Persistent Organic Pollutants in Environment and Human Health

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Abstract: Persistent organic pollutants (POPs) are often referred to as "silent killers" due to their bio accumulative and long-term persistence. These can be found in every living thing, from plants to animals to people. These are to culprits for several environmental and human health problems. POPs are a leading cause of diabetes, obesity, endocrine disruption, cancer, cardiovascular disease, reproductive problems, and environmental damage. POP pollution and dangers are of concern to scientists, governments, and NGOs alike. This article reviews the most recent findings about the effects of POP contamination on human health and the natural environment.

Keywords: Organic Pollutants, Impact, Environment, Health.

INTRODUCTION

Toxins that remain in the environment and build up in living organisms are called persistent organic pollutants (POPs). Due to their chemical and physical properties, POPs pose a worldwide threat that has prompted international accords to address the issue of their reduction or elimination. Although POPs have been linked to a broad variety of harmful consequences in both laboratory and observational studies, population-level research has consistently demonstrated that POPs are most dangerous for their impact on embryo lethality and developmental abnormalities. The majority of these effects peaked in the 1960s and 1970s, although some of them persist even now [1].

The article provides a concise overview of the major ecotoxicological concerns related to POPs and the substance of the international agreements that have been made to far. The chemical and physical properties of POPs, as well as their environmental distribution and the mechanisms by which they exert their effects on living things are discussed at length. This includes the POPs' primary mode of action, the effects as they are measured at the population level, and the factors that contribute to their exposure.

Together, persistence in the environment and bioaccumulation are characteristics shared by persistent organic pollutants (POPs) [2]. The chemical and physical properties account for these aspects. International agreements have been concerned with the worldwide scope of POP problems and the need of reducing or eliminating them. Embryo mortality and developmental abnormalities are two of the many negative consequences associated with POPs that have been shown in both laboratory and observational investigations [3, 4]. The impacts increased between the 1960s and the 1980s, and some of them are being felt now. The Stockholm Convention website lays out the basic criteria for defining the elimination of new POPs; nevertheless, their use pattern or production volume provide additional assistance for comprehending the likelihood of danger. Long-distance transportation of chemicals is shown in the table below, although only some of these substances have their production volumes and human and environmental risks quantified. Organochlorine insecticides, polychlorinated biphenyls (PCBs), polychlorinated dioxins and furans (PCDFs - as a single entry), and the chlorinated fungicide/industrial solvent hexachlorobenzene (HCB) were among the original 'dirty dozen' POPs identified for ban or restricted use by the Stockholm Convention. Non-chlorinated chemicals such as perfluorooctanesulfonate (PFOS), the most researched of the perfluorinated compounds (PFCs), and several brominated flame retardants (BFRs) were added in 2009. Hydrophobic alkyl chains of different lengths are paired with hydrophilic end groups to form PFCs [5]. Compounds with a completely fluorinated carbon chain are known as perfluorinated carbons (PFCs). There are a wide variety of compounds in the class of BFRs, each with its own unique set of properties. Polybromodiphenylethers (PBDEs) stand out as the most widely utilized and hence the most often found in environmental samples. In a recent decision, the European Food Safety Authority (EFSA) prioritized the use of many novel flame retardants (FRs) for which the outcome and danger were unknown or poorly understood. Further environmental monitoring of tris (2,3-dibromopropyl) phosphate (TDBPP) and dibromoneopentyl glycol (DBNPG) is warranted on the basis of strong evidence that these substances are genotoxic and carcinogenic.

