DIOXIN EFFECT ON HUMAN HEALTH - A REVIEW

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Abstract
Dioxin is a name generally given to a class of super toxic chemicals, formed as a by-product of the manufacture, molding or burning of organic chemicals and plastics that contain chlorine. It exhibits serious health effects when it reaches as little as a few parts per trillion in body fat. Its effects in disrupting hormones, modifying genetic mechanisms of the cell, causing a wide range of effects, from cancer to reduced immunity, nervous system disorders, miscarriages and birth deformity can not be over-emphasized. Human activities over time have gradually led to the increase of its concentration in the natural environment, globally. It has become pertinent for contamination monitoring and assessment programmes to reduce its levels and trends in the environment and in reducing its hazardous effects on humans.

Keywords: Dioxins, Health, Impact, Monitoring, contamination, Food Supply

Introduction
Dioxins are a family of compounds that share certain chemical structures and biological characteristics. There have been concerns over the years about the potential health impacts of dioxins found in the environment and in food supply. Additionally, because of the interest in understanding the effects of dioxins by government, public health groups, industry, and others, significant coordinated regulatory and voluntary efforts have reduced human exposure from industrial processes. According to Environmental Protection Agency (EPA) data in the United States, dioxin emissions from all quantified sources have declined at least 90 percent over two decades (24).

According to (27), dioxins were first discovered as the cause of severe health problems among workers who had been exposed to the by-products of explosions in chemical plants that manufactured certain chlorine-based pesticides in the 1950s. In these accidents dioxin was formed and released into the work-place environment, causing systemic health problems among workers. In the 1960s and 1970s, dioxin was identified as a contaminant in the pesticides themselves – the component of Agent Orange and health problems began to emerge among soldiers and civilians exposed to Agent Orange in the Vietnam War. Subsequently, toxicological and epidemiological studies showed that dioxin was an extraordinarily potent carcinogen and caused damage to a variety of organ and system in laboratory animals (27).

In the 1980s, the scope of the problem suddenly exploded. Dioxin was discovered formed not just in the manufacture of few pesticides, but in a wide range of industrial processes involving chlorine and chlorinated materials. Trash incinerators, pulp and paper mills that use chlorine as a bleaching agent were found to release particularly large quantity of dioxin(1). The scope of environmental contamination by dioxin also turned out to be much greater than previously thought. Dioxin was discovered in air, water and wild life on a truly global basis from great lakes to the deep oceans to the North pole. Significant dioxin concentrations were found in the bodies of the general human population and “market-bask” studies of the human food supply. By the end of the 1980s, it was clear that every person in the world is now exposed to dioxin (8).

Only in the 1990s, however, has the health risk posed by universal dioxin exposures become clear. In 1994, the U.S Environmental Protection Agency (EPA) released its long awaited “Dioxin Reassessment” (19, 20). A project originally begun when the paper and chemical industries pressured the agency to revise downward its estimate of dioxin’s toxicity and thus weaken regulations on dioxin sources (21).

Global Dioxin Pollution
Two aspects of the environmental behaviour of dioxin like compounds make them particularly troublesome. First they are extraordinarily persistent, resisting physical, chemical and biological degradation for decades and longer (13). As a result, even dilute discharges accumulate on the environment over time, reaching particularly high levels in aquatic sediments and in the atmosphere; dioxins are
now distributed on a truly global basis (8). Inuit natives of Artic Canada for instance, have some of the highest body burdens of dioxins, furans and poly chlorinated biphenyls (PBCS) recorded, due to diet dependent on fish and marine mammals from a local food chain contaminated by dioxin from distant industrial sources (13).

Second, dioxins are highly oil-soluble but insoluble in water, they thus bio-accumulate in fatty tissues and are magnified in concentration as they move up the food chain. In greater than the levels found in the ambient air, soil, sediments (18). Dioxins are extraordinarily persistent in human tissues with an estimated half-life of 5 to 10 years in humans (19). At the apex of the food chain, the human population is particularly contaminated. A spectrum of dioxin-like compounds has been identified in the fat, blood and mother’s milk of general population (7). Virtually all human exposures to these compounds occur through food supply, particularly through consumption of fish, meat, egg and dairy products (2). Significant quantities are passed from mother to child, during the most sensitive stages of development, across the placenta and via mother’s milk (4).

