

## **Environmental Contaminants: Evaluating the Impact on Aboriginal Children**

I see the faces of my people, your sons' sons, your  
daughters' daughters, laughter fills the air...  
Chief Dan George



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## **Overview**

1. Brief overview of Canadian Aboriginal Population
2. Vulnerabilities of Aboriginal Children
3. Transport routes
4. Environmental Contaminants and Health Effects and Exposure Pathways
5. Risk Assessment, Risk Management, Risk Communication
6. Perception of Risk
7. Implication for Environmental Assessment
8. What we are doing
9. Research Needs



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## **Canadian Aboriginal Population**

- Currently, in Canada, there are 615 First Nation communities, which represent more than 50 nations or cultural groups and 50 Aboriginal languages
- More than one million people in Canada identify themselves as an Aboriginal, 4% of the population (as of 2006).
- Fifty-three percent are registered Indians, 30% are Métis, 11% are non-status Indians and 4% are Inuit. Over half (54%) of Aboriginal people live in urban areas.
- Inuit are the Aboriginal people of Arctic Canada. About 45,000 Inuit live in 53 communities in: Nunatsiavut (Labrador); Nunavik (Quebec); Nunavut; and the Inuvialuit Settlement Region of the Northwest Territories (most live above the 60th parallel)
- The proportion of children in our Aboriginal population is greater than Canada's population: Aboriginal children (up to 14 years of ages, including Métis) represent 29.5% of Canada's total Aboriginal population.

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## **Vulnerabilities of Children**

- Greater susceptibility to lower doses of contaminants and potentially severe developmental problems and,
- Differences in exposure pathways such as skin contact, the placenta and breast milk. These alter what constitute a "safe" level of contaminants consumption. Ex: methyl-mercury is found to be significantly elevated in umbilical cord blood as compared to maternal blood levels,
- Immature nature of their nervous, immune and reproductive systems, as well as the unique hormone levels associated with successive development stages.

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## **Vulnerabilities of Aboriginal Children**

- Traditional based diets, such as fish, marine mammals and game, can be more contaminated with persistent toxic substances, such as organochlorine pesticides, polychlorinated biphenyls (PCBs) and certain metals, compared to store-bought foods.
- Aboriginal children often experience poverty and related risk factors to a much greater extent than other children in Canada.

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## Transport Routes

### Atmospheric transport

- Transported via wind current, in particular to the Arctic as colder climates increases deposition and accumulation.

### Marine transport

- Ocean currents have been shown to transmit heavy metals, organochlorides and radionuclides, including to Arctic waters.

### Terrestrial and freshwater transport

- In the Arctic, spring melt transports contaminants from the terrestrial environment to rivers and lakes.(surge of contaminant absorption) which could increase with climate change

- Children are exposed to contaminants found in soils (play, handle and eat soil)

### Biotic transport

- Land-based animals and birds form a large part of traditional diets.
- Plants and animals can assimilate contaminants found in soils, sediments, air or water and therefore enter the food chain.

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## Environmental Contaminants and Health Effects

### Heavy metals

#### Mercury:

- A naturally occurring metal that has elemental (metallic), inorganic and organic forms.
- Canada's Arctic is prone to deposition from long-range atmospheric transport via mercury depletion events (MDE).
- Inorganic mercury can be metabolized by microorganisms into methyl mercury, an organic form, that bioaccumulates in terrestrial and especially aquatic food chains, and therefore in humans via dietary intake (mercury realised from hydro reservoirs).

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## Effects of Mercury

- Long-term exposure can permanently damage the brain, kidney and cause reduced cognitive performance.
- Acute methyl mercury poisoning including mental retardation, cerebral palsy, deafness, blindness and dysarthria in persons exposed in utero and sensory and motor impairment in exposed adults.
- Health effects from chronic, lowlevel exposure to methyl mercury, include neurotoxicity, and impairment of sensory and motor functions and increased risk of cancer.
- Accumulates in higher concentration on the fetal side of the placenta. Studies have shown neurotoxic effects from prenatal exposure via traditional marine mammal diet consumed by the mother.

