

A high-angle photograph of a family having a picnic on a green blanket on a grassy lawn. A woman with long dark hair is on the left, wearing a red top, with her hands raised towards a young girl in a white shirt and pink pants. A boy is on the right, wearing a grey shirt and shorts, with his hands near his feet. Various picnic items are scattered on the blanket, including a blue water bottle, a bag of snacks, a bowl of fruit, and plates of food.

Metallic Lunch:

AN ANALYSIS OF HEAVY METALS IN THE CANADIAN DIET

A Report Published By:



ENVIRONMENTAL DEFENCE CANADA

...because our environment needs us

released
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Environmental Defence Canada provides Canadians with the tools and knowledge they need to protect and improve their environment and health. We are a national, charitable organization committed to engaging the public, finding solutions, and protecting the environmental rights of future generations.

To do so, we:

- research and develop campaigns to inform Canadians about critical environmental issues;
- provide legal, scientific and communications assistance to qualified groups and individuals; and
- participate in significant legal proceedings, and advocate for law and policy reform.

OUR WORK

We focus our work in core programme areas:

1. Protecting the Land
2. Producing Safe Food
3. Reducing Air Pollution
4. Safeguarding Our Water
5. Reducing Toxic Chemicals
6. Promoting Native Environmental Rights

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Executive Summary



...BECAUSE OUR LIVES DEPEND ON IT

Using data collected by Health Canada as part of its Total Diet Study (TDS), Environmental Defence Canada assessed the health risks associated with dietary heavy metal exposure. Some heavy metals are contaminating our food, putting the long-term health of Canadians at risk.

The Total Diet Study collects data on food contamination from cities across Canada and calculates the total daily intake of many common toxic substances. Environmental Defence Canada received TDS heavy metal data through an *Access to Information* request and compared this data to scientifically established intake guidelines for these metals. These guidelines were developed by the US-based Agency for Toxic Substances and Disease Registry and the US Environmental Protection Agency through their public health research.

Environmental Defence Canada determined that a number of metals foreign and toxic to human bodies - specifically cadmium (Cd) and lead (Pb) - are being consumed by all age groups above intake guidelines. Other metals that are required in small amounts for proper health - copper (Cu), magnesium (Mg), molybdenum (Mo), nickel (Ni), and zinc (Zn) - are being consumed above intake guidelines by some age groups. The following table outlines those metals for which consumption exceeds the intake guideline.

Summary Table

Metal	Intake Guideline Violations
Cadmium	all age groups
Lead	all age groups
Copper	infants, children, males 12-39 years
Manganese	infants, children, males of all ages
Molybdenum	infants, children
Nickel	infants
Zinc	infants, children, males 12-19 years

Canadians depend on federal agencies to ensure that the food they eat is free of toxic pollution. Health Canada, the Canadian Food Inspection Agency (CFIA), Environment Canada, and Agriculture and Agri-Food Canada are not successfully meeting this obligation. Environmental Defence Canada has uncovered significant heavy metal contamination in food. Despite the fact that Canadians are already over the limit of heavy metal intake guidelines, industry continues to pollute Canada's environment with these toxic substances.

The Total Diet Study is an indicator of the current food safety situation, and must be used as a trigger for action. Environment Canada, Health Canada, the CFIA, and Agriculture and Agri-Food Canada must take precautionary measures, working together for long-term policy and legislative changes that will eliminate the release of heavy metals into the environment. As steps towards achieving this goal, Environmental Defence Canada recommends the following actions to ensure that the long-term health of Canadians is not endangered:

1. Environment Canada must enact regulations for the phase-out of heavy metal releases to air and water under the *Canadian Environmental Protection Act*.
2. The *Food and Drugs Act* and *Regulations* must be reviewed and updated. Under the *Act*, toxic food residue standards, called Maximum Residue Limits, must be developed, enacted, and made legally enforceable for all heavy metals.
3. The Canadian Food Inspection Agency must carry out effective monitoring of all heavy metal contamination of food, and must pull all foods exceeding the Maximum Residue Limits off the shelves.
4. The Total Diet Study program must continue to monitor and analyze Canadian food pollution data, and communicate all results to the public in a timely and accessible manner.
5. Health Canada must produce an online registry of food contamination data modeled after Environment Canada's National Pollutant Release Inventory.
6. Agriculture and Agri-Food Canada must set national farm management standards that protect food from heavy metal contamination, such as regulating the land application of phosphate fertilizers and sewage sludge.