The daily PCDD/PCDF dose of an average nursing infant in the U.S is 10 to 20 times greater than the average adult exposure thus receives about 10% of the entire lifetime exposure to these compounds during the first year of life (19). In laboratory animals, exposure to dioxins, particularly 2, 3, 7, 8, - TCDD has been associated with a remarkable variety of toxicological effects. Some of these effects have occurred at extraordinarily low doses. For instance, exposure of monkeys to just 5 parts per-trillion of 2, 3, 7, 8 – TCDD concentrations in the diet caused impaired neurological development and endometriosis (5). Pregnant rats receiving a single dose of 2, 3, 7, 8 – TCDD on day is of pregnancy had male off springs which appear normal at birth, but at puberty were demasculinized with altered reproductive anatomy, reduced sperm count, feminized sexual behaviour (15). The recent finding that the genome of the HIV – 1 virus contains regulatory sequences that bind the dioxin receptor complex and active transcription of viral genes is a cause for concern that dioxin-like chemicals may also play a role in the expression of infectious disease (15).

Dioxins clearly cause cancer. All 18 studies on the carcinogenicity of 2, 3, 7, 8 – TCDD have been positive demonstrating that dioxin is a multi site carcinogen in both sexes in the rat, mouse, and hamster by all routes of exposure (20). EPA has estimated that current background exposures pose cancer risks as high as one-in-one thousand, a level that exceeds ‘acceptable’ risk standards by up to a thousand times and, if accurate, could correspond to as many as 3,500 U.S cancer deaths per year due to dioxin exposure (19). According to one review, epidemiological data from occupationally exposed workers now show accumulating and convincing evidence that exposures to TCDD are associated with several cancers in human’s respiratory, lung, thyroid gland, connective and soft tissue sarcoma, hematopoietic system, liver, thyroid glands and all cancers (10). The most toxic dioxin, 2, 3, 7, 8 – TCDD was recently classified as a known human carcinogen by the International Agency for Research on Cancer (IARC), and is classified as a probable human carcinogen by the environmental Protection Agency, and the National Institute for Occupational Safety and Health. The new (IARC) classification provides an important international recognition of the potential for dioxin to impact human health.

While the non-cancer effects of dioxin in humans have received less attention, there is evidence that PCDD/F exposure reduces male sex hormones levels and libido (19, 14) and increases the risk of diabetes and related metabolic conditions (10). In human infants, several studies indicated dioxin-mediated effects on physical, cognitive, sexual development. Infants born to mothers who had consumed two or three meals per month of great lakes fish were under responsive and hyporeflexic at birth and subsequently exhibited dosed dependent deficits in visual recognition, memory and activity levels, these deficits were still present at follow-up at age four (14).

PCBs were measured in umbilical cord serving as a marker of total pollutant exposure, and the severity of developmental deficits correlated with PCB levels (10). There is an evidence for alterations in thyroid hormone levels, increased incidence of intracranial haemorrhage, immune suppression associated with lactational exposure to PCDDs, PCDFs and PCBs in Europe and Artic Canada (13).

In Africa and in Nigeria, little or no awareness has been created about dioxin exposure on
human and its health implication. As a result of the high or increased dioxin concentration available in both environment and food supply in these areas of the world evident by increased environmental pollution, degradation and contaminated food supply. The obvious need for this paper cannot be over emphasized. It is in fact, timely for the much degraded environment we are in especially in Nigeria and African at large. The increased rate of cancer too is also a proof of the need to reduce the toxic levels of this hazardous pollutant by creating awareness, monitoring of its concentrations in the environment and food supply, discouraging activities that aids its release into the environment.

Sources of Dioxins
According to (19, 20) medical waste incinerators, municipal waste incinerators, hazardous waste burning incinerators, cement kilns, industrial and residential wood burning facilities, and sewage sludge incinerators are the largest identified dioxin sources. Also important in this category are combustion-based metallurgical processes (including copper, lead and steel smelters/recyclers), combustion of automobile and truck fuels, and the burning of wood products. Minor sources within drum and barrel reclamation, tyre incineration, carbon reactivation fires in homes, offices and industrial fires may be an important dioxin source, but inadequate information was available for EPA to develop an estimate.

However, three independent studies have confirmed EPA’s picture of dioxin generation, particularly the central role of incinerators. One of such is a comprehensive report by the centre for Biology of Natural Systems; found that six source sectors accounted for 91.5% of all identified dioxin deposition into Great Lakes. Medical waste incinerators, municipal solid waste incinerators, iron ore sintering plants, hazardous waste incinerators, cement kilns, and secondary copper smelters (11). A Princeton University study found that trash incinerators, hospital waste incinerators, hazardous waste incinerators, open garbage burning, copper and steel recyclers were responsible for 83% of dioxin air emissions in the United States (8). A world wide inventory of dioxin sources placed municipal waste incineration, hazardous waste incineration, ferrous metal smelting at the top of its list (9).