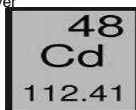
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## Cadmium

- Emitted mainly by human activity including, primary lead production, secondary lead smelting, primary copper smelting, hazardous and municipal waste incineration and petroleum refining.
- It is absorbed through inhalation and ingestion and accumulates in the liver and kidney.
- Significant amounts of cadmium have been found in the liver and kidney of moose in Canada's Arctic, therefore of significant concern.



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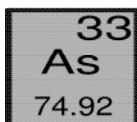
## Effects of Cadmium

- Health effects associated with high dose chronic exposure include kidney damage, which can lead to osteomalacia or osteoporosis.
- Low level exposure has been associated with renal dysfunction and diminished bone density.
- Maternal cadmium levels have been linked to birth outcomes, such as gestational age and birth height.
- Low levels of iron are linked to increased absorption of cadmium (requires further investigation), which puts children with iron deficiency at greater risk.

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## Arsenic

- Arsenic is a naturally occurring element that can be found in organic and inorganic forms as a metalloid.
- Mostly used as a wood preservative (copper chromated arsenated). Also emitted from mining operations, ore smelters and coal power plants.
- Exposure can occur through traditional diet and significant levels have been found in seaweed, fish, and wild berries collected near gold mine tailings.



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## Effects of Arsenic

- Acute exposure can cause gastrointestinal problems, neurotoxicity, bone marrow suppression, hepatic toxicity and mild mucous membrane and cutaneous changes.
- Chronic exposure to inorganic arsenic include cancer, hypertension, neurotoxicity. There is also some evidence of dermatosis, cardiovascular damage and liver damage.
- Effects of low-level chronic exposure (relevant to First Nations) include neurodeficits in children, spontaneous abortions, stillbirths and preterm births.
- Little information on exposure to the organic form of arsenic.

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## Lead

- Elemental lead is naturally found in soil and rocks. It can combine to form organic or inorganic molecules.
- It has been added to manufactured items, including paint and gasoline and is emitted from mine smelters.
- A point source issue for First Nations is lead shot used for hunting and lead weights used for fishing.



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## Effects of Lead

- Acute exposure can cause clinical anemia, kidney malfunction, abdominal pain, seizures, encephalopathy and paralysis.
- Low-level exposure can cause neurodeficits in adult and children, decrease in renal function and increase in blood pressure.
- Children are at particular risk from lead exposure because they have higher absorption rates and lower tolerable daily intake levels. The health impacts can be significant and appear later in childhood.
- The fetus and infant can be affected via placenta and breast milk and relatively low levels have been shown to cause neurocognitive deficits.
- Several research papers have also linked lead levels to violence.

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## Organochlorides

- Organochlorides (ex: PCBs) are lipid soluble and bioaccumulate in both human and wildlife fatty tissues.
- They are used in insulators, heat-exchange fluids, pesticides and they are also a by-product of incineration of food or municipal waste or the bleaching process in pulp and paper mills.
- Historic pollution still persists in the food chain and, some processes still emit organochlorides.
- Another means of point source exposure is radio stations scattered in remote areas.
- Arctic Aboriginals show elevated levels compared to southern population, which is largely linked to marine mammal diet.
- Northern populations are mostly exposed via long range transport.

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## Effects of Organochlorides

- Affect children's growth, related to development delays, endocrine disruption, and neurobehavioural deficits,
- Other toxic effects include liver damage and nervous system damage and possible carcinogenic effect,
- Perinatal exposure does have detrimental effects on the health of children, including respiratory infections, ear infections and immune deficits,
- Exposure during the fetal or childhood stages, prior to maturation of the reproductive system, may influence the likelihood of male reproductive tract disorders and reduced semen quality.

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## Radionuclides

- Both natural (natural sources in temperate zones) and anthropogenic activities (historic nuclear testing and accidents such as Chernobyl).

- Radionuclides are present in some northern traditional foods, in particular, caribou, but levels are not generally of concern.

### Effects of Radionuclides

- Acute effects include radiation syndrome (nausea, vomiting, diarrhea, bleeding skin and ocular lesions, neurological damage, chromosomal abnormalities, compromised immune function, coma and death).

- Chronic exposure to ionizing radiation can reduced male fertility, increase frequency of chromosomal aberrations in the sperm or egg, chromosomal mutations, neurotoxicity and cancer.

