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# **Overview: Human Health Effects of Environmental Contaminants**



# OVERVIEW: HUMAN HEALTH EFFECTS OF ENVIRONMENTAL CONTAMINANTS

Human activity has led to the production and release into the environment of a wide variety of biological, radiologic, physical and chemical contaminants. As a result, every resident of the Great Lakes basin and of North America now has detectable levels of numerous organic and inorganic pollutants in blood, hair or body tissues. Over the last 50 years the number of chemicals that are subject to controls on their use, transportation, and disposal has increased dramatically. Public support for more extensive and strict control of environmental agents has also increased, along with knowledge and interest in environmental issues generally.

While overall contamination of the ecosystem is now lower than in the 1970s, due to bans of a large number of airborne, food borne, water borne contaminants, restrictions on the use of toxic substances and clean up of some contaminated sites, most people believe many of the current levels of contamination to be unacceptable and a risk to their immediate and long-term health. (Decima Research Inc. 1993).

## **Contaminants Are One of Many Risk Factors**

The effects of chemical and radiologic contaminants at levels normally found in the environment are one of numerous risk factors that can affect a person's health. Based on our present knowledge, the most significant determinants of health are lifestyle factors such as smoking, drug and alcohol abuse, inadequate shelter, poor nutrition, lack of exercise and stress, or factors such as exposure to viral or bacterial agents and hereditary factors that predispose a person to disease. However, it is important to recognize that exposure to contaminants combined with other factors (e.g., predisposition to respiratory disease or cancer) can put people at greater risk.

The Ontario Health Survey 1990 Regional Report, from the Ontario Ministry of Health, provided data on the health status of over 61 000 Ontario residents, especially in relation to lifestyle and socio-economic factors. The survey findings showed that the most common health problems of Ontarians were high blood pressure, mental disorders, limb and joint disorders, and arthritis and rheumatism. The greatest number of deaths were caused by smoking.

## **1.1 EFFECTS OF CHEMICAL CONTAMINANTS ON WILDLIFE**

Now well documented, the effects of persistent chemical contaminants on wildlife have added to the weight of evidence and are seen by many as an early warning for possible threats to human health. Like humans, many wildlife species being studied are at the top of the food chain, and as such are exposed to similar mixtures of persistent chemical contaminants.

RELEASE OF CONTAMINANTS INTO THE NATURAL ENVIRONMENT IS ONLY ONE DETERMINANT OF ENVIRONMENTALLY RELATED IMPACTS ON HUMAN HEALTH. THE SUSTAINABLE USE OF RESOURCES ALSO PLAYS AN IMPORTANT ROLE IN DETERMINING HEALTH AS CAN BE DEMONSTRATED BY THE PROFOUND ECONOMIC AND SOCIAL IMPACT OF THE DECLINE OF THE EAST COAST COD FISHERY IN CANADA. CURRENT RESEARCH ON ENVIRONMENTAL HEALTH CONCERNS GENERALLY INCLUDES SOME ANALYSIS OF THE SOCIO-ECONOMIC IMPACTS ON HEALTH ATTRIBUTABLE TO ENVIRONMENTAL FACTORS.

## A NEW ERA

THE PROGRESS MADE OVER THE YEARS IN REDUCING THE LEVELS OF PERSISTENT ENVIRONMENTAL POLLUTANTS IN THE GREAT LAKES HAS RESULTED IN DRAMATIC IMPROVEMENTS IN REPRODUCTIVE SUCCESS AND SIGNIFICANT INCREASES IN THE POPULATIONS OF MANY FISH AND WILDLIFE SPECIES IN THE GREAT LAKES BASIN. THESE SUCCESSSES MUST BE CONTINUED, EVEN IN THIS NEW ERA IN WHICH FURTHER PROGRESS IS MORE COMPLEX AND PROBLEMATIC. THERE IS GROWING RECOGNITION THAT THE GLOBAL PROBLEM OF LONG-TERM, LOW-LEVEL EXPOSURE TO ENVIRONMENTAL CONTAMINANTS CANNOT BE RESOLVED BY ANY ONE COUNTRY ACTING ALONE.

