

A Review on Endocrine Disrupting Chemicals

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Received: January 17, 2022

Published: January 28, 2022

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Abstract

The hormone biosynthesis, metabolism, or function, are deviated from normal homeostatic control or reproduction due to Endocrine-disrupting chemicals which are present in food, consumer products and our surrounding environment. We offer data that endocrine disruptors show consequences in reproduction system of both male and female, many types of cancer like prostate cancer, and also disease related to Neuroendocrinology which are stated in Scientific Statement of The Endocrine Society. EDCs is a major public health concern as per the epidemiological investigations and also clinical observations in humans. The mechanism of EDC involves different kinds of pathways, which includes peroxisome proliferator-activated receptor; Thyroid, estrogenic, anti-androgenic, and many other actions through receptors on nucleus or neurotransmitters, enzymes etc. Humans and wildlife animals can also be used as models in many other pathways. Furthermore, EDCs encompasses a wide range of compounds, including organo chlorinated pesticides and industrial chemicals, plastics and plasticizers, fuels, and a variety of other chemicals found in the environment or in common use.

Keywords: Endocrine Systems; Endocrine Disruptors; Affect the Humans and Wildlife; Avoid Using Plastic Bottles; Metals; Pesticides; Fertilizers

Introduction

The glands in the endocrine system secrete chemical substances. This chemical substances are called as hormones, which govern the functioning of cells or organs. Cell growth, metabolism and sexual development and their functions are regulated by hormones. Hormones which are released into the bloodstream show its effect on one or more organs in our entire body [1].

Hormones are chemical messengers that the body produces. They information is transferred from one cell to another cell to maintain the functions and coordination between different parts of the body. The major glands of endocrine system are adrenal, pituitary, hypothalamus, thyroid, reproductive organs and parathyroid. The pancreas is also considered as part of this system as it

plays a major role in production of hormones and also digesting them.

Feedback mechanism regulates the endocrine system in a same way as the temperature in the room is regulated by thermostat. Brain sends the signal in the form of "releasing hormone" to the pituitary gland, which in turn stimulates the pituitary to release a "stimulating hormone" into the blood to reach their target site. The stimulating hormone then instructs the target gland to release its hormone. The releasing and stimulating hormones are inhibited when their concentration in the blood rises and the concentration of hormones at their target site also decreases gradually. This approach results in stable blood concentrations of pituitary gland-regulated hormones.

Figure 1**Figure 2****What are EDCs?**

the function of the body's hormones are altered and disrupted by certain substances or chemical mixtures are called as EDCs. Some EDCs work as "hormone mimics," fooling our bodies into thinking they are hormones, while others prevent natural hormones from accomplishing their job. Other EDCs can impact how hormones are created, broken down, or stored in our bodies, causing them to raise or decrease their levels in our blood. Finally,

some EDCs can alter our body's sensitivity to two separate hormones [1].

Negative human health outcomes like Learning disabilities, metabolic problems, respiratory issues, quality of sperm and issues in fertilization are linked to EDCs.

How are they exposed?

People are exposed to EDCs in a variety of ways, including the air we breathe, the food we consume, and the water we drink, because they come from a variety of sources. EDCs can also pass through the skin and enter the body.

Example of common EDC sources:

- The soil and groundwater which contains industrial chemicals and pesticides thus they can enter the food chain by accumulating in fish, animals, and humans.
- Pesticide residues can be found in non-organic vegetables.
- Some consumer products like soaps, lotions and some cosmetics contain EDCs or are packed in containers that can leach EDCs.
- The materials used in production, processing, shipping, and storage if they contain EDCs can leach and accumulate in processed foods.
- Estrogen-mimicking substances generated by plants like Soy-based food contain phytoestrogens.
- Due to weathering the EDCs accumulate in materials such as lead, flame retardants, PCBs and also in household dust.
- Building material or furniture [1].

Effects of EDCs**Response towards psychological stress**

Changes in neurological and behavioral

- It reduces the ability in stress handling.

Metabolism

Obesity and type 2 diabetes are observed to be caused by EDCs, while impaired functioning of thyroid is due to flame retardants and industrial chemicals.

Reproduction

The sex hormones of both male and female are stimulated or inhibited by some EDCs like PCBs, DDT etc. which effects reproductive health of the individual [7].

Thyroid function can be harmed by several industrial pollutants and flame retardants.

Growth and development

Disruption of sexual development, weakening of immune system and atlered growth of the baby is due to high exposure to EDCs during gestation.

Cancer

- The growth of breast and prostate cancers is accelerated by EDCs which mimic estrogen and androgen.
- Some EDCs may affect mammary gland development and raise the risk of breast cancer later in life if they are exposed to them during pregnancy [3].

