly by the autonomic nervous system and partly by the endocrine system.[2] The autonomic nervous system is concerned with rapid changes, while hormones of the endocrine system are mainly involved in slower and more precise adjustments. The endocrine system consists of a number of distinct glands and some tissues in other organs. Although the hypothalamus is classified as a part of the brain and not as an endocrine gland it controls the pituitary gland and has an indirect effect on many others.

TABLE 1: Endocrine glands & its functions

ENDOCRINE GLANDS	LOCATION IN THE BODY	HORMONE(S) SECRETED BY THE GLAND	FUNCTIONS
Pituitary	Just under the brain, and above the roof of the mouth	1. Growth hormone 2. TSH 3. ACTH 4. LH 5. FSH 6. Prolactin 7. Oxytocin 8. Vasopressin	1. Growth 2. Metabolism 3. Stress and immune responses 4 & 5. Reproduction in both males and females 6. Milk production 7. Milk release during nursing, and uterine contraction during delivery of a baby 8. Electrolyte balance and blood pressure.
Pineal	Next to the base of the brain	Melatonin	24-hour biological rhythms of sleep, wakefulness and activity.
Thyroid	Both sides of the lower throat	1. Thyroid hormones 2. Calcitonin	1. Metabolism 2. Calcium balance.
Parathyroid	Adjacent to the thyroid gland	Parathyroid hormone	Calcium balance
Hypothalamus	Base of brain	1. GHRH 2. TRH 3. CRH 4. GnRH 5. Dopamine	1. Growth 2. Metabolism 3. Stress and immune responses 4. Reproduction 5. Lactation (dopamine is the prolactin-inhibiting hormone).
Pancreas	Abdomen	1. Insulin 2. Glucagon	1 & 2. Blood sugar and other nutrient regulation.
Adrenal	Above the kidney	1. Glucocorticoids (cortisol) 2.Mineralocorticoids (aldosterone) 3. Sex steroids (DHEA and others)	1. Stress and immune responses 2. Blood pressure and water balance 3. Growth of muscle and bone.
Ovary (female)	Abdomen	Sex steroids, especially estrogens and progesterone	Reproduction in females
Testis (male)	Scrotum	Sex steroids, especially androgens (testosterone)	Reproduction in males

1. Endocrine disruptors:

Endocrine Disrupting Chemicals (EDC) often disrupt the endocrine system by mimicking or interfering with a natural hormone. These "hormone mimics" can trick the hormone receptor into thinking the EDC is the hormone, which can trigger abnormal processes in the body. Studies support a link between EDCs and harm to human health, but the cause-and-effect relationship is not yet fully understood. Still some EDCs are known to pose a threat to people who have excessive exposure to them.[3] EDC'S were found in Industrial chemicals can leach into soil and groundwater and then make their way into the food chain and build up in fish, animals, and people, A developing foetus or infant is more vulnerable to the effects of EDCs than an adult because organ systems are still developing. Of the hundreds of thousands of man-made chemicals, it is estimated that about 1,000 may have endocrine-acting properties. Global production of plastics grew from 50 million tons in the mid-1970s to nearly 300 million tons today. Consumer products such as plastics, household chemicals, fabrics treated with flame retardants, cosmetics, lotions, products with fragrance, and anti-bacterial soaps, Pesticides, fungicides, or industrial chemicals in the workplace The best way to avoid exposure is to check labels and avoid products with known EDCs.[4]

EDCs, a broad category of compounds used in consumer products, electronics and agriculture, have been associated with a diverse array of health issues. These non-natural chemicals or mixtures of chemicals can mimic, block, or interfere with the way the body's hormones work. They have been linked to human health issues related to sperm quality, fertility, abnormalities in sex organs, endometriosis, early puberty, nervous system function, immune function, cancers, breathing problems, metabolic issues, obesity, heart health, growth, neurological and learning disabilities, and more. Exposure to EDCs can happen anywhere and come from the air we breathe, the food we eat, and the water we drink. EDCs can also enter the body through the skin and by transfer from mother to foetus (across the placenta) or mother to infant (via breast feeding) if a woman has EDCs in her body.[5] Examples of EDCs include bisphenol A (BPA), phthalates, pesticides, and pollutants such as dioxin and polychlorinated biphenyls (PCBs). People and animals come into contact with EDCs by a variety of routes, including consumption of food and water, through the skin, by inhalation, and by transfer from mother to foetus (across the placenta) or mother to infant (via lactation) if a woman has EDCs in her body.