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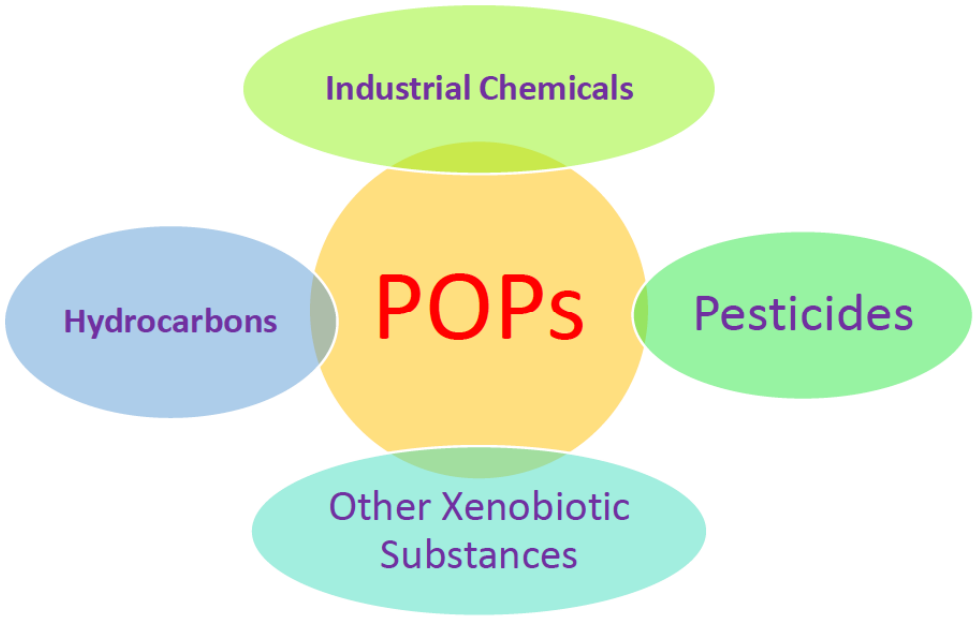

Figure 1: Sources of POPs in the Environment.

Because of the potential for bioaccumulation, substances such 1,2-bis (2,4,6-tribromophenoxy)ethane (BTBPE) and hexabromobenzene (HBB) were discovered based on the limited experimental data on environmental behavior [6-8].

POPs are evolving as their counterparts to the 'dirty dozen' are being added to the list of chemicals commonly measured in environmental media. But there are over 30,000 chemicals in the globe, and some of them are POPs that were previously unknown to science until the recent discovery of the widespread distribution of PFOS. The 'dirty dozen' lessons learnt cannot be forgotten for these reasons [9].

ROLE AND EFFECT OF PERSISTENT ORGANIC POLLUTANTS

In recent years, several industrialized nations have taken action to reduce the emission of PCBs into the environment. The World Health Organization (1976), the International Agency for Research on Cancer (1978), and the Organization for Economic Co-operation and Development (1982) all cite a recommendation made by the OECD in 1973 as a key factor in setting these restrictions. Since then, the 24 nations that make up the OECD have instituted restrictions on production, distribution, retail, import, export, and consumption, as well as a labeling system. POPs have devastating effects on animals, the environment, and by extension, people. Some of the numerous negative impacts of POPs include reduced fertility and birth defects, an increased risk of cancer, and altered enzyme activity in the liver [10-13].

POPs are introduced into the food chain via sediment after being emitted into the atmosphere, water, and soil. These are carried great distances by air and sea currents all across the planet. After then, they spread via air-water interaction and cycles like rain, snow, and dry particles, putting at risk even the most isolated communities that depend on aquatic food [14].

EFFECT OF POPS ON ENVIRONMENT

We now know that POPs pose a worldwide risk because they may move great distances via the air and water through evaporation and redeposition, making them difficult to contain or eliminate. The atmosphere plays a pivotal role in the worldwide transit of POPs. These substances are often present in atmospheric gases because to the semi-volatile nature of the atmosphere. Other processes, including degradation, soil deposition, vegetation, bioaccumulation, sedimentation, and so on, act upon these POPs once they are released into the atmosphere. The Global Distillation Effect theory proposes that gas-phase contaminants, such as those found in tropical or temperate source areas, will be transported to colder, higher-latitude regions, where they will condense and accumulate in soil, vegetation, and other places, eventually making their way into food chains [11]. This

is because POPs are temperature-dependent, and the theory predicts that the transport of these contaminants will affect vapor pressure and Henry's constant.

Over the course of the previous several decades, many Asian developing nations have relied heavily on industrial, agricultural, and vector control uses of persistent organic pollutants (POPs) such polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs). India uses 85,000 metric tons of pesticides annually, with DDTs, HCHs, and malathion making about 70% of that total [13]. Waste from densely populated areas is often dumped untreated into uncontrolled open dumps in emerging Asian nations because of a lack of proper waste management infrastructure. The public is worried about the detrimental effects this conduct might have on nearby towns and the environment. These concerns were exacerbated when new, robust studies showed an elevated risk of exposure to dangerous chemicals including dioxins and related compounds, as well as heavy metals, in these dumping sites [14].

These POPs were discovered in high amounts in all the world's seas, deserts, the Arctic, and the Antarctic because they are very fugitive and resistant to photolytic, biological, and chemical destruction. PCBs have been the subject of several globalization studies. It was discovered that POP levels were through the roof. PCBs have been the subject of several globalization studies. High concentrations of various organochlorines have been found in ocean water, rainwater, and wild animals, although only by a few of investigations. Fish from the Antarctic were found to have a similar concentration of HCB to fish from the North Sea [15].

EFFECT OF POPS ON HUMAN HEALTH

The diplomatic signing of the Stockholm Convention in 2001 acknowledged a "black list" of POPs among the various POPs that are prevalent in our environment. Industrial compounds like hexachlorobenzene and polychlorinated biphenyls (PCBs) and other chemical by-products like polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) — the general name "dioxins" is used for PCDDs and PCDFs — include dioxins. These POPs have been associated to carcinogenic and endocrine disrupting effects in a wide range of biota [9], and are thought to biomagnify easily in the food chain.

Adipose tissue from humans in various countries has contained POP residues for a considerable amount of time. The toxicity and longevity of pesticides are useful for eliminating pests, but they may have unintended consequences for people and ecosystems. Since the early 1960s, evidence of organochlorine pesticides (OCPs) in the environment and, by extension, in the food chains of humans and other animals, has been mounting. Most organic chlorinated compounds (OCPs) found in human tissues, especially adipose tissue, are dichlorodiphenyltrichloroethane (DDT) and its derivatives. In 1874, German scientists first produced DDT, an organochlorine chemical. DDT's insecticidal properties were identified in 1939, and the chemical was first used commercially in 1945. Humans

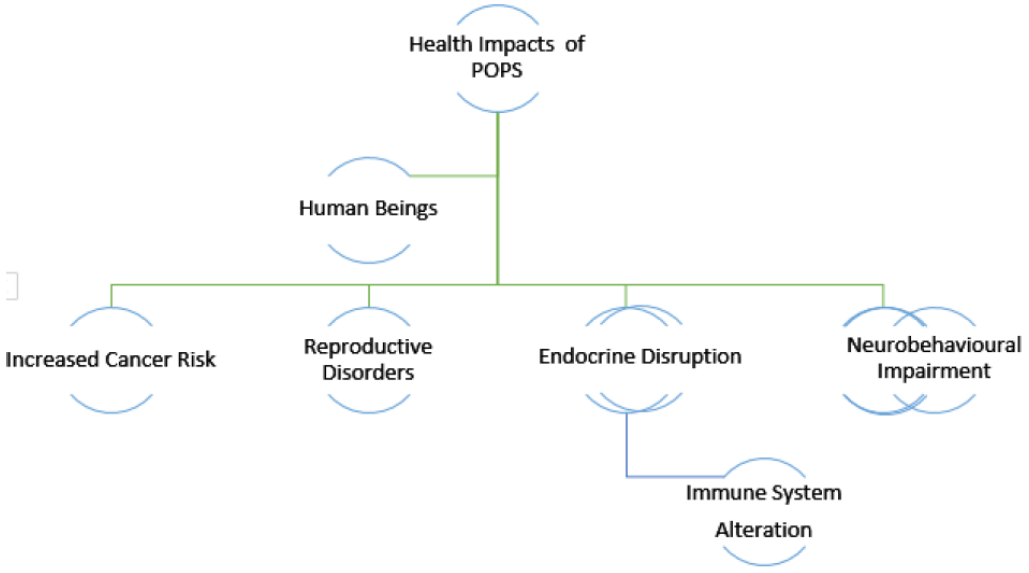

Figure 2: Health Impacts of POPs.