Introduction

*This report
reveals the
serious problem
of heavy metal
contamination
in food and the
health effects
associated with
chronic over-
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these metals.*

Health care is one of the most important issues in Canada today. Governments both nationally and provincially are dedicating resources to improving the health of Canadians. To make the most efficient use of limited health care dollars, a proactive approach must be taken to promote good health and prevent poor health.

An important part of preventative health care is maintaining a safe food supply. Canadians depend upon the federal government to protect the safety of food in Canada. Environment Canada, Health Canada, the Canadian Food Inspection Agency, and Agriculture and Agri-food Canada are principal players in the effort to ensure that food in Canadian homes and restaurants is free of pollution.

Environmental Defence Canada's *Producing Safe Food* campaign envisions:

- a transparent and accountable food safety system that effectively monitors and enforces food pollution violations;
- a safe and environmentally sustainable food system free of dangerous chemicals and other toxic substances in both locally produced and imported food.

Metallic Lunch: An Analysis of Heavy Metals in the Canadian Diet is the first in a series of reports directed at exposing the existing limitations of our food safety system. Using previously unreleased raw data from Health Canada's TDS, it reveals the serious problem of heavy metal contamination in food and the health effects associated with chronic overexposure to these metals.

The Total Diet Study program is an important indicator of the current safety of our food supply. As such, it must trigger action when problems are revealed.

Metallic Lunch is a warning cry to the federal government, and all relevant departments and agencies, to respond to the disturbing reality of ubiquitous food pollution by developing policies, regulations and monitoring systems that will reduce exposure levels in all aspects of the Canadian diet.

2.1 THE ORIGINS OF THE TOTAL DIET STUDY PROGRAM

Health Canada's Total Diet Study, which tests contaminant levels in food sold in Canadian grocery stores, is a highly effective tool for monitoring the success of Canada's food safety system.

The Total Diet Study concept began in the United States during the Cold War when the Consumers Union published several reports about radioactive fallout in the American food supply. The United States government responded by developing the TDS in 1961 to monitor strontium-90, cesium-137, pesticides, and selected nutrients in the diets of young men.¹ By testing many different foods and preparing them in the appropriate manner, an estimate of a person's total daily exposure to toxic contamination could be determined.²

The United States Food and Drug Administration posts all Total Diet Study data on its web site at <http://vm.cfsan.fda.gov/~comm/tds-toc.html> for public review.



1. Pennington, J.A.T., Gunderson, E. 1987. History of the Food and Drug Administration's Total Diet Study - 1961 to 1987. *Journal of the Association of Official Analytical Chemists*, 70, 772-782.

2. Ibid



Introduction



2.2 THE TOTAL DIET STUDY IN CANADA

The World Trade Organization now requires Total Diet Studies to be conducted by its member states, and the World Health Organization of the United Nations has developed guidelines for the implementation of Total Diet Studies. The first Total Diet Study was carried out in Canada between 1969 and 1973.³ Since then, several subsequent testing rounds have been completed. The Canadian TDS tracks a wide range of contaminants, including heavy metals, veterinary drugs, pesticides, PCBs and other industrial chemicals.