Common EDC's:

Some common EDCs and their uses include the following:

- **PESTICIDES:** Example EDCs: DDT, Chlorpyrifos, Atrazine, 2,4-D, Glyphosate
- **CHILDREN'S PRODUCTS:** Example EDCs: Lead, Phthalates, Cadmium
- **INDUSTRIAL SOLVENTS OR LUBRICANTS AND THEIR BYPRODUCTS:** Example EDCs: PCBs and Dioxins
- **PLASTICS AND FOOD STORAGE MATERIALS:** Example EDCs: BPA, Phthalates, Phenol
- **ELECTRONICS AND BUILDING MATERIALS:** Example EDCs: Brominated Flame Retardants, PCBs
- **PERSONAL CARE PRODUCTS, MEDICAL TUBING**: Example EDCs: Phthalates, Parabens, UV Filters
- **ANTI-BACTERIALS:** Example EDCs: Triclosan
- **TEXTILES, CLOTHING:** Example EDCs: Perfluorochemicals

TABLE 2: Examples of EDC routes of exposures in humans:

How we are exposed to EDCs	Where the EDCs come from EDC	Example(s)
Oral consumption of contaminated food or water	Industrial waste or pesticides contaminating soil or groundwater	PCBs, dioxins, perfluorinated compounds, DDT
Oral consumption of contaminated food or water	Leaching of chemicals from food or beverage containers; pesticide residues in food or beverage	BPA, phthalates, chlorpyrifos, DDT
Contact with skin and/ or inhalation	Household furniture treated with flame retardants	BFRs
Contact with skin and/ or inhalation	Pesticides used in agriculture, homes, or for public disease vector control	DDT, chlorpyrifos, vinclozolin, pyrethroids
Intravenous	Intravenous tubing	Phthalates
Application to skin	Some cosmetics, personal care products, anti-bacterials, sunscreens, medications	Phthalates, triclosan, Parabens, insect repellants
Biological transfer from placenta	Maternal body burden due to prior/current exposures	Numerous EDCs can cross the placenta (BPA, DES)
Biological transfer from mother's milk	Maternal body burden due to prior/current exposures	Numerous EDCs are detected in milk (alkyl phenols)

2. EDC's & Endocrine diseases:

It has been estimated that, globally, upwards of 24% of human diseases and disorders are attributable to environmental factors[6] and that the environment plays a role in 80% of the mostly deadly diseases, including cancer and respiratory and cardiovascular diseases.[7] Because perturbation of the endocrine system is fundamental to the most prevalent of these diseases, EDCs may be primary contributors. The incidence of endocrine-associated paediatric disorders, including male reproductive problems (cryptorchidism, hypospadias, testicular cancer), early female puberty, leukemia, brain cancer, and neurobehavioral disorders, have all risen rapidly over the past 20 years. The prevalence of developmental disability in US children increased from 12.84% to 15.04% between 1997-2008.[8] The preterm birth rate in the US, UK and Scandinavia has increased by more than 30% since 1981, an outcome associated with increased rates of neurological Introduction to EDCs (December 2014) 17 disorders, respiratory conditions and childhood mortality, as well as obesity, type 2 diabetes, and cardiovascular disease in adulthood. Data from human, animal, and cell-based studies have generated considerable evidence linking EDC exposure to these and other human health disorders. The increased endocrine disease rates parallel increased production of manufactured chemicals. Global production of plastics grew from 50 million tons in the mid-1970s to nearly 300 million tons today. Similar trends hold for other chemical sources including pesticides, fire retardants, solvents, and surfactants. Sales for the global chemical industry have sharply increased from USD$171 billion in 1970 to over USD$4 trillion in 2013. These and other chemicals such as PCBs, BPA, and phthalates, are detectable in human serum, fat, and umbilical cord blood.[9,10]

3. Exposure of humans to EDCs

Exposure to EDCs may also be in the form of pesticides, algicides, and other chemicals designed to kill unwanted organisms. Spraying of homes, agricultural crops, and ponds releases airborne and sedimented chemicals that are inhaled, get on skin, and are ingested from sprayed food. It is not surprising that some of these chemicals are EDCs.