- Adverse effect on the fetus was discovered after Hiroshima and Nagasaki bombings

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## Mixtures of Contaminants

- A traditional diet can expose Aboriginal children to a mixture of environmental contaminants. The potential for interaction between contaminants or between contaminants and other dietary nutrients may result in antagonism, additivity or synergism;

- Ex: combination of organochlorides and methyl mercury exposure increases behavioural alterations and persistent physical development delays;

- Protective effect of selenium from methyl mercury poisoning.

- Interaction between calcium consumption and placental/breast milk lead-exposure.

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## Exposure Pathways

- Age-based differences in traditional diet

- North vs south

- Via the placenta

- Transdermal pathways

- Absorption through the gastrointestinal tract (GI)

- Absorption can also occur via the respiratory tract

- Distribution

- Susceptibility

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## Implication for Environmental Assessment

- Environmental Assessment is a tool that can help predict the release of environmental contaminants and their potential impacts, as well as determining the acceptability of the risk from these impacts;

- The benefits to including the determinants of health in the EA decision making process are clear;

- The integration of Health Impact Assessment (HIA) within the EA process would minimize adverse health impacts, reduce levels of anxiety about the risks from the environmental contaminants, but mostly it would better inform decision-makers on the significance of these effects and therefore enable them to modify or reject a project when warranted;

- More clearly defined and mutually agreed upon approach to consulting and accommodating Aboriginal rights, title and interests when evaluating the benefits and risks of a development project related to health.

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## Implication for Environmental Assessment

- Redesigned the EA process to include the monitoring of health outcomes and other social outcomes throughout the life of the project (including decommissioning);

- Will support Aboriginal community and individual health and support a body of knowledge about how and what kinds of development truly benefit communities.

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## Risk Assessment, Risk Management, Risk Communication

### Traditional Foods Benefits vs Contaminants

- Traditional foods are an integral component of good health for Aboriginals. They provide social, cultural, spiritual, nutritional and economic benefits. A shift away= a rise in levels of obesity, cardiovascular disease and diabetes.

- Effective risk management and communication will be needed to ensure that communities are able to determine what amounts of food are safe to eat without giving up all the benefits of a traditional diet

- Acknowledgement that a traditional diet results in a more complicated exposure pattern than is often modeled in the laboratory

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**Risk Assessment, Risk Management, Risk Communication**

**Traditional Foods Benefits vs Contaminants**

- Bridging science with traditional knowledge- collaborative process that is community- based and participatory.
- Effective management of the risk of contaminant exposure requires a culturally appropriate human health risk assessment process.
- Aboriginal communities can collaboratively design alternatives that are flexible to each community's needs and that incorporate their values, priorities and traditional decision-making systems.

**Perception of Risk**

**Risks assessment and risk management for children require an acknowledgement of the importance of perceived risks within a community and their impact on community and individual health and well-being**

- Reduction in consumption of traditional foods may lead to possibly adopting a less healthy market foods diet,
- Confusion and fear from less-than-informed decisions about what is safe to eat and the causal relationship to disease,
- Pregnant mothers may also be prone to react to reports of environmental contaminants, resulting in greater reliance on market foods and creating the potential for a less healthy diet.

**What we are doing**

**Northern Contaminants Program (NCP)**

- Research in understanding and reducing contaminants in traditional Northern foods in Canada

**Arctic Monitoring and Assessment Program (AMAP)**

- Advise the governments of the eight Arctic countries (Canada, Denmark/Greenland, Finland, Iceland, Norway, Russia, Sweden and the United States) on matters relating to threats to the Arctic region from pollution, and associated issues.

**National First Nations Environmental Contaminants Program (NFNECP)**

- A collaborative program between the First Nations University of Canada (FNUC) and Health Canada, for Community-based research, to assess the extent of environmental contaminant exposure and the potential for associated risks to the health and wellbeing of First Nations in Canada.

**What we are doing**

**Biomonitoring**

- Biomonitoring of First Nations on reserve in Canada to measure levels of contaminants in First Nations. The contaminants measured in this survey will be identified by FN but will be similar to the Canadian Health Measures Survey and the Inuit Health Survey.