The Canadian TDS program collects food from retail outlets in five major cities across Canada. Imports and domestically produced food are not distinguished in the sampling process. The food samples are prepared in a laboratory according to normal cooking practices.⁴ Samples of the same food type are blended into a single "composite" that is then tested for contamination. An average contamination level is then calculated for each contaminant in each food type.⁵

Next, scientists calculate the exposure that Canadians receive through their diet. To do this, Health Canada conducted a survey to determine the average amount of each food that is eaten by Canadians of different ages. This survey is called the Nutrition Canada National Survey, and was conducted between 1970 and 1972.⁶

3. Conacher, H.B.S., Graham, R.A., Newsome, W.H., Graham, G.F., and Verdier, P. 1989. The Health Protection Branch Total Diet Program: An Overview. *Canadian Institute of Food Science and Technology Journal*, 22, 322-326.

4. Conacher H, Mes J. 1993. Assessment of Human Exposure to Chemical Contaminants in Food. *Food Additives and Contaminants*, 10, 5-15.

5. Conacher, H.B.S., Graham, R.A., Newsome, W.H., Graham, G.F., and Verdier, P. 1989. The Health Protection Branch Total Diet Program: An Overview. *Canadian Institute of Food Science and Technology Journal*, 22, 322-326.

6. Health Canada. 1973. *Nutrition Canada National Survey*. Ottawa: Information Canada.

Health Canada used the food consumption data from 1972 as a primary source to calculate present day exposure to heavy metals,⁷ though portions of this data have since been updated and compared with US data and provincial surveys.

The average contamination of the food is multiplied by the average amount that is eaten to calculate the total daily exposure to the contaminant from that food. The daily exposures from all foods are then added together to calculate the total daily dietary exposure to the contaminant.⁸

Some results of Health Canada's TDS program are occasionally published as articles in scientific journals, but the raw data is not made available to the public.

2.3 OBTAINING THE TOTAL DIET STUDY DATA

Health Canada has never before released the complete Total Diet Study database to the public. Environmental Defence Canada's food safety research led to a formal request through the *Access to Information Act*, an appeal when the request was denied, and several letters to then-Minister of Health Allan Rock.

Health Canada finally promised to give us the data in response to our plans to publicly release a less accurate form of food safety information that we received from the Canadian Food Inspection Agency. Health Canada sent us the heavy metal data from the Total Diet Study several months later, in the summer of 2001.

A 25-year-old male's exposure to aluminum from chocolate bars

When chocolate bars were tested for aluminum (Al), scientists found 4.4 milligrams of aluminum (mg Al) in each gram of chocolate bar. The Nutrition Canada Survey states that an average 25-year-old male eats 8.11 grams of chocolate bars per day. The total daily exposure to aluminum from chocolate bars is then calculated as follows:

4.4 mg Al per gram of chocolate X 8.11 grams of chocolate per day
= 35.7 mg Al per day from chocolate bars.

To calculate the total dietary exposure to aluminum, the same calculation is performed for each food type, and the resulting values are added together.

7. Health Canada. 1990. Action Towards Healthy Eating - Canada's Guidelines for Healthy Eating and Recommended Strategies for Implementation. Ottawa: Public Works and Government Services Canada. Retrieved online February 25, 2003 from: http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/action_healthy_eating_toc_e.html.

8. Health Canada. 2002. [Total Diet Study Heavy Metal Analysis]. Unpublished raw data received through Access to Information Request.



Introduction



Unless otherwise referenced, the Total Diet Study data and related information discussed in this paper were taken directly from the raw data files and text documents received from Health Canada through this *Access to Information* request.⁹

9. Through the Access to Information request, Environmental Defence Canada received 87 files including spreadsheets, reports, meeting minutes, memos, and other documents.