DDT and chlorpyrifos, the first banned in many parts of the world but the second still registered in most countries, appears below. Other routes of exposure to EDCs include food and water containers that contain chemicals that may leach into foodstuffs and beverages. A well-known example is bisphenol A (BPA) and there is growing evidence that substitutes for BPA are also EDCs. Intravenous and other medical tubing contains some classes of known EDCs such as phthalates, allowing direct contact between chemicals and the bloodstream.

The following sections include examples of commonly used EDCs from three categories;

- Pesticides (DDT, chlorpyrifos)
- Utility products (children's products – inorganic lead; electronics – brominated flame retardants)
- Food contact materials (BPA)

These are just a few of the many known sources of EDCs. Other categories include personal care products (phthalates, triclosan, mercury, alkylphenol poly-ethoxylates), textiles and clothing (perfluorochemicals), and building products (high-volume use of brominated flame retardants and chemicals in insulation), among others.

3.1. Pesticides:

Chlorpyrifos

Organophosphorus pesticides (OPs) are some of the most commonly used insecticides worldwide, and chlorpyrifos is a typical OP. It is used to control household pests such as cockroaches, flies, termites, fire ants, mosquitoes, and lice. Chlorpyrifos is used agriculturally to combat pests on cotton, grain, seed, nut, fruit, wine, and vegetable crops. It is also used in forestry, nurseries, food processing plants, on golf courses, and in water supplies to combat larvae, especially mosquitoes. It has numerous other uses, such as impregnated bags to cover ripening bananas in plantations, in cattle ear tags, and in paint. It is acutely toxic to some species that are beneficial to agriculture, such as earthworms and honeybees. There is some evidence that chlorpyrifos can accumulate up the food chain in certain species, and it has been measured in fish in the Arctic as a result of global transport.

Phthalates

Phthalates are a class of plasticizers used to soften polyvinyl chloride (PVCs), add fragrance to a product, or enhance pliability in plastics and other products. Phthalates are classified as low molecular weight (3-6 carbon backbone) and high molecular weight (>6 carbon backbone), with the low molecular weight classes thought to pose the most significant health risks. Phthalates act by interfering with androgen (testosterone) production. Because androgens are critical to male development, including genital development, boys are thought to be most vulnerable to exposure. However, androgens also play important roles in females, making phthalates relevant to both sexes.

Use of some phthalates has been restricted from toys since 1999 in the EU and 2008 in the US. **Phthalates are found in:**

- Shampoo, lotion, nail polish and other personal care products;
- Cosmetics; Baby products including lotion, shampoo, powders and teethers
- Toys
- Scented products such as candles, detergent and air fresheners
- Automobiles (phthalates are responsible for the 'new car' smell)
- Medical equipment including tubing, blood bags, and plastics in the NICU
- Building materials including vinyl flooring, wall paper, paint, glue and adhesives
- Enteric coatings of pharmaceuticals
- Art supplies including paint, clay, wax and ink.

Phthalate exposure is linked to:

- Genital abnormalities in boys
- Reduced sperm counts
- Decreased 'male typical' play in boys
- Endometriosis
- Elements of metabolic disruption including obesity.

3.2. Utility products:

Children's products – Lead

Lead is a naturally occurring element found in the Earth's crust, and its wide spread occurrence in the environment is largely the result of human activity. Major sources of environmental lead pollution include mining, smelting, refining, and informal recycling of lead; use of leaded petrol (gasoline); production and use of lead-acid batteries and paints; jewellery making, soldering, ceramics, and leaded glass manufacture in informal and cottage (home-based) industries; electronic waste; and use in water pipes and solder. Significant sources of exposure to lead still remain, particularly in developing and transition countries. Experiences in developed countries demonstrate that reductions in the use of lead in petrol (gasoline), paint, plumbing, and solder can result in substantial reductions in lead levels in the blood.