Dioxin in Food Supply
The major sources of dioxin are in our diet. Since dioxin is fat-soluble it bio-accumulates, climbing up the food chain. A North American eating a typical North American diet will receive 93% of their dioxin exposure from meat and diary products. (23% is from milk and diary alone; the other large sources of exposure are beef, pork, fish, poultry and eggs). In fish, these toxins bio-accumulate up the food chain so that dioxin levels in fish are 100,000 times that of the surrounding environment (23). Since dioxin is hydrophobic (water-fearing) and lipophilic (fat-loving), it will rapidly accumulate in fish rather than remain in the water.

The same goes for other wildlife. Dioxin works its way to the top of the food chain. Men have no ways to get rid of dioxin rather than letting it break down according to its chemical half-lives. Women, on the other hand have two ways, which it can exit their bodies. Namely: (i) Across the placenta into the growing infant, (ii) through breast-feeding making breast-feeding for non-vegetarian mothers quite hazardous (23).

Effects of Dioxins on Human Health
Short-term exposure of humans to high levels of dioxins may result in skin lessons, such as chloracne and patchy darkening of the skin, and altered liver function. Long-term exposure is linked to impairment of the immune system, the developing nervous system, the endocrine system and reproductive functions. Chronic exposure of animals to dioxins has resulted in severed types of cancer. TCDD was evaluated by the WHO’s international Agency for Research on Cancer (IARC) in 1997. Based on animal data and on human epidemiology data, TCDD was classified by IARC as a “known human carcinogen”(28; 30).

Phasing Out PVC
Reducing the production and use of PVC is a simple and effective avenue to prevent PVC-related dioxin pollution. By replacing PVC with alternative, chlorine-free materials, dioxin formation associated with PVC can be eliminated entirely. Given the importance of the PVC life cycle in the nation’s dioxin burden, a PVC phase-out must be a top priority in any dioxin preventing strategy (30; 19, 21).

Alternatives to PVC
Alternatives are available now for the vast majority of all uses of PVC, and the most appropriate alternative is unique to each PVC application. Construction applications, such as pipes fittings,
Total Exposure = 119 pg/day

- Beef Ingestion: 38.0
- Dairy Ingestion: 24.1
- Milk Ingestion: 17.6
- Chicken Ingestion: 12.9
- Pork Ingestion: 12.2
- Fish Ingestion: 7.8
- Egg Ingestion: 4.1
- Inhalation: 2.2
- Soil Ingestion: 0.8
- Water Ingestion: Negligible

Figure 1: Levels of dioxin in food supply Source: (EPA, 2006)

sidings, and window profiles, account for over 50% of PVC consumption. Other PVC uses include furniture, wall, and floor coverings, automobiles, electronic equipment, wire and cable coatings packaging, and medical devices. In industrialized nations, packaging is a relatively minor PVC use, but it plays a more important role in nations with developing or transitional economies where consumerism is on the increase (16).

**Progress towards a PVC Phase-Out**

A large number of communities, manufacturers, and hospitals have begun or completed successful efforts to eliminate PVC from their product lines or facilities. For instance, over 200 communities in Europe – including major cities in Austria, the Netherlands, Germany, Sweden, Luxembourg, Denmark and Norway have policies to restrict or avoid the use of PVC in public construction projects, many successfully built major new buildings without PVC (26). In transportation, the Euro-Tunnel, and subway systems in London, Vienna, Bilbad, Düsseldorf, and Berlin are PVC-free. The British, German, and U.S Navies do not employ PVC for ship-board uses (26).

The Olympic stadium and other parts of the Sydney 2000 Olympic village are being built with a commitment to avoid, or minimize the use of PVC (25). In industries, there are numerous example or manufacturers that have successfully replaced PVC in their product lines. Volkswagen has stopped using PVC in its vehicles, and Mercedes, BMW and Opel have adopted similar policies. Sony-Europe, AEG, Ikea furniture, Hertitz, Tarkett, as well as numerous retailers throughout the world have adopted PVC phase-out policies for their lines of appliances, furniture, office equipment, flooring and product packaging (26; 25). The Swedish Parliament has called for a phase-out of specific PVC uses. The Danish government has instituted a goal of phasing-out important PVC additive due to their numerous negative environmental properties. The government plans to promote PVC – free construction in all building bids, and to institute policies against PVC incineration. The Spanish Senate has asked the government to replace the use of PVC in packaging with non-polluting substitutes, and to study the possibilities of total PVC phase-out in Spain (12).

**Minimizing Dietary Exposure to Dioxins**

Choosing a balanced diet that is low in saturated fats and total fats helps consumers minimize any potential exposure to dioxin from food because dioxins are found mostly in animal fats due to its fat soluble properties of the dioxin compound (24). It is advisable to choose leaner cuts of beef, pork, and poultry and to trim the fat and remove skin from chicken before cooking, and also to choose non-fat and low-fat milk and milk products (24).

The following are also measures recommended to minimize dietary exposure to dioxins:-

- Slim milk should be sued instead of full-fat diary products such as skin milk
products or non-diary substitutes should be used.
- Females considering having children should eat non-diary or low-fat dairy products, low-fat vegetarian diet for several years before having children.
- Pork, beef and fresh water fish especially those from polluted water should be avoided or minimized to the barest minimum since they tend to have large concentration of dioxins of all food sources.
- Chicken has the lowest dioxin content of all meats, but it is still significant. Vegetarian meat substitutes such as tofu beans, and rice have essentially no contamination (29, 30; 24).

Avoiding Other Sources of Dioxins
The following are measures taken to avoid other sources of dioxin exposure.
- Weed killers or insecticides that contain chlorine especially chlorophenol weed killers, such as 2,4-D, found in fertilized weed killers mainly used by commercial lawn services and farmers should be avoided.
- Avoid “permethrin” flea sprays for pets.
- All organic chemicals that have “chloro” as part of their names (such as the wood preservative pentachlorophenol, which is probably the most dioxin-contaminated house hold chemical) should be avoided.
- Bleached paper products and chlorine bleach (sodium hypochlorite) and products containing it should also be avoided. Oxygen bleach should be used instead.
- All household or personal products and toys made of or packaged in polyvinyl chloride (PVC) labeled V or # 3 plastic should be avoided.
- The use of Saran Wrap and similar “cling-type” plastic wraps should be avoided unless they are clearly identified as polyethylene).
- All fruits and vegetables should be washed carefully to remove chlorophenol pesticide residue. Grapes and raisins should also be avoided unless they are clearly labeled as organic i.e grown without pesticides.
- All products that have cottonseed oil as an ingredient (such as potato chips) should be avoided since cotton is sprayed with chlorophenol insecticides. Do not use soaps containing tallow, as it is made from animal fat.
- Deodorants and soaps containing “triclosan” a chlorophenol should be avoided.
- Use unbleached (brown) coffee filters or those marked as having been bleached, with non-chlorine bleach.
- If you smoke cigarettes (although tobacco has other cancer hazards), roll your own in unbleached paper.

Conclusion
As a result of the health risk posed by dioxin, there is an urgent need for a control and monitoring assessment especially in the developing countries, like Nigeria, where there is low awareness about the health consequences and environmental impacts of dioxins.

The adverse effects of this compound on human health cannot be over emphasized. It is evident that health breakdown (ill health) can be prevented and cured first by eliminating as much as possible immuno-suppressant elements from one’s diet, life style and environment hence the need of checking this notorious environmental pollutant, which is highly ubiquitous.

Human health is essential and should not be compromised. Health breakdown due to these factors can be avoided possibly or minimized. It saves humanity several consequences and also saves the economy of a people “Health is wealth” and should be valued, with sound health, all life endeavours can be pursued and achieved.

Recommendation
It is hereby recommended that governmental policies should be put in place to monitor and assess pollutant concentrations in both environment and food. In addition to this, the following should also be done to actualize this aim of reducing dioxins and other toxic pollutants to zero level in the environment.
- Phasing out of PVC production, chlorinated chemical and PVC products. Efforts should be made by industries municipalities, local and Federal government regulatory agencies especially in Nigeria, to cut back industrial processes to successfully reduce dioxin levels released in the
environment from industrial and community sources.

- Governmental, community and individual efforts should be encouraged to stop indiscriminate bush burning, trash burning and uncontrolled incineration of waste products.

- Efforts should be made to create public awareness and enlightenment. This can be done through public awareness campaign by government and non-governmental agencies.

- It is also recommended that governmental agencies such as NAFDAC should include dioxin concentration monitoring in food and drinks as part of their efforts in safeguarding the health of the nation.

- In this regard, NAFDAC should also be enjoined to control packaging of foods and drinks to ensure that chlorine-free materials are used as appropriate.

- The Nigerian, environmental Protection Agency or Board as the case may be can not be left out in this issue. They should work in conjunction with the Ministry of health and Environment and other agencies home and abroad to ensure adequate pollution control technology, public enlightenment and enforcement of policies regarding pollution.

- The 1991 decree on pollution in Nigerian Inland waters should be effectively implemented to ensure safe environment for fishes.

- Finally, both governmental and individual efforts should be intensified to ensure a zero level of dioxin or a significant reduction in the environment, food and body burden. The World Health Organization (WHO) should be encouraged to intensify their activities in relation to dioxin in developing nations such as Nigeria. They should also be appealed to in respect of equipping and establishing laboratories to carry out researches in this area especially in Nigeria and Africa. Subvention could also be given to assist developing nations to carry out proper monitoring and assessment of the dioxin levels of their environment and food supply.

References