Heavy Metals and Food Safety



A "heavy metal" is an element that exhibits certain metallic properties such as high electrical conductivity and very high density.¹⁰ The toxicities of heavy metals vary. Some, such as zinc and manganese, are essential dietary nutrients that are required for good health. Others, such as cadmium and lead have no biological function in the human body, and can cause adverse health effects at very low levels.¹¹

3.1 HEAVY METALS OF PARTICULAR CONCERN

Of primary concern are metals that are not used by the body to maintain health. These metals, such as lead and cadmium, pose the greatest risk to human health. They build up in the body throughout a person's life, and can reach potentially dangerous levels over time.¹²

Other metals are required for our body to function normally. Zinc, copper, molybdenum, magnesium, and others are all used by the body to stay healthy. Safety standards for these metals are set as ranges of healthy consumption. Negative health effects can be seen when too much or too little of these metals are ingested.

10. Baird, C. 1995. Environmental Chemistry. New York: W.H. Freeman and Company.

11. ATSDR. 1999. Toxicological profile for cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp5.html>; and ATSDR. 1999. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp13.html>.

12. Baird, C. 1995. Environmental Chemistry. New York: W.H. Freeman and Company; and Meranger, J.C., Conacher, H.B.S., Cunningham, H.M., and Krewski, D., 1981, Levels of cadmium in human kidney cortex in Canada. Canadian Journal of Public Health, 72, 269-272.

3.2 METALS INCLUDED IN THE TOTAL DIET STUDY DATA

The Total Diet Study performed by Health Canada measured the concentrations of 21 heavy metals in food stuffs consumed by the average Canadian (Table 1). Exposure to these metals is expressed in milligrams (mg) of metal consumed per kilogram (kg) of body weight per day (mg metal/kg/day).

Table 1: Metals for which Environmental Defence Canada has TDS data (Total: 21 metals)

Name of Metal	MRL/RFD	Intake Guideline (mg metal/kg bodyweight/day)
Aluminum	MRL	2.0
Barium	RFD	0.07
Bismuth	N/A	N/A
Cadmium	MRL	0.0002
Cerium	N/A	N/A
Cesium	N/A	N/A
Cobalt	MRL	0.01
Copper	MRL	0.02
Lanthanum	N/A	N/A
Lead	RFD	0.0000785
Manganese	MRL	0.07
Mercury	MRL	0.0001
Molybdenum	RFD	0.005
Nickel	RFD	0.02
Rubidium	N/A	N/A
Selenium	MRL	0.005
Strontium	RFD	0.6
Thallium	RFD	0.00008
Thorium	N/A	N/A
Yttrium	N/A	N/A
Zinc	MRL	0.3





Heavy Metals and Food Safety

Canada's food safety laws, contained in the Food and Drugs Act and Food and Drug Regulations, do not enforce dietary intake levels of heavy metal contaminants.

The results were divided into age and gender groups to account for changes that occur in our diets as we age, and differences in the eating habits of men and women. A break down of age and gender is described in Table 2.

Table 2: Age and Gender Groupings in the Total Diet Study

Age Group	Gender Group
0-1 month	Male/Female together
2-3 months	
4-6 months	
7-8 months	
9-12 months	
1-4 years	
5-11 years	
12-19 years	Male/Female separate
20-39 years	
40-64 years	
65+ years	

3.3 REGULATING FOOD SAFETY IN CANADA

Canada's food safety laws, contained in the *Food and Drugs Act* and *Food and Drug Regulations*, do not regulate dietary intake levels of heavy metal contaminants.¹³ Instead, they regulate levels of some contaminants in foods themselves.

13. The complete text of the Food and Drugs Act and Regulations can be found on the Health Canada web site at: <http://laws.justice.gc.ca/en/F-27/index.html>.

The *Regulations* outline maximum levels of arsenic, lead, and tin allowed in specific food types; different levels of metal are allowed based on the type of food (Table 3). Paragraph B.15.001 of the Food and Drug Regulations specify that:

B.15.001. A food named in Column III of an item of Table I to this Division is adulterated if the substance named in Column I of that item is present therein or has been added thereto in an amount exceeding the amount, expressed in parts per million, shown in Column II of that item for that food. SOR/78-404, s. 1; SOR/79-249, s. 1.