In many countries, an important route of entry for chemicals and metals is through consumer products, especially products aimed at children. More than 100 out of 569 (18%) children's products tested by IPEN (2012) in Armenia, Belarus, Kazakhstan, Kyrgyzstan, Russia, and Ukraine contained lead levels that exceeded local regulation limits for lead in soil. In the Philippines, 15% of 435 children's products tested by IPEN in 2011 contained lead at or above the US regulatory limit. Similar tests by IPEN of 500 children's products in five cities in China in 2011 revealed 48 products (10%) that contained lead at or above the regulatory limit in China and 82 products (16%) that exceeded the 90 ppm regulatory limit for lead content in paint used in the US and Canada.

Electronics

Polybrominated diphenyl ethers (PBDEs) are persistent organic pollutants (POPs) that have widely been used as flame retardants in consumer products since the 1970s including computers, electronics and electrical equipment, textiles, foam furniture, insulating foams, and other building materials.[23] Historically, three different mixtures known as Penta BDE, Octa BDE, and Deca BDE have been commercially available. The predominant use of Penta BDE has been in polyurethane foam within furniture, while Octa BDE and Deca BDE have been used in electronics and other plastic products. In many countries Penta BDE and Octa BDE have been phased out and replaced by other brominated flame retardants, including Fire master 550, tetra bromo bisphenol A (TBBPA) and hexabromocyclododecane (HBCD).[24] Due to their persistent and bio-accumulative properties, and ability to transport long distances, Penta BDE, Octa BDE and HBCD have been added to Annex A of the Stockholm Convention for global elimination.[25] Deca BDE is currently under evaluation for addition to the Convention and is still widely available in developing countries. A brief summary on the recent San Antonio Statement on brominated flame retardants (BFRs). Nearly 150 scientists from 22 countries have now signed the "San Antonio Statement on Brominated and Chlorinated Flame Retardants" presented at the 30th International Symposium on Halogenated Persistent Organic Pollutants, held in 2010 in San Antonio, Texas. The San Antonio Statement addresses the growing concern in the scientific community about the persistent, bio-accumulative, and toxic properties of brominated and chlorinated organic flame retardants (BFRs and CFRs, respectively) and the exposure to humans and wildlife as a result of intensive use. The scientist signatories are experts on the health effects and environmental fate of BFRs and CFRs and environmental contaminants in general. The International Panel on Chemical Pollution (IPCP), an international network of scientists working on various aspects of chemical pollution, also has approved the statement. The statement calls attention to a continuing pattern of substituting one dangerous flame retardant for another, and recommends improved use and disposal of BFRs and CFRs, use of safer alternatives, as well as better labelling and availability of information about BFRs and CFRs in consumer products. Finally, it calls for more scientific attention to the actual need for flame retardants in products.

3.3. Food contact materials:

Bisphenol A

BPA is found in a variety of food containers such as hard, rigid plastics, and the epoxy-based linings of canned foods. Until the past few years, most rigid, reusable plastic containers, such as water bottles, were made of polycarbonate and contained BPA. Now, alternative, BPA-free products, made from different materials, are readily available. Because of rising health concerns, use of BPA in some plastic containers, such as baby bottles, is now banned in many countries and being voluntarily reduced or phased out in others. BPA remains a common component of the epoxy resins that line the interior of canned foods such as soup, canned vegetables, and beans. This liner is important because it helps protect the contents from contamination by pathogens, which can cause serious food-borne illnesses such as botulism. Not all can linings contain BPA but it is impossible for the consumer to know which do and which do not. BPA can leach from these linings into the food, thereby exposing consumers. Other common household products containing BPA include polycarbonate eyeglasses, thermal paper receipts, and plastic water pipes. In 2010, The Chapaevsk Medical Association (CMA) tested 21 food samples from three Russian cities for levels of BPA, and found that 81% of the samples were contaminated. Canned infant food was found to have some of the highest levels of contamination. Results were shared at several seminars and workshops with physicians, chemists, government officials, industry leaders, and other NGOs. Among other recommendations, CMA suggests continued bio-monitoring in humans (particularly infants) for BPA levels, implementing epidemiological impact studies in the general public, and starting a public information and awareness campaign about the dangers of BPA in foods and consumer products.

4. EDCs effects on glands:

EDCs can **interfere with the steps in hormone signaling**. They can trick a receptor by mimicking a hormone, which can turn on a hormone response and inappropriately trigger hormonal processes. Or they can bind to a hormone's receptor and block activation, prevents appropriate hormonal processes from taking place.

4.1. Pituitary gland:

The diencephalic system represents a preferential target of EDCs, which may alter proper function of CNS mimicking neurotransmitter actions, beside their ability to bind endocrine receptors.[11] Several EDCs act on the pituitary gland, therefore influencing the different endocrine axes: as a result, a wide spectrum of clinical manifestations has been associated with exposure to pollutants, such as precocious/delayed puberty and circadian disruption.[12]

4.2. Reproductive system:

As the chemical structure of most of EDCs mimics sex gonadal hormones and has the ability to bind to endocrine receptors interfering with hormonal signals, reproductive system represents the most vulnerable endocrine axis to EDCs actions. The US EPA described five classes of EDCs endowed with anti-androgenic properties and, simultaneously, with weak estrogenic activity: Drugs or synthetic estrogens (i.e., 17 β estradiol, diethylstilbestrol), Phytoestrogens (i.e., isoflavonoids, cumestans, lignans, stilbens), Pesticides (i.e., organophosphates, carbamates, organochlorines, synthetic pyrethroids); Plasticizers and chemicals produced by incomplete combustion of polyvinyl chloride (PVC), Paper and Putrescible substances (i.e., dioxin); Industrial substances and their by-products (i.e., phenols, dioxins, heavy metals, perfluorooctanoic acid, flames retardants).[13,14] The timing of EDC exposure should be considered when assessing their effects on the organism; especially in the initial stages of development, when the mammalian organism is extremely sensitive to disturbing agents, exposure might have more pronounced and long-lasting effects. It is therefore unsurprising that prenatal exposure may result in significant changes. The effects of EDC on ovarian development have mainly been investigated using animal models or in vitro systems. Collectively, the collected data in the literature have shown that some EDC exposures damage the developing ovary by interfering with germ cell nest destruction, meiosis, follicle formation and vitality. Early postnatal exposure to EDCs may results in significant changes in genetic transcription of somatic cells, altering the proper timing of physiological process of puberty which may be delayed or anticipated. Furthermore, EDCs appears to have a consistent role in decreasing both male and female fertility; testicular hypotrophy and ovarian polycystic syndrome (PCOS) seems to be associated to EDCs exposure. In particular, EDCs seems to have a causative role in the onset of testicular dysgenesis syndrome (TDS). Impaired spermatogenesis, testicular cancer, undescendent testis and hypospadias may be considered the symptoms of a developmental disorder, TDS, an increasing disease due to adverse environmental influences. Experimental and epidemiological studies show that TDS is the result of an interruption of physiological embryonal programming and gonadal development during fetal life. Generally, in the most severe forms low serum testosterone is observed[15] and an increased risk of testicular cancer compared to milder forms has been highlighted. Phthalates, vinclozolin, acetaminophen, and polybrominated diphenyl ethers (PBDE) seem to play a significant etiopathogenetic role in the onset of TDS. In female, there is little evidence regarding the effects of EDCs on fertility. Nevertheless, this data seems to suggest that long-term exposure to EDCs may alter female fertility.[16] In particular, EDCs appears to have an etiopathogenetic role in the onset of endometriosis and of ovarian pathology.[17] Phthalates, Diethylstilbestrol, Bisphenol A (BPA), TCCD may be involved in the onset of endometriosis occurring in 10% of fertile women, causing infertility in 50% of affected subjects. Ovarian pathology seems to be related to the exposure to: PCB, phthalates, atrazine, genistein, BPA, TCDD, parabens, triclosan, Dichlorodiphenyltrichloroethane (DDT), and Metoxychloride (MXC). Even in males, reproductive function may affected by pollutants and EDCs, but evidence is scarce; EDCs, such as phthalates, bisphenol A, biphenyls, and vinclozolin, widespread use of therapeutic drugs, obesity and sedentary life-style may play a crucial role in this supposed decrease of male fertility.