Canadian Health Measures Survey (CHMS) Cycle 1 Environmental Chemicals

Measure	Matrix	Sample Size	Age (years)				
			6-11	12-19	20-39	40-59	60-79
Metals (Pb, Cd, Hg, Mn, As, Cu, Mo, Ni, Se, U, Zn, Sb, V)	Blood & Urine	5200	☑	☑	☑	☑	☑
PCB (24 congeners, Arochlor 1260)	Plasma	1500			☑	☑	☑
Organochlorine pesticides (14)	Plasma	1500			☑	☑	☑
Polybrominated compounds (10 congeners)	Plasma	1500			☑	☑	☑
Perfluorinated compounds (PFOS, PFOA, PFHxS)	Plasma	1500			☑	☑	☑
Cotinine	Urine	5200	☑	☑	☑	☑	☑
Bisphenol A	Urine	2400	☑	☑		☑	
Organophosphate pesticides (6 Dialkyl phosphate metabolites)	Urine	2400	☑	☑		☑	
Phenoxy herbicides (2,4-D and 2,4-dichlorophenol)	Urine	2400	☑	☑		☑	
Pyrethroid pesticides (5 metabolites)	Urine	2400	☑	☑		☑	

Source: Health Canada

**What we are doing**

**Biomonitoring (continued)**

- Inuit Health Survey
  - Clinical tests included:
    - Heart health including blood pressure, pulse and carotid artery health
    - Blood glucose and diabetes risk
    - Height, weight, body composition and waist circumference
    - Exposure to infection (*H. pylori* and zoonosis)
    - Bone health (women >40 years only)
    - Nutrient status including vitamin A, vitamin D, iron, selenium and fatty acids
    - Exposure to environmental contaminants
- The Child Inuit Health Survey
  - looked at the health of children, ages 3 – 5, with a focus on:
    - Nutrient status including vitamin D and iron
    - Bone health
    - Exposure to mercury
    - Exposure to a bacteria (*H. pylori*) that may cause weak blood (iron deficiency)
    - Vision

## What we are doing

### Environmental Health Guides/Tool Kits

•Raise awareness and provide advice on simple actions to reduce their environmental risk.

### Traditional Foods Guide

Guide produced to raise awareness of safe handling and preparation of traditional food and foodborne illnesses.

### First Steps in Lifelong Health , a Vision and Strategy for Children's Health and Environment in Canada

•The vision and strategy describes a path forward for child-protective policies, specifically in chemical management and consumer product safety

### •Burden of disease

A Project to estimate the environmental burden of disease for significant causes of mortality and morbidity among Canadian children.

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## Research Needs

•Child-specific risk assessments of environmental contaminant exposure and application of child-specific safety factors in risk assessment;

•Development of updated toxicity testing to detect unanticipated and subtle effects over an entire lifespan;

•Cumulative effects from multiple contaminants;

•Models that acknowledge the inevitable interaction between contaminants, nutrients, other health determinants and industrial point sources.

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## Research Needs (continued)

•Development of new toxicodynamic and toxicokinetic models that account for the unique physiologies of children and infants

•Longitudinal research to help to confirm the effects of low-level chronic exposure and to determine safe levels for mothers/infants;

•Increased knowledge on both the benefits and risks associated with a traditional diet to assist in the decision-making and risk management needed to address the acknowledged risks from contaminants;

•Increased contaminant exposure monitoring, registries of potentially contaminant-related ailments, a greater comparison of environmental contaminant effects across populations and between communities and more longitudinal cohort studies;

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## Research Needs (continued)

•Investigation of mixtures of contaminants and cumulative health effects;

•Improved quantitative assessment of exposure at different life stages, including acute and chronic exposures, and exposure via multiple routes and to mixtures of contaminants;

•Precautionary safety factors applied in risk assessment;

•Acknowledgement of toxic effects over multiple generations and incorporation of Aboriginal perspectives on well-being in order to be relevant and more effectively communicated and understood.

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**"The earth does not belong to man; man belongs to the earth...Man did not weave the web of life; he is merely a strand in it. Whatever he does to the web, he does to himself."**

— Chief Seattle's statement of 1854, as cited by Wheatley, M.A. 1997

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