Table 3: Canadian Maximum Residue Limits of Heavy Metals in Food

Metal	Tolerance (ppm)	Food Type
Arsenic	3.5	Fish Protein
	1.0	Edible Bone Meal
	0.1	Fruit juice, fruit nectar, beverages when ready-to-serve and water in sealed containers other than mineral or spring water
Lead	10	Edible Bone Meal
	1.5	Tomato Paste and Tomato Sauce
	0.5	Fish Protein and whole tomatoes
	0.2	Fruit juice, fruit nectar, beverages when ready-to-serve and water in sealed containers other than mineral or spring water
	0.15	Evaporated milk, condensed milk and concentrated milk formula
	0.08	Infant Formula when ready-to-serve
Tin	250	Canned foods

(Table I of Division 15 from the Food and Drug Regulations C.R.C., c. 870)





Heavy Metals and Food Safety

*A lack of
evidence
of harm
is not
evidence
of lack of
harm.*

Under the *Canadian Food Inspection Agency Act*, the Canadian Food Inspection Agency (CFIA) is responsible for the administration and enforcement of the *Food and Drug Act* as it pertains to food. The CFIA is a federal agency that was created to combine the administrative and enforcement roles of four federal ministries: Agriculture and Agri-Food Canada, Fisheries and Oceans Canada, Health Canada and Industry Canada.

The CFIA is supposed to prevent food that is unfit for human consumption from reaching the dinner plates of Canadians.

3.4 USE OF INTAKE GUIDELINES

Health Canada's Total Diet Study program is not an enforcement tool in the food safety system. Instead, it is used to inform food policy and regulatory development.

It monitors the overall state of food safety using internationally established intake guidelines developed by toxicologists. While perhaps not designed to be, it is an indicator of the effectiveness of the CFIA's enforcement efforts. Unfortunately, the program is backlogged and unable to analyze food samples and produce final numbers until many years after the samples have been taken.¹⁴

As the understanding of the food safety problem expands, a new framework for risk assessment is emerging. As a result, the use of intake guidelines has come under close scrutiny. We are faced with chronic exposure to low levels of various toxic substances from multiple sources, and Environmental Defence Canada questions the lack of a precautionary principle that considers these factors in risk assessment. A lack of evidence of harm is not evidence of lack of harm.¹⁵

14. Health Canada. 2002. [Total Diet Study Heavy Metal Analysis]. Unpublished raw data received through Access to Information Request.

15. Groth, Edward, III. 2000. *Science, Precaution and Food Safety: How Can We Do Better?* New York: Consumers Union of U.S. Inc. Retrieved online February 20, 2003 from: www.consumersunion.org/food/codexcp200.htm

In the past, Health Canada has used Provisional Tolerable Daily Intakes (PTDIs) developed by the World Health Organization as the oral exposure guidelines for determining whether the contaminants found in Canadian food pose a significant risk to the health of the average Canadian.

In the interest of adequately representing the risk Canadians face from food contamination, Environmental Defence Canada chose the lowest available oral exposure guidelines, developed by the United States Environmental Protection Agency (US EPA) and the Agency for Toxic Substances and Disease Registry (ATSDR). These guidelines are not guaranteed safety levels, but are reference levels for assessing risk associated with contaminant intake.

Metallic Lunch compares the data generated by Health Canada's Total Diet Study Program to the US EPA and ATSDR's oral exposure guidelines in order to identify potentially hazardous exposure levels. It is important to note that further and ongoing research may uncover health concerns related to exposure at lower limits than currently assigned to each toxic compound.





Heavy Metals and Food Safety

The Reference Dose is useful as a reference point from which to gauge the potential effects of the chemical at other doses.

3.4.1 THE UNITED STATES ENVIRONMENTAL PROTECTION AGENCY'S ORAL REFERENCE DOSE¹⁶

The US EPA develops Oral Reference Doses (RfDs) for substances that are of environmental or human health concern. The RfD is typically expressed in milligrