Better Information for Better Health

First Nations Food, Nutrition and Environment Study (FNFNES)

Chemical Factsheets

Since the early 1900's the chemical industry developed thousands of substances resulting in more than 78,000 substances being used in commerce today. We are exposed to chemicals every day, from household cleaning compounds to cosmetics to additives in the food we eat. If not handled properly, some of these chemicals can be hazardous to human health and the environment when at elevated level of exposure.

In order to protect public health it is important to control the release of these chemicals and monitor their levels in the environment and certain foods.

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UNDERSTANDING CHEMICAL POLLUTANTS

What chemicals in the environment are we worried about?

We often hear that we are unknowingly being exposed to chemicals in the air we breathe, food we eat and water we drink. What are they and what do they do? The following is a list of chemicals that are commonly found in the Canadian environment. The First Nations Food, Nutrition and Environment Study (FNFNES) collected traditional food and drinking water samples from First Nation communities and measured the concentrations of these chemicals to assess the risk of exposure. The results of testing are presented in the Regional Reports. These factsheets are included to provide background information to the general reader on these chemicals. Because the focus of FNFNES is on long-term low-level exposure from food and water, the acute effects of high doses such as those from occupational exposure are not presented.

Based on the evidence gathered from animal experiments and human populations accidentally exposed to these chemicals, threshold levels of many of these chemicals have been established. For public health protection, national and international guidelines have been established. When the daily intake is below these threshold values, no adverse health effects are expected among the studied population.

Included are Chemical Factsheets on the following substances:

Benefit of Traditional Foods vs Risk: Traditional foods offer many nutritional and cultural benefits. These must be weighed against the market-food alternatives and levels of contamination.

Persistent Organic Pollutants: Toxic organic chemical substances that do not break down or dissipate in the environment. They can stay in your body for a very long time.

Pesticides and Herbicides: These kill insects, weeds and fungus which harm agricultural crops. They can affect the nervous system and immune functions.

Polychlorinated byphenyls (PCBs): These industrial chemicals, while banned have been used in transformers, capacitors and as coolants and persist in the environment. They can affect the development of children.

Polybrominated Diphenyl Ethers (PBDEs): These compounds are used as flame retardants and are often found in building materials and consumer goods such as electronics and furniture. They can affect immune functions.

Dioxins and Furans: There are 210 different types of dioxins and furans, all of which are persistent organic pollutants and some of which can cause cancer.

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Polycyclic Aromatic Hydrocarbons (PAHs): These are produced through burning and some PAHs can cause cancer.

Perfluorinated Compounds (PFCs): Toxic and carcinogenic in animals, PFCs lasts indefinitely in the environment. It is used in the manufacture of non-stick surfaces such as on cookware. They can affect thyroid functions.

Cadmium: A metallic chemical element used to make alloys and batteries that can damage the kidney.

Lead: A heavy blue-grey metal which affects the brain development of children.

Mercury: A silver metal that is liquid at room temperature, mercury can take a variety of forms, some of which are more easily absorbed by the human body and can affect child development.

Arsenic: A silvery-white poisonous metal that is used to make insecticides and poisons for rodents. It is toxic to animals and humans and can cause cancer.

More factsheets are available at the First Nations Environmental Health Innovation Network (FNEHIN) website: www.fnehin.ca

Benefit of Traditional Foods vs Risk

Traditional foods should not be avoided because of suspected contamination as they are an excellent source of nutrients. The test results of contaminants found in traditional foods collected in your area are reported in the regional reports and any that are high in contaminants have been highlighted. This will provide you with local information that can be used to choose the best food to maximize the nutrient intake and lower your exposure to environmental contaminants.

Wild game has been found, on average, to be higher in protein and lower in both fat and cholesterol than domesticated meats.[1] First Nations have long relied upon traditional foods for a healthy, balanced and nutritious diet. Traditional foods are an optimal food choice that can be found locally and acquired with traditional knowledge. Studies, such as this one, show that those who consume traditional foods have a more nutritious and healthier diet than those that don't and that traditional foods can make important contributions to the intake of several important nutrients.