4.3. Adrenal gland:

Only a few studies have assessed the effects of EDC on the adrenal gland, especially concerning the risks related to exposure to chemicals. This paucity of evidence is not easily comprehensible, considering that the proper functionality of HPA axis is necessary for human life and it is a common target for many drugs and chemicals. Indeed, adrenal glands present some structural and biochemical features that make them ideal targets for EDCs, such as an elevated blood flow, lipophilic structure due to the high content in polyunsaturated fatty acids in cell membrane, and presence of CYP 450 enzymes producing toxic metabolites and free radicals.[18] The most studied effect of EDCs on this axis is represented by their ability to interfere with the biosynthesis and metabolism of steroidal hormones through the modulation or the inhibition of enzymes involved in steroidogenesis. Aromatase, 5-α reductase, as well as 3-β, 11-β, 17-β hydroxysteroid dehydrogenases have a crucial role in metabolic pathways of adrenal steroidogenesis and their proper function is affected by EDCs, in particular xenoestrogens impair adrenal function inhibiting these enzymes. Also, Steroid Acute Regulatory Protein (SARP), which regulates the first step of adrenal steroidogenesis, is a target of EDCs.[19] Hundreds of chemicals and drugs may interact with HPA axis and every step of steroidogenesis may be affected by EDCs as well as each chemical disruptor may act altering different step of steroidogenesis.[20] In evaluating the pathologic effects of EDCs on HPA axis, it should be considered that even a partial impairment of proper adrenal function may have severe effects on human health. In this perspective, bioaccumulation of these chemicals in adipose tissue might generate a "cocktail," with clinical effects that may be observed only after several years of constant, low-dose exposure. Hexachlorobenzene is among the chemicals which is able to disrupt corticoid hormone function in Wistar rats.

4.4. Thyroid gland:

Several environmental chemical substances are known to alter iodine absorption by inhibiting the Sodium-Iodide symporter channel (NIS): in particular, perchlorate and thiocyanate are able to affect thyroidal metabolism inhibiting NIS. This channel transports iodine inside thyrocytes and, considering the pivotal role played by iodine in the biosynthesis of thyroid hormones, it is comprehensible that an alteration of NIS may impair thyroid function. High levels of perchlorate are present in explosives, fertilizers, and in air-bags.[21-23] A survey performed by National Health and Nutrition Examination Survey (NHAMES) 2001– 2008 suggests its presence also in foods, such as milk, vegetables, fruits, eggs in USA. Thiocyanate is present in cigarette smoke and in Brassicaceae. Braverman et al. observed 3,100 subjects exposed to perchlorate, thiocyanate, and nitrates; this exposure resulted in a significative decrease of free thyroxine levels, which was more marked in pubertal subjects and it was not associated to increase of TSH levels.[24] Perchlorate, thiocyanate, and nitrates are widespread and their presence is not limited to industrial products, but many foods and potable water are contaminated by these EDCs. They are able to cause a loss of function of NIS binding to NIS and blocking iodide transporter. As a consequence, a lower iodine bioavailability may result in hypothyroidism, even more if the exposure to high doses is prolonged in certain area affected by iodine deficiency. No conclusive result can be drawn from current data, but iodine supplementation in pregnancy and in children may protect from the action of these EDCs. Further studies should investigate the dose-effects relationship in these regards.[25]

Conclusion:

The present review finds convincing evidence of the contribution of endocrine-disrupting chemicals to the emerging global society, sufficient to argue for the recognition of EDCs. Today, humans and wildlife are constantly exposed to thousands of chemical residues, through air, food, and water. Daily use of chemical products is an essential part of our modern society and it had improved our quality of life, but the resulting environmental pollution has the potential to cause harmful effects on humans and to the environment. Early life exposure to EDCs possibly results in increased levels of Attention-deficit/hyperactivity disorder, immunity, metabolism, puberty, reproduction, anxiety, modified levels of exploratory behaviour, reduced social interaction or increased aggression, recognition learning and memory. People and biota are constantly and chronically exposed to thousands of chemicals from various environmental sources through multiple pathways. To avoid EDCs exposure, prevention & protection strategies for individuals and policy makers/authorities should be developed and implemented. Future research in the field is crucial in an effort to unravel the potential perilous toxic effects of early life exposure to EDCs even in low doses.

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