List of EDCs

Chemical	Effects	Source
BPA	Mimics actions of oestrogen, causes breast cancer and heart diseases	Lining of food cans, polycarbonate plastic bottles
Dioxin	Reduces the sperm quality, promotes cancer development	Mostly found in farmed fish
Atrazine	Promotes breast tumours, prostate inflammation and delays puberty.	Industrially farmed corn
Phthalates	Promotes obesity, diabetes, thyroid dysfunction	Plastic food containers, PVC plastic wraps.
Perchlorate	Promotes thyroid Disfunction	Found in foods and drinking water.
Lead	Reduces sex hormone Promotion	Drinking water and old paints
Mercury	Impairs foetal brain development, disrupts female reproductive hormone balance.	Sea foods contaminated by indus-trial run off
PFC's	Reduces the sperm quality, promotes kidney diseases, thyroid disfunction and high cholesterol	Nonstock cookware.

Table a

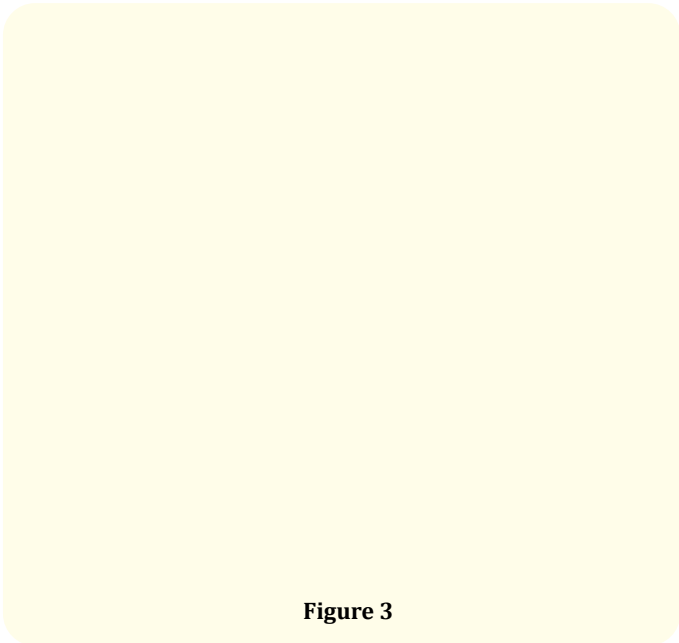


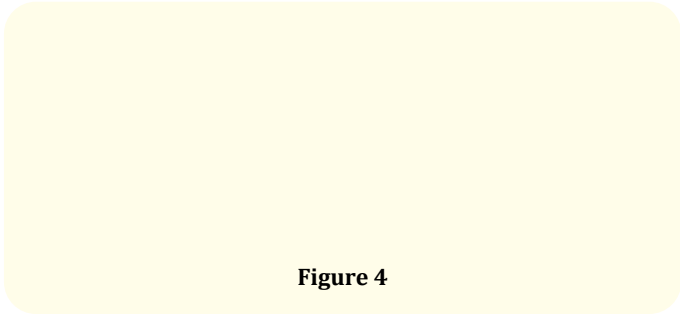
Figure 3

How do EDCs work?

Endocrine disruptors can:

- Overstimulation is due to duplicating or partially mimicking the existing natural hormones like estrogen and androgens thus it prevents the endogenous hormone binding to its receptor.
- Thus the body is unable to respond to the signal. Anti-estrogens and antiandrogens are examples of compounds that block or antagonize hormones.
- For example by altering their metabolism in the liver we can block, interfere and control the production of natural hormones [2].

When endocrine disruptors are injected into the body. The normal hormone levels may be increased or decreased; they may also show effects on hormone production as well as mimic natural hormones.

**Figure 4**

Bisphenol a: An endocrine disruptor

About 67 percent of the bisphenol A product is used to make polycarbonate, and the remaining 30 percent is utilized to generate epoxy resin. The remaining 3% is incorporated into other goods. Polycarbonate plastic is involved in the production of everyday items like including water bottles and also equipments in medical and sports. Epoxy resins are utilized as coatings on practically all food and beverage cans are coated with epoxy resins in order to prevent the reaction with the metal. Plastics goods which are made up of polycarbonate such as water bottles, dinnerware, and containers to store food, the BPA from the containers may migrate into food [3].