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Persistent Organic Pollutants (POPs)

Persistent organic pollutants are organic compounds that are resistant to environmental degradation through chemical, biological, and photolytic (broken down by sunlight) processes. Because they are not easily broken down, they can persist in the environment, sometimes for decades. They can be transported far from their sources by air and ocean current (e.g. from the industrialized south to the Canadian Arctic). They can be bioaccumulated in plants, animals and humans (absorbed into the body at a rate greater than is removed), and biomagnified (increase in concentrations) along the food chain. At high enough concentrations POPs can have harmful effects on human health and the environment.

POPs include some of the most well known and toxic environmental contaminants, such as polychlorinated biphenyls (PCBs), dioxins and furans. POPs commonly found in traditional foods and discussed in the FNFNES reports include hexachlorobenzene (HCB), p,p' dichlorodiphenyltrichloroethane (DDT) and its metabolite p,p-dichloro-2,2bis (4-chlorophenyl) ethylene (DDE), PCBs, dioxins and furans. Although the levels of many of these contaminants have declined since most developed countries have restricted their use decades ago, they are persistent and remain in the environment and our bodies for long periods of time.[2]

POPs can affect neural development and the immune system and can also disrupt hormonal balance and regulation. The developing fetus and infants are at higher risk of POPs exposure as POPs can pass through the placenta to the fetus, or be ingested by babies through breast milk. It is important to note that the benefits of breast feeding have always out-weighed the risk of contaminants in breast milk in all cases studied worldwide.

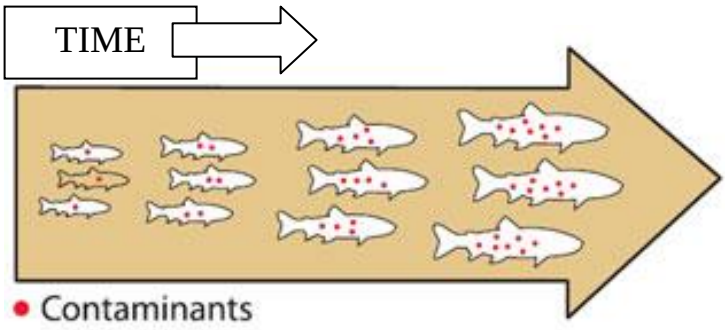

Illustration of how POPs accumulate in animals and people faster than the body can excrete the substance[3]

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Pesticides and Herbicides:

What are they? Pesticides are chemicals used to eliminate or control a variety of domestic or agricultural pests that can damage crops and livestock and reduce farm productivity. The most commonly applied pesticides are insecticides (to kill insects), herbicides (to kill weeds), rodenticides (to kill rodents), and fungicides (to control fungi, mold, and mildew). Of these pesticide classes, herbicides (weed killers) are the most widely used.

Where are they found? Pesticide residues are common food contaminants. Older pesticides such as organochlorines (like DDT) can be found in fatty tissues such as meat, fish and milk products while modern pesticides such as organophosphates are mainly found on the surface of fruits and vegetables. Since organophosphates are water soluble, they can be easily washed away. Therefore, always wash fruits and vegetables thoroughly with water before eating. Due to surface runoff, pesticides and herbicides can also be found in surface water, if there has been heavy use in the area. This may be a concern as it could contaminate drinking water from surface supplies.

What are the major health effects? Some pesticides are toxic to the nervous and immune system, and some are endocrine (hormone) disruptors. Endocrine disruptors are substances that can interfere with the endocrine system of animals, including humans by mimicking certain hormones. Endocrine disruption is important because hormones play a critical role in controlling how the body develops. A number of environmental contaminants (as well as other substances, such as some pharmaceuticals) are endocrine disruptors. Some pesticides, such as pentachlorophenol are contaminated with dioxins, which may play a role in their toxicity[4]. For example, daily ingestion of low doses of diquat, an extensively used herbicide, induces intestinal inflammation in rats. It has been suggested that repeated ingestion of small amounts of pesticides, as could be found in food, may have consequences for human health and may be involved in the development of gastrointestinal disorders[5] . Exposure to pesticides during the fetal stage and in childhood can cause long-term damage.

What are the guideline levels in water and food and daily intake?

The tolerable daily intake (TDI) established by Health Canada for DDT, a classic organochlorine pesticide and for chlorpyrifos, a common organophosphate pesticide, is 0.01 mg/Kg BW/day.

There is no drinking water guideline for DDT as it does not dissolve in water easily. The drinking water guideline for chlorpyrifos is 0.09 mg/L.[6]

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Polychlorinated biphenyls (PCBs)

What are they? PCBs are a class of compounds that are mixtures of up to 209 different chlorinated hydrocarbons, or congeners. Different congeners sometimes act differently from one another, and some are more resistant to break down than others in the environment. Some congeners can act like dioxins ("dioxin-like congeners") and others act in other ways ("nondioxin-like congeners"). PCBs were used in paints, lubricants and electrical equipment.

Where are they found? PCBs are generally found in higher concentrations in fatty foods of animal origin, such as some fish, meats and dairy products. Everyone living in developed countries have PCBs in their bodies and long-range transport of PCBs by global air currents have caused PCBs to be distributed globally.[7] Most PCBs enter the environment from landfill sites and leaks from old equipment. Food is the largest source of exposure but air, water and soil can play a part as well.[8]

What are the major health effects? Since people are never exposed to only one of these groups, people exposed to PCBs are at risk of the same health effects caused by dioxins, as well as those caused by non-dioxin-like PCB congeners. People eating large amounts of certain sports fish, wild game and marine mammals are at increased risk for higher exposures and possible adverse health effects. Long-term, high level exposure may also cause liver and kidney cancer.[9] Fetal exposure to PCBs can cause developmental deficits such as lowering IQ among children.

What are the guideline levels in water and food and daily intake?

The tolerable daily intake (TDI) established by Health Canada is 0.001 mg/Kg BW/day.[10]

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Flame Retardants - Polybrominated Diphenyl Ethers (PBDEs)

What are they? Flame retardants are chemicals that prevent the spread of fire and are persistent organic pollutants. PBDE flame retardants are added to some plastics, electrical and electronic equipment, upholstered furniture, non-clothing textiles and foam products. Because PBDEs are added to the products rather than chemically bound into them, they can be slowly and continuously released from the products during their manufacture, while in use, or after their disposal. As of 2008 the EU has banned several types of brominated flame retardants following evidence beginning in 1998 that the chemicals were accumulating in human breast milk.

Where are they found? PBDEs have been found both in the environment and in humans, including in human breast milk in Canada, the United States and Europe. PBDEs are generally found in higher concentrations in fatty foods of animal origin, such as some fish, meats and dairy products. Exposure to PBDEs is nearly impossible to avoid due to their presence in the air, indoor dust, water, food, animal fats, and breast milk. Nearly all Americans tested have trace amounts of flame retardants in their body. While the levels in humans are very low, they have been increasing with time, and are higher in North Americans than in Europeans.

What are the major health effects? Many are considered harmful, as they are linked to adverse liver, thyroid, reproductive/developmental and neurological effects. Concerns are being raised because of their persistence, bioaccumulation, and potential for toxicity, both in animals and in humans. A growing body of research in laboratory animals has linked PBDE exposure to an array of adverse health effects including thyroid hormone disruption, permanent learning and memory impairment, behavioural changes, hearing problems, delayed puberty onset, decreased sperm count, birth defects and possibly, cancer.[11]

What are the guideline levels in water and food and daily intake?

There is no guideline level for PBDE from Health Canada.

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Dioxins and Furans

What are they? There are over 200 types of polychlorinated dibenzodioxins (PCDDs), or dioxins. Polychlorinated dibenzofurans (PCDFs) are related chemicals. Some other persistent organic pollutants can act like dioxins, and are called "dioxin-like compounds."

Where are they found? The largest source of dioxins and furans entering the environment is through large-scale waste incinerators. Emissions are also made from small-scale burning of plastics, diesel, treated wood and cigarette smoke. The primary source of exposure to dioxins and dioxin-like compounds in developed countries is via food, especially meat, milk, dairy, eggs, and fish, which together make up 93% of total exposure. Inhalation, consumption of water, vegetable oils, grains, fruits and vegetables only constitute a small percentage of overall exposure.[12]

What are the major health effects? Dioxins are known to suppress the immune system of animals and humans,[13] and are likely to cause cancer.[14] Changes to animals' hormone and reproduction systems and development have also been observed due to high exposure to dioxins and furans.[15] The question of whether dioxins can influence the body's immune system to attack its own cells causing disease, like type 1 diabetes, is still being investigated.

What are the guideline levels in water and food and daily intake?

Health Canada has set a tolerable daily intake (TDI) for PCDDs and PCDFs at 2.3 pg/Kg BW/day (Health Canada, 2005 and WHO 2010).

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Polycyclic Aromatic Hydrocarbons (PAHs)

What are they? PAHs are a group encompassing over 100 different chemicals and are usually found as two or more of these compounds in a mixture. They are created through incomplete burning of many substances.

Where are they found? Exposure can be through inhalation, drinking contaminated water, or eating contaminated foods including grilled or charred meats. Air can become contaminated with PAHs by wild fires, vehicle exhaust, trash incinerators, cigarette smoke or coal tar, and water and foods can be contaminated from the soil and ground water.[16] Waste sites where construction materials or ash are buried can also contaminate ground water. Breathing smoke which contains PAHs is the most common way people are exposed to PAHs. Eating food grown in contaminated soil can expose people to PAHs. Charring or grilling food can increase the amount of PAHs that the food contains.

What are the major health effects? Some PAHs are expected to be carcinogens and have caused cancer and reproductive problems in laboratory animals, but there is a lack of data on the effect of PAHs on humans.[17] Although, exposure to PAHs can damage lungs, liver, kidneys and skin of humans.[18] According to the US Environmental Protection Agency, PAHs also can damage red blood cells and weaken the immune system. PAHs are a large class of chemicals which range from nontoxic to extremely toxic. Their toxicity, and therefore the amount of the PAH needed to cause a health effect, is dependent upon the type of PAH. Seven types of PAHs have been deemed probable human carcinogens by the U.S. Environmental Protection Agency.

What are the guideline levels in water and food and daily intake?

Health Canada recommended a maximum acceptable concentration of 0.01 ug/L Benzo[a]pyrene) (a PAH) in drinking water. Health Canada has no guideline level for non-carcinogenic endpoints of PAHs. The oral slope factor for Benzo[a]pyrene is 2.3 mg/Kg BW/day.

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Perfluorinated Compounds (PFCs)

What are they? Perfluorinated compounds (PFCs) are a family of fluorine-containing chemicals with unique properties to make materials stain and stick resistant. PFCs are incredibly resistant to breakdown and are turning up in unexpected places around the world. Although these chemicals have been used since the 1950s in countless familiar products, they've been subjected to little government testing. There are many forms of PFCs, but the two getting attention recently are: PFOA or perfluorooctanoic acid, used to make Teflon products and PFOS or perfluorooctane sulfonate, a breakdown product of chemicals formerly used to make Scotchgard products.