It is now accepted that the offspring of at least 14 species of fish and top predator, fish-eating wildlife in the Great Lakes have experienced a wide variety of adverse health effects, including, thyroid dysfunction, reduced fertility and hatching success, birth deformities, metabolic problems, endocrine disruption, changes in reproductive behaviour, damage to the immune system, and population declines.

Since the mid 1970s, the concentrations of organochlorine chemicals found in Great Lakes fish and bird species (e.g., spot-tail shiners, lake trout, herring gulls) have declined as a result of lower levels of these contaminants in the environment. In many cases, populations have recovered since the declines in the 1970s. However, while levels are lower, many have not been decreasing significantly since the mid-1980s. There is evidence of a levelling off in declines of dieldrin, DDE and 2,3,7,8-TCDD (dioxin). As well, some chemicals (e.g., polychlorinated biphenyls, dioxin, methyl mercury) are still at unacceptably high concentrations in some fish species in some Great Lakes locations. The continued presence of chemicals in the environment is still causing adverse health effects in wildlife, including more subtle effects on the reproductive, endocrine, neurologic, and immune systems in developing offspring. In particular, there is some evidence that organochlorine-induced hormone disruption may have negative effects on hormonal (i.e., endocrine) function, resulting in altered sexual development and reproductive function, as well as changes in reproductive behaviour.

### **Recent findings regarding adverse health effects in wildlife**

- Current reproductive problems seen in Great Lakes fish-eating birds (e.g., herring gulls, common terns, and double-breasted cormorants) appear to be due largely to PCBs, rather than organochlorine pesticides. While DDT was the main chemical responsible for eggshell thinning and other problems in the 1970s, PCBs may be the main chemical of concern presently.
- Through subtle biochemical and physiological changes, organochlorine chemicals found in the Great Lakes basin ecosystem can cause adverse developmental effects in the reproductive, endocrine, and nervous systems of embryos. Thus, they are potential contributors to some of the declines in and failure of wildlife populations to recover, even though the levels of these compounds have dropped significantly since the mid-1970s.
- Organochlorine chemicals can alter not only developing embryos but also early postnatal development, leading to effects ranging from immunosuppression and early death to reduced fertility at adulthood, and to subtle effects on the endocrine system and subsequent development.
- There is evidence from studies on wildlife species that estrogenic (and/or anti-androgenic) compounds can disrupt certain hormones in the body and can cause effects at various biological levels, from mortality of embryos and adults, to altered sexual development and reproductive behaviour, to more subtle effects such as changes to the capacity of the gonads to produce certain sex hormones.

- In particular, there is some evidence that organochlorine chemicals that can mimic the activity of the female sex hormone estrogen in the body can cause endocrine (i.e., hormonal) and reproductive problems. For example, alligator populations in a Florida lake and several turtle species can exhibit sex reversal (male to female) if developing embryos are exposed to an estrogenic compound during a specific period of time. Masculinization of female fish and feminization of male fish has also been observed in fish exposed to estrogen-like contaminants.
- Exposure to PCBs, TCDD (dioxin), and other organochlorine chemicals has been shown to suppress the immune system in several wildlife species and in laboratory animals. This may encourage the development of infections and lead to a reduced ability to resist disease, as well as favour the development of tumours. For example, there is some evidence that Beluga whales (in the St. Lawrence estuary) may have experienced damage to their immune systems when exposed to organochlorine contaminants (e.g., PCBs and TCDD).

## **1.2 CURRENT HUMAN HEALTH CONCERNS**

Most Canadians believe that current levels of environmental contaminants are still unacceptable and that they pose a risk to their health (Decima Research Inc. 1993). Current human health concerns include known, suspected, and potential health effects from chemical, radiologic and microbiological contaminants.

In recent years the emphasis in terms of chemical and radiologic contaminants has changed from protecting people mainly from substances that cause cancer or structural birth defects, toward attention to chemicals that can disrupt reproductive, developmental, neuro-behavioural, immune system, endocrine, and metabolic processes. This new focus highlights the effects which, though they may be the result of minute chemical or radiation exposures, are passed down from parents to their offspring. This current research emphasis on the potential effects of low-level exposures raises the possibility that, in addition to the higher-risk populations mentioned below, individuals in the general population could also be at risk for subtle adverse health effects. Studies of health effects in the Great Lakes basin have also expanded to include the cardio-respiratory effects of air pollutants, and effects associated with radionuclides and microbial contaminants.

Table 1.1 summarizes current contaminant-related human health concerns.



**Table 1.1****CURRENT HUMAN HEALTH CONCERNS RELATING TO ENVIRONMENTAL CONTAMINANTS**

<b>HEALTH CONCERN</b>	<b>DESCRIPTION</b>
Cancer	<ul style="list-style-type: none"><li>• There are over a hundred different types of cancer, but the incidence of potentially hormone-stimulated cancers, such as breast, testicular and prostate cancers, have increased in the last few decades.</li></ul>
Inheritable Damage	<ul style="list-style-type: none"><li>• Exposure can result in changes in the inheritable genetic material (i.e., DNA).</li></ul>
Birth Defects	<ul style="list-style-type: none"><li>• Physical defects or malformations that occur during embryo development resulting in deformed offspring. Certain chemicals can also affect the growth and development of the children of the person who has been exposed.</li></ul>
Reproductive Damage	<ul style="list-style-type: none"><li>• Reduced fertility is the reduced ability of a couple to produce a live offspring, possibly due to reduced quality and/or quantity of eggs and/or sperm.</li><li>• Prenatal exposures can affect reproductive organ development and sexual development, which appear during childhood or post-adolescence; and reproductive tract disorders.</li><li>• Possible role hormone-disrupting organochlorines play in causing reproductive damage.</li></ul>
Developmental and Behavioural Effects	<ul style="list-style-type: none"><li>• Contaminants affect the development and function of the central nervous system, leading to developmental and behavioural problems, (e.g., lead adversely affects childhood learning).</li></ul>
Damage to the Immune System	<ul style="list-style-type: none"><li>• Exposure can reduce the body's ability to protect against and fight disease.</li></ul>
Effects on the Respiratory and Circulatory System	<ul style="list-style-type: none"><li>• There are direct effects on the lung, heart and blood vessels, lung volume and airways (e.g., asthma).</li></ul>
Viral and Bacterial Infections	<ul style="list-style-type: none"><li>• The effects of microbial contaminants are well known and can range from mild (e.g., skin rashes) to severe (e.g., death).</li></ul>

**Q. What do we know about synergistic, additive or antagonistic effects of chemicals on human health?**

- A. People and animals are constantly exposed to mixtures of natural and synthetic chemicals found in the environment. One can expect that there is some interaction between these chemicals, both in the environment and in the bodies of people. Most of the toxicological studies of chemicals deal with high doses of one or mixtures of a few chemicals. Some of the experimental studies have shown that organochlorine pesticides can either enhance or counteract each other's effects (e.g., on the immune system), depending on the composition of the mixture. We do not know how the environmental contaminants interact with each other and what the resulting health effects would be.

**Q. Are environmental pollutants affecting human hormone systems and if so, how?**

- A. Several chlorinated organic chemicals (DDT, PCBs, dioxins, etc.) can act as surrogate hormones and disrupt hormone (endocrine) systems in a wide range of animal species (birds, fish and mammals). Laboratory animal studies have shown that these chemicals, in high enough concentrations, can change behaviour, (sexual and maternal and responses to frustration) and can delay and/or accelerate some types of development and disease conditions. Evidence in human populations is difficult to collect, however, humans are possibly affected in similar and subtle ways. Hormone-like effects of some persistent toxic substances are one more reason to virtually eliminate environmentally persistent chlorinated organic compounds.

**Q. Is there a link between breast cancer and environmental pollutants, e.g. DDT?**

- A. Some types of breast cancer (estrogen-responsive tumours) are affected by hormones and hormone-like substances. DDT is one of several persistent chlorinated organic compounds that can mimic estrogen, a potent sex hormone. Preliminary information suggests that estrogen-responsive breast tumours are associated with higher concentrations of DDT in breast tissue. The potential for DDT and other persistent toxic substances to cause some breast cancers is biologically plausible but far from proven. Several large studies are now under way to examine these associations.