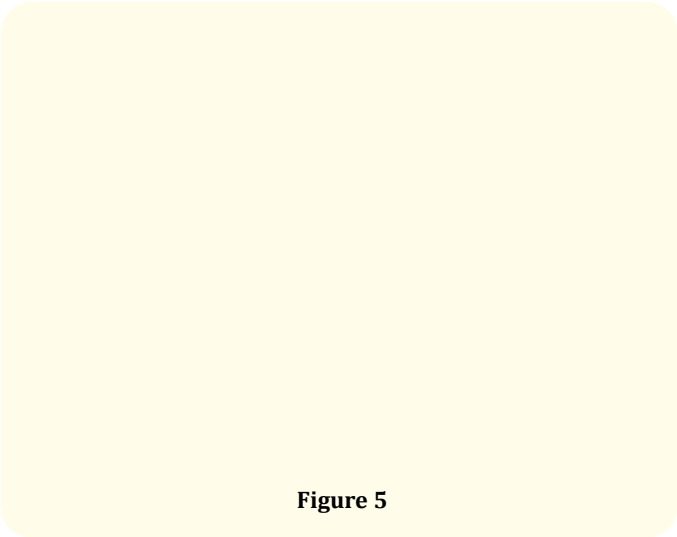
Routes of exposure to bisphenol A

Through an animal or a human through eating, inhalation, or skin contact Bisphenol A may enter. The polycarbonate bottles and cans from bisphenol A which are coated with epoxy resins may contaminate the food and drinks.

Mechanism of action

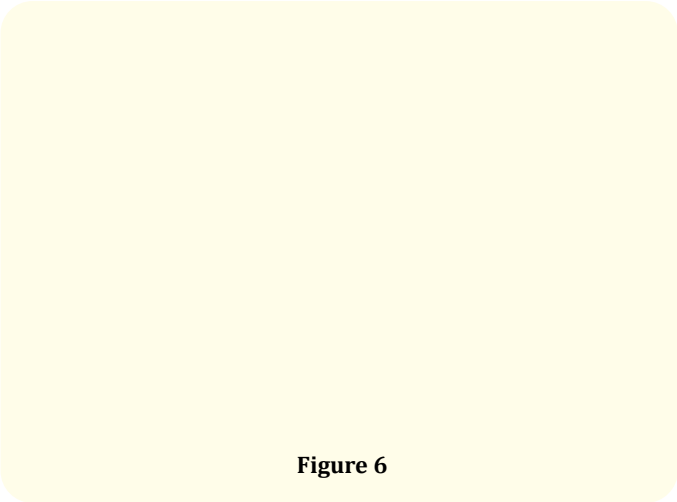
BPA binds to the receptor of estrogen and activates it as it is a xenoestrogen. Although BPA has a lower affinity for genomic ER than estradiol, its circulating concentrations are greater and within a physiologically active range. Furthermore the responses due to signals of nongenomic, the BPA bioactivity is least as it is estradiol [4].

BPA prevents binding of androgens to androgen receptor as it is an antiandrogen. It can also affect the steroid hormone synthesis and circulating steroid hormone concentrations, as well as thyroid hormone synthesis, as BPA inhibits the conversion of T4 (thyroxine) to T3 (thyroid hormone) (triiodothyronine).

**Figure 5**

Effects of BPA

BPA has a number of negative effects on your health. The diseases like asthma, metabolic disease, cardiovascular disease, diabetes are associated with toxin substances. The major source of side effects is that the BPA is soluble. This implies that the bond formed by the plastic can be disrupted when it comes into touch with liquids or when it is heated, allowing BPA to leak into the contents of your meal or beverage [5].

**Figure 6**

The possibilities to reduce the exposure of bisphenol A

Plastic containers should not be used to heat food. Avoid cooking food in plastic containers since heat might release toxins. This is the only main reason that cold liquids in plas-

tic containers have to be consumed. So the Plastic containers should be washed only with detergents which are mild since harsh detergents help to liberate chemicals from plastics, so that it may lead to leaching of chemicals into the food.

Figure 7

The plastic bag packed with waste food should not be thrown on roads, because cattle eat them and get exposed to BPA. Stop using plastic containers in animals for feeding, watering, and other purposes on a regular basis, and avoid washing these plastic containers with harsh detergent or soap.

Lead

Lead is abundant in nature, particularly in rocks in various combinations. However, due to widespread contamination, lead is widely dispersed in the environment in the form of air, water, soil, vegetation, and animals. Pb contamination of humans and animals occurs by ingestion, inhalation, or transdermal contact. Lead can be ingested by people through occupational and environmental sources. This is mostly due to: Lead particles may be inhaled by gas produced by burning of materials which contains lead, and drinking lead contaminated water. The Use of some unregulated cosmetics and medications is another source of exposure. Certain types of kohl, as well as numerous traditional treatments used in India, Mexico, and Vietnam, have been found to have significant levels of lead. As a result, people should only buy and utilize products that are controlled. Because they absorb 4-5 times the amount of lead ingested as adults from the same source, young children are more vulnerable to lead poisoning. Furthermore, children's inherent curiosity and age-appropriate hand-to-mouth action lead to them

mouth and ingesting lead-containing lead-coated objects such as contaminated dirt or dust, as well as flakes from decomposing lead-containing paint. The lead present in door frames, furniture and painted walls is another route of exposure as children pick and eat it. The poisoning of lead is due to soil contaminated with lead and also dust filled with lead [2].