Where are they found? PFCs are used in a wide array of consumer products and food packaging. Grease-resistant food packaging and paper products, such as microwave popcorn bags and pizza boxes, contain PFCs. PFOS was used until 2002 in the manufacture of 3M's Scotchgard treatment and used on carpet, furniture, and clothing. PFOA is used to make DuPont's Teflon product, famous for its use in non-stick cookware. If Teflon-coated pans are overheated, PFOA is released. PFCs are in cleaning and personal-care products like shampoo, dental floss, and denture cleaners. Even Gore-Tex clothing, beloved in the Northwest for its ability to shed water, contains PFCs.

What are the major health effects? In recent studies there have been indications that PFOAs interfere with normal reproduction by adversely affecting fertility, and has caused developmental toxicity in offspring resulting in birth defects.[19]

What are the guideline levels in water and food and daily intake?

There is no guideline level for PFCs from Health Canada.

Metals: Metals include elements like arsenic, mercury, lead and cadmium, all of which are toxic. Metals occur naturally in the environment with large variations in concentration. In modern times, economic activity has resulted in several sources of metals that are introduced to the environment via pollution. Waste-derived fuels and coal are especially prone to containing metals, so they should be a central concern in a consideration of their use. Living organisms require trace amounts of some metals, such as iron, cobalt, copper, manganese, molybdenum, and zinc which are beneficial. However, excessive levels can be detrimental to health. Other metals such as cadmium, lead, mercury, and arsenic are considered to be toxic and have no known vital or beneficial effects and over time their accumulation in the bodies of animals can cause serious illness.

Cadmium

What is it? Cadmium is a natural element that is found in all soils and rocks. It is a metal that resists corrosion and is used in many applications such as batteries, some plastics such as PVC, and metal coatings.

Where is it found? It can enter the environment from mining, industry, coal and household waste burning and hazardous waste sites and can travel great distances before entering the local environment through ground or water. Cadmium does not break down, can travel great distances in the environment and can change in form. Cigarette smoke is a major source of exposure to cadmium and can effectively double the average daily intake. Other sources of exposure include from foods (Cadmium is often found to be highest in shellfish and the liver and kidneys of large mammals like moose and deer) drinking water, and breathing air near a waste incinerator.

What are the major health effects? Long-term exposure to lower levels can cause kidney and lung damage, fragile bones and an increase in cancers.

What are the guideline levels in water and food and daily intake?

The drinking water guideline for Cd is 0.005 mg/L. The tolerable daily intake (TDI) established by Health Canada is 0.008 mg/Kg BW/day.

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Lead:

What is it? Lead is found naturally in the environment and has many industrial uses.

Where is it found? Lead was once commonly used in gasoline, paint, pipes and lead shot ammunition, although its use has now been restricted in these areas. It can currently be found in some types of batteries (car batteries), toys, solder, and PVC plastic. Some of the most common ways to be exposed to lead include improper disposal of old lead-based paint, leaded gasoline, some ceramics or other lead containing products. Lead from these sources can find its way into drinking water in homes with old pipes containing lead solder, inhaling paint dust or ingesting broken or peeling lead paint, and through eating birds or other animals that have been killed with lead shot. If the bird survives, these fragments then stay in the bird and are absorbed by the bird, to be eaten by the next hunter who successfully hunts the bird. These fragments are usually too small to be detected by the person eating the bird. Detectable fragments contain even more lead and should be avoided when eating for everyone. Canada has banned the use of lead shot for hunting, but lead ammunition is still readily available.

What are the major health effects? Lead is well known to be a serious toxin for humans and has contributed to nervous system, kidney and reproductive system problems. Long term exposure can also cause anemia. Recent studies in children in other parts of the world are beginning to suggest that amounts of lead much lower than previously thought can contribute to impaired intelligence. This is especially true for very young children.

What are the guideline levels in water and food and daily intake?

The drinking water guideline for lead is 0.01 mg/L. The tolerable daily intake (TDI) established by Health Canada is 0.0036 mg/Kg BW/day.