convert DDT to the safer and more water-soluble form tetrachlorodiphenylethane (DDD). Another family of DDT derivatives, dichlorodiphenyldichloroethanes (DDEs), rapidly accumulate in human adipose tissue and offer a serious health danger owing to their extended half-life. The body may acquire DDE via DDT metabolism or by eating foods contaminated with DDE [15].

Concerns have been raised, however definitive evidence linking low-level exposure to environmental chemicals, endocrine disrupting activities, and negative health effects in humans has not yet been produced by analysis of human data. Information gathered from both *in vivo* and *in vitro* studies of wild animals should be included. Concerningly [16, 17], it is difficult to establish a connection between prenatal, postnatal, and childhood exposure and adult functioning.

Concerns about the effects of EDC exposure on human health have largely centered on the potential for reduced semen quality (*i.e*., reduced numbers, motility, and altered morphology of sperm), male reproductive tract abnormalities (*e.g*., hypospadias and cryptorchidism), an altered sex ratio, endometriosis, precocious puberty, and early menarche. Sperm counts have dropped, according to studies conducted in a wide range of nations [18].

Various people believe that EDC exposure has led to adverse health effects because of the rise in the incidence of certain hormone-related cancers in various parts of the globe. Particularly worrisome are the rising rates of breast and testicular cancer. Researchers have looked at whether or not exposure to organochlorine pesticides increases the risk of breast cancer via a number of human epidemiological research and experimental laboratory experiments [19].

Persistent non-lipophilic compounds, such as perfluorinated compounds used as repellents, and lipophilic contaminants, such as dioxins, PCBs, polybrominated diphenyl ethers (PBDEs), and chlorinated pesticides, all pose risks to human health. The ability to persist is not required for a chemical to be toxic. The food supply and the bodies of many people throughout the globe are contaminated by volatile organic compounds, phthalates, and bisphenol A that are present in and leak from common industrial items. Type 2 diabetes is an insulin-related condition, and it was recently shown that exposure to certain chlorinated POPs enhances the risk of acquiring type 2 diabetes [20]. Contrary to what one would expect from a linear dose-response curve [21], this elevated risk seems to occur at very low doses. PCBs also considerably increase the risk, while DDE and hexachlorobenzene seem to have the greatest correlations [22, 23]. This connection is presumably the outcome of gene induction, but its precise mechanism is unclear since type 2 diabetes is an insulin receptor disease. One of the biggest causes of diabetes is obesity. The risk of diabetes is not elevated in the obese who do not have high levels of POPs, according to several studies [24-26].

CONCLUSION

The buildup and persistence of persistent organic pollutants in living beings and the environment is becoming a serious problem due to the increased industrial usage of these pollutants. There are a number of methods by which it kills organs and tissues, but two of the most important are oxidative stress and cell death. However, many poor nations throughout the globe still violate the Aarhus and Stockholm agreements, as well as other international measures created to minimize the use of POPs and remove them entirely. These conventions call for a ban on all POPs classified as class 1 and 2. While many organizations are making progress toward their objectives, it is important to remember the human cost of even a little misstep. Decisions about the potential adverse consequences of chemical exposure are increasingly governed at the international and national levels by the precautionary principle when sufficient scientific evidence is lacking. There is not yet solid evidence linking endocrine disruptors to adverse health effects. Further study and development are required to identify the most pressing health concerns at all times, however it is clear that the danger of endocrine disruptors is greatest at certain stages (preconception, pregnancy, and postpartum).

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