Effects

Lead is transferred to organs such as the brain, kidneys, liver, and bones after its entry and gets accumulated in teeth and bones. It is exposed to the fetus when they get exposed during pregnancy and lead may be transferred into the blood from the bone deposits. Malnourished Children are especially prone to lead poisoning especially lack of nutrients in the body and also in calcium and iron deficiency. It majorly occurs in very young and poor people.

Phthalates

The flexibility, transparency, and durability in plastics are increased by adding phthalic acid ester also known as Phthalates. These can be found in inks, paints, adhesives, and even certain food, cosmetics, and medications.

Exposure to phthalates

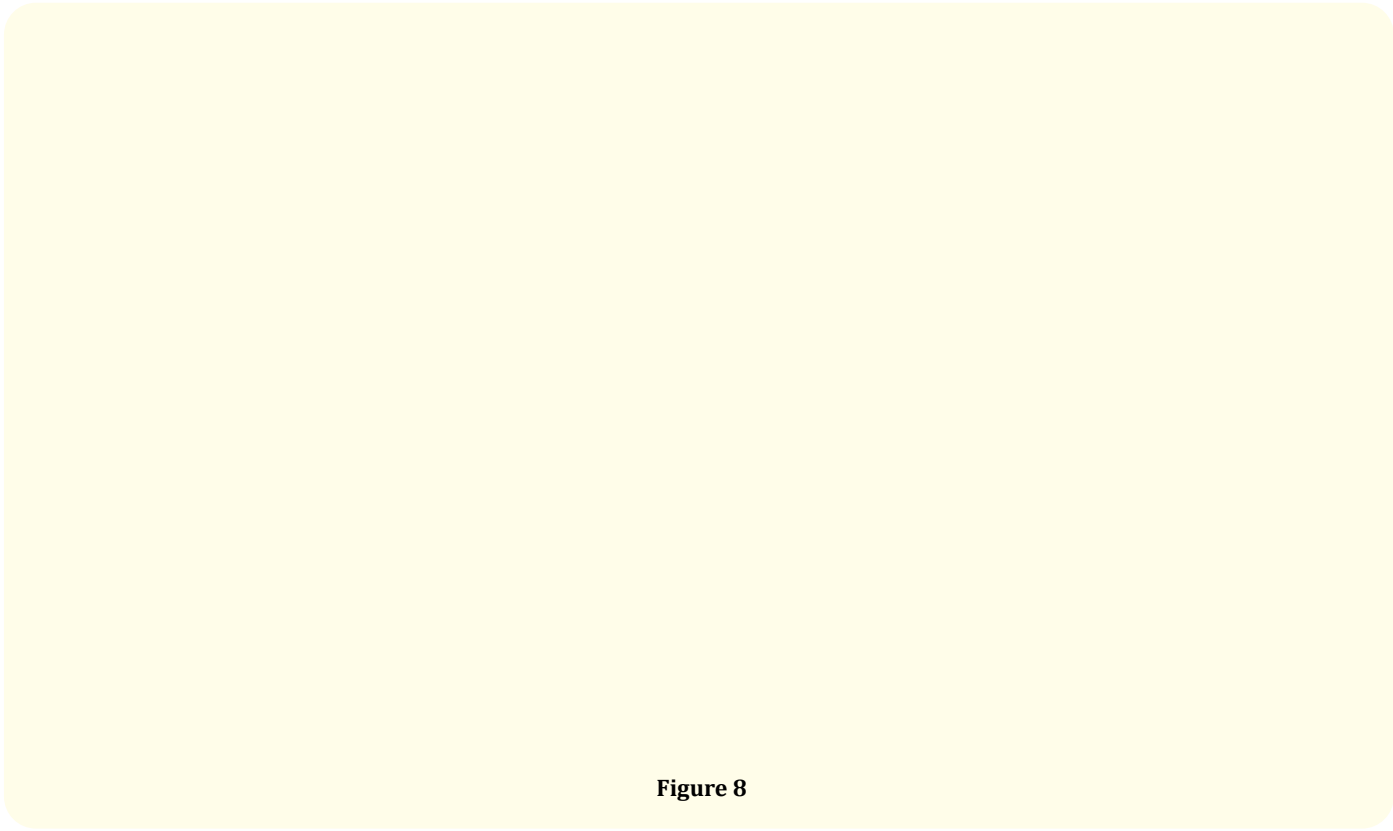
Phthalates are entered into our body through consuming the food which are exposed to phthalates, inhalation and dermal contact. Children have the highest overall dietary DEHP intake, followed by adolescents under the age of 19. Phthalates may be present in herbal preparations and nutritional supplements, particularly those indicated for use during pregnancy. Dermal exposure to phthalates such as DBP, which are used in many cosmetics such as perfume, hair gels, hair sprays, lotions, nail paint, and so on, may also be key routes of exposure [2].

Effects of phthalates

Male reproductive disorders such as hypospadias and poor sperm count are more likely. It also serves as an excuse to gain weight and also to have resistance to insulin. Phthalates also interfere with glucose metabolism by affecting pancreatic -cells.