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Mercury:

What is it? Mercury is the only metal that is liquid at normal air temperature and pressure. Mercury occurs in deposits throughout the world mostly as cinnabar (mercuric sulfide). Mercury can exist in different forms in the environment. It can be either elemental form as liquid or vapour, dissolved inorganic form or organic form. Mercury can change forms through natural processes.

Where is it found? Mercury can be released naturally from rocks, soil and volcanoes. It is found in certain dental fillings (dental amalgam), thermometers, and compact fluorescent lights (CFLs) and its use in other applications is being phased out.

Mercury is released from waste incineration, coal and fossil fuel burning, cement production, mining and smelting. Much of the airborne mercury that settles in Canada actually originates from outside Canada. Mercury can also be released into the environment through flooding. For example, a new reservoir is created, the mercury naturally present in soils and vegetation is converted in water by bacterial action to methylmercury, a more toxic form of mercury where it enters the food chain and bioaccumulates in fish. Mercury accumulates within living organisms so that when one animal eats other animals, much of that mercury stays within the animal which has eaten the other. This process of bioaccumulation applies to humans who eat animals which contain mercury so that those higher in the food chain (predatory fish and carnivorous mammals) often have higher mercury levels. Methylmercury is most often found in large predatory and bottom feeding fish (such as mackerel, orange roughy, walleye, trout) and shellfish.

What are the major health effects? Long-term exposure to mercury can affect brain functions, weaken the immune system, and cause neurological disorders and damage. High-level exposure can also permanently damage the brain, kidneys, and developing fetus and produce tremors, changes in vision or hearing and memory problems. Children are more sensitive to mercury than adults and mercury can be passed from a mother's body to the fetus.

What are the guideline levels in water and food and daily intake?

The drinking water guideline for mercury is 0.001 mg/L. The provisional tolerable weekly intake (pTWI) for methylmercury established by the WHO is 1.6 ug/Kg BW and 4 ug/Kg BW for inorganic mercury.[20] Health Canada has set guideline levels for methylmercury at 0.47 ug/Kg BW/day for adults and 0.2 ug/Kg BW/day for women of child bearing age, pregnant women and children.[21]

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Arsenic

What is it? Arsenic is a natural element found widely throughout the earth. It can be found in some drinking water, such as from deep wells, and is produced as a by-product from certain mining operations. The main use of metallic arsenic is for strengthening alloys of copper and especially lead (for example, in automotive batteries). Arsenic is commonly found in semiconductor electronic devices. Arsenic and its compounds, especially the trioxide, are used in the production of pesticides, herbicides, insecticides and treated wood products.

Where is it found? Arsenic is found everywhere in low levels; including in air, food and water. It can even result in arsenic poisoning in certain areas of the world when ingested in drinking water. It can take on various different forms, some of which are more toxic than others, and is most often used as a preservative in pressure treated wood, and as an active ingredient in some pesticides (such as those used in orchards). Sources of contamination include cigarette smoke and coal burning facilities. Arsenic can travel great distances when in the air and water. Exposure to arsenic is most often from arsenic treated wood, small amounts from food, water and air and living within an area with high natural levels of arsenic in rock.

What are the major health effects? Arsenic can irritate the throat and lungs, cause numbness in hands and feet, nausea and vomiting, decreased production of blood cells, skin irritation on contact, loss of movement and in very high levels can cause death. Studies have shown that ingesting certain types of arsenic can increase the risk of skin, liver, bladder and lung cancer.[22] Long-term exposure of children may also affect development. Arsenic is considered to cause cancer.

What are the guideline levels in water and food and daily intake?

Health Canada recommended a maximum acceptable concentration of 0.01 mg/L arsenic in drinking water. Health Canada has no guideline level for non-carcinogenic endpoints. The oral slope factor for arsenic is 1.5 mg/Kg BW/day.

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