Dioxins

- Chemical contaminants come under the class of Dioxins and it is also known as persistent organic pollutants.

**Figure 8**

- The world environment is abundant with dioxins so that they accumulate in the food chain, primarily in animal fatty tissue.
- More than 90% of exposure to humans occurs through food cultivated in soil, primarily by animal meat and dairy products, as well as sea fish and shellfish. Many national governments have food supply monitoring programs in place.
- Dioxins are highly hazardous and can cause reproductive and developmental issues, immune system damage, hormone interference, and cancer.
- Because dioxins are ubiquitous, everyone has been exposed, which may not harm the health of humans. Human exposure is best prevented or reduced through source-directed methods, such as careful management of industrial operations to limit formation.
- Dioxins persist in the body for a long period due to their chemical stability and tends to be absorbed by adipose tissue, where they are then retained. It is believed that their half-life in the body ranges between 7 and 11 years. So Dioxins may likely to get accumulated in the food chain in the environment. The concentration of dioxin increases as an animal moves up the food chain [10].

Sources of dioxin contamination

Dioxins are primarily byproducts of industrial operations, but they can also be produced naturally by volcanic eruptions and forest fires. Dioxins are unintended byproducts of a variety of manufacturing processes and also produced from the insecticides and herbicides. Due to burning incompletely, incinerators of waste are unregulated frequently the worst perpetrators in terms of dioxin emission into the environment. There is technology available that enables regulated waste incineration reduced dioxin emissions.

There are extensive stockpiles of PCB-based trash and industrial lubricants, many of which contain significant amounts of PCDFs, all over the world. The release of dioxins into the environment is due to storage for longtime and unusual disposal as well as pollution of human and animal food supplies. PCB-based garbage is difficult to dispose of without endangering the environment and human populations. Such stuff must be processed as hazardous waste and incinerated in specialized facilities using high-temperature incineration [2].

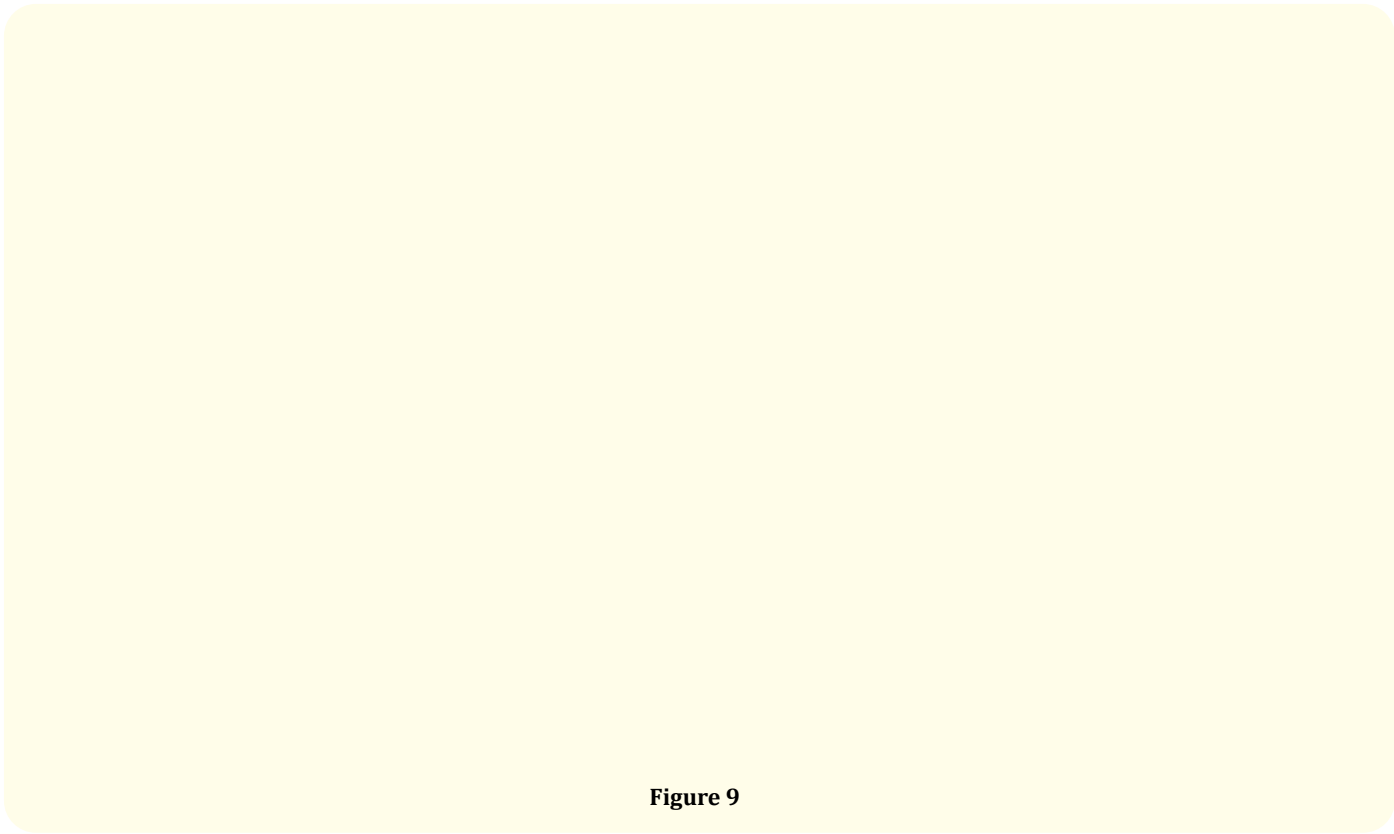
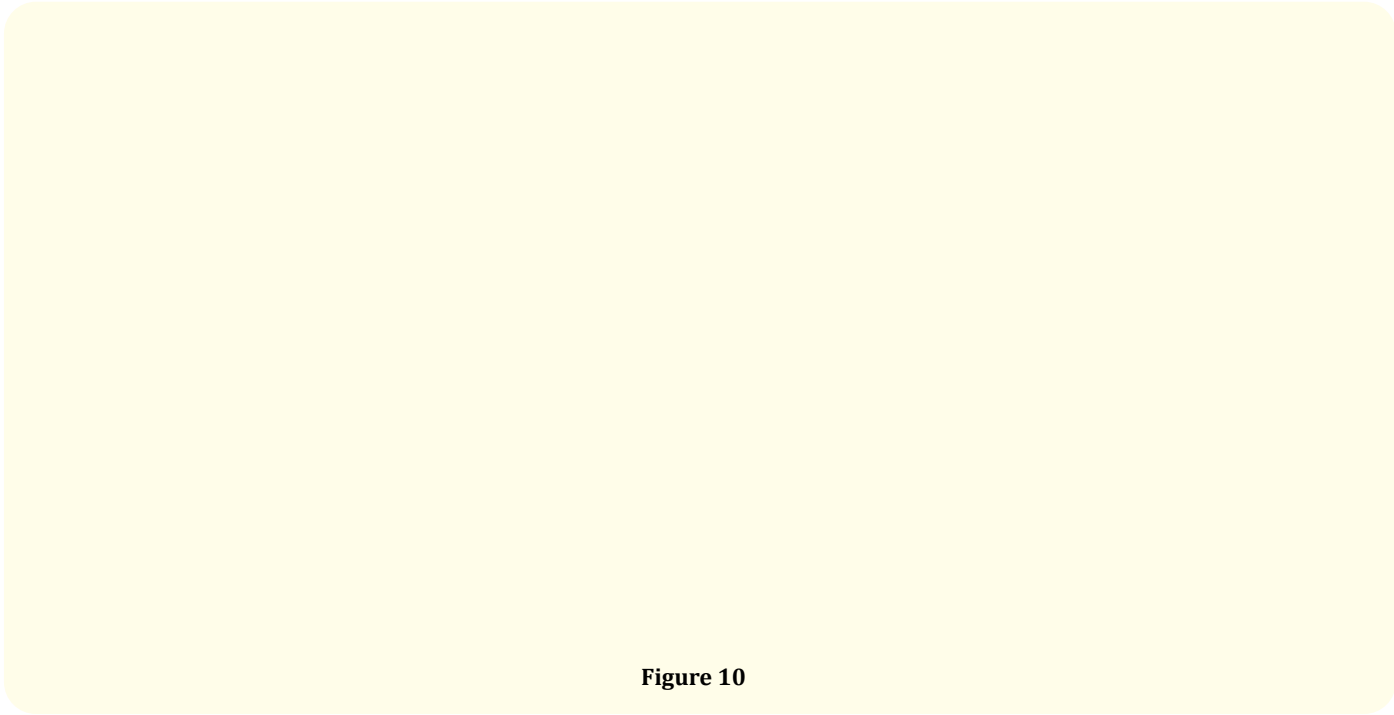


Figure 9

**Figure 10**

Dioxins effects on human health

Humans exposed to high quantities of dioxins for a short period of time may develop lesions related to skin such as chloroquine and spotty, dark skin, and altered function of liver. Long-term exposure has been associated to immune system, developing neurological system, endocrine system, and reproductive function damage [9].

Chronic dioxin exposure in animals has resulted in numerous types of cancer. Because dioxins are ubiquitous, everyone has background exposure and a certain quantity of dioxins in their bodies, resulting in the so-called body burden.

Sensitive groups

Dioxin exposure is more dangerous to the developing fetus. Because newborns' organ systems are still developing, they may be more exposed to certain impacts. Many of the individuals may get exposed to dioxins and their levels gets increased through the food they ingest [3].

Prevention and control of dioxin exposure

The Human exposure to dioxin is reduced and prevented through best accomplished through directed methods, such as careful management of industrial processes to prevent dioxin generation as much as feasible.

The contamination of feed and food is monitored through certain mechanisms which guarantee that tolerance levels are not exceeded. The protection of public health is monitored by official of national government by ensuring the manufacturing methods of raw materials and taking the responsibility of safe production. Countries should have contingency procedures in place to identify, hold, and dispose of tainted feed and food when contamination is suspected.

Mechanisms of actions of phthalates, BPA, dioxins

Avoiding EDCs

Consume food from plants

The meat and products of diary are rich in dioxins and they are known disruptors of endocrine. The dioxins levels in the body are reduced by taking plant products in our diet and by avoiding the meat in our daily diet.

Swap non-stick cookware for cast iron or stainless steel

The nonstick pans are coated with perfluorinated chemicals and they enter our body in contact with food and acts as disruptors of endocrine. Instead, consider a cast iron pan—when properly seasoned, a cast iron pan can provide a silky, non-stick surface.

Avoid using plastics, not just BPA

All the plastic container and bottle which are sold as a free of BPA they may not be sure and it is not safe to use. Recent research has connected BHPF, a chemical contained in BPA-free plastics, to adverse consequences similar to those of BPA. Instead of plastic, consider glass, high-quality food-grade silicone (stature only utilizes the best), stainless steel, or beeswax covers created from fabric and a unique beeswax/resin mixture [6].

Beauty products labels has to be checked

The cosmetics like shampoos, lotions, perfumes etc. contains Parabens which are the chemicals of endocrine disruptors. Look for items with brief ingredient lists that are packed with easily recognizable ingredients [7].

Filter your water

Arsenic and perchlorate, among other hormone-disrupting chemicals, can be found in tap water. Invest in an excellent water filter to remove these particles and keep your water pure and fresh.

Avoid the fake stuff

Avoid using synthetic aromas, softeners of fabrics and air refreshers as all of them contain phthalates, so we have to find alternative for them [4].

By sterilizing air through HEPA filter

The dust entering into our surroundings may contain many endocrine disruptors so it better to filter the air or dust enters into our home by using HEPA filters and also by covering vacuum cleaner with this filter we can reduce the disruptors.

Personal care products

Hormonal balance is effected by ingredients used in cosmetics, moisturizers, shampoos, and conditioners. To prevent exposure, switch to cleaner, greener personal care products and reduce overall use. Consider wearing less makeup or not wearing it at all on weekends. By using the shampoo less frequently and by also diluting the shampoo before using scalp should be done [4].

Use of fruits and vegetable

The wastage obtained from industries, and also by using Pesticides, herbicides during cultivation may get contaminated and act

as an endocrine disruptor. By taking food from local farms and by gardening vegetables may help to maintain good health.

Conventional use of farmed meat, poultry, and dairy product

The commercial products includes like antibiotics, hormones, and industrial additives. By buying the product from local farms or gardening the vegetables may decrease the exposure to harmful endocrine disruptors [7,11-35].

Conclusion

Endocrine disrupting chemicals affect humans and wildlife in a variety of ways, they can be reduced by making changes such as avoiding the use of plastic bottles, metals, pesticides, and fertilizers, among other things. It's better to use BPA free baby bottles.

For storage of food items and for lunch boxes its better use stainless steel or glass containers.

However EDC have major effect on growth, metabolism, and reproductive system of humans.

Further research has be done in epidemiology studies, however care should be taken in pregnant women, growing children and babies.

Bibliography

1. Colborn T., *et al.* "Developmental effects of endocrine-disrupting chemicals in wildlife and humans". *Environmental Health Perspectives* 101.5 (1993): 378-384.
2. Zoeller RT., *et al.* "Endocrine-disrupting chemicals and public health protection".
3. Heindel JJ., *et al.* "Parma consensus statement on metabolic disruptors". *Environmental Health* 14 (2015): 54.
4. Guillette LJ and Thea M Edwards. "Environmental influences on fertility: can we learn lessons from studies of wildlife?". *Fertility and Sterility* 89 (2008): e21-24.
5. Guillette LJ., *et al.* "Alterations in the development of reproductive and endocrine systems of wildlife populations exposed to endocrine- disrupting contaminants". *Reproduction (Cambridge, England)* 122.6 (2002): 857-864.
6. Le Blanc G. "Steroid hormone-regulated processes in Invertebrates and their Susceptibility to Environmental Endocrine disruption" (2000).

7. Hamlin H and Guillette LJ. "Wildlife as sentinels of environmental impacts on reproductive health and fertility". *Environmental Impacts on Reproductive Health and Fertility* (2010).
8. Schug TT, et al. "Mini Review: Endocrine Disruptors: Past Lessons and Future Directions". *Molecular Endocrinology* 30.8 (2016): 833-847.
9. Palanza P, et al. "Effects of developmental exposure to bisphenol A on the brain and behavior in mice". *Environmental Research* 108.2 (2008): 150-157.
10. Kundakovic M., et al. "Sex-specific epigenetic disruption and behavioral changes following low-dose in utero bisphenol A exposure". *Proceedings of the National Academy of Sciences of the United States of America* 110.24 (2013): 9956-9961.
11. Zoeller RT, et al. "Endocrine-disrupting chemicals and public health protection: a statement of principles from The Endocrine Society". *Endocrinology* 153 (2012): 4097-4110.
12. Gore AC, et al. "EDC-2: The Endocrine Society's second scientific statement on endocrine-disrupting chemicals". *Endocrine Review* 36 (2015): E1-150.
13. Mnif W, et al. "Effect of endocrine disruptor pesticides: a review". *International Journal of Environmental Research and Public Health* 8 (2011): 2265-2303.
14. Schug TT, et al. "Endocrine disrupting chemicals and disease susceptibility". *The Journal of Steroid Biochemistry and Molecular Biology* 127 (2011): 204-215.
15. De Coster S and van Larebeke N. "Endocrine-disrupting chemicals: associated disorders and mechanisms of action". *Journal of Environmental and Public Health* 2012 (2012): 713696.
16. Nohynek GJ, et al. "Endocrine disruption: fact or urban legend?" *Toxicology Letter* 223 (2013): 295-305.
17. Kabir ER, et al. "A review on endocrine disruptors and their possible impacts on human health". *Environmental Toxicology and Pharmacology* 40 (2013): 241-258.
18. Committee ES. "Scientific Opinion on the hazard assessment of endocrine disruptors: scientific criteria for identification of endocrine disruptors and appropriateness of existing test methods for assessing effects mediated by these substances on human health and the environment". *EFSA Journal* 11 (2013): 3132.
19. Slama R, et al. "Scientific issues relevant to setting regulatory criteria to identify endocrine-disrupting substances in the European Union". *Environmental Health Perspectives* 124 (2016): 1497-1503.
20. Zama AM and Uzumcu M. "Epigenetic effects of endocrine-disrupting chemicals on female reproduction: an ovarian perspective". *Frontiers in Neuroendocrinology* 31 (2010): 420-439.
21. Baldi F and Mantovani A. "A new database for food safety: EDID (Endocrine disrupting chemicals - Diet Interaction Database)". *Annali dell'Istituto Superiore di Sanità* 44 (2008): 57-63.
22. Lubrano C, et al. "Obesity and metabolic comorbidities: environmental diseases?" *Oxidative Medicine and Cellular Longevity* 2013 (2013): 640673.
23. Monneret C. "What is an endocrine disruptor?" *Comptes Rendus: Biologies* 340 (2017): 403-405.
24. Balaguer P, et al. "Structural and functional evidences for the interactions between nuclear hormone receptors and endocrine disruptors at low doses". *Comptes Rendus: Biologies* 340 (2017): 414-420.
25. Sargis RM. "Metabolic disruption in context: clinical avenues for synergistic perturbations in energy homeostasis by endocrine disrupting chemicals". *Endocrine Disruptors* 3 (2015): e1080788.
26. Barouki R. "Endocrine disruptors: revisiting concepts and dogma in toxicology". *Comptes Rendus: Biologies* (2017) 340:410-3.
27. Zhang X and Ho SM. "Epigenetics meets endocrinology". *Journal of Molecular Endocrinology* 46 (2011): R11-32.
28. Marty S. "Introduction to "screening for endocrine activity-experiences with the US EPA's endocrine disruptor screening program and future considerations". *Birth Defects Research Part B: Developmental and Reproductive Toxicology* 101 (2014): 1-2.
29. Champion S, et al. "Male reprotoxicity and endocrine disruption". *Exp Suppl.* 101 (2012): 315-360.
30. Gore AC. "Neuroendocrine targets of endocrine disruptors". *Hormones* 9 (2010): 16-27.
31. Sen A and Sellix MT. "The circadian timing system and environmental circadian disruption: from follicles to fertility". *Endocrinology* 157 (2016): 3366-3373.

32. Harding AK, *et al.* "Endocrine disrupting chemicals research program of the U.S. Environmental Protection Agency: summary of a peer-review report". *Environmental Health Perspectives* 114 (2006): 1276-1282.
33. Sweeney MF, *et al.* "Environmental endocrine disruptors: effects on the human male reproductive system". *Reviews in Endocrine and Metabolic Disorders* 16 (2015): 341-357.
34. Skakkebaek NE, *et al.* "Testicular dysgenesis syndrome: an increasingly common developmental disorder with environmental aspects". *Human Reproduction* 16 (2001): 972-978.
35. Anawalt BD. "The silent spermatozoon: are man-made endocrine disruptors killing male fertility?" *Asian Journal of Andrology* 15 (2013): 165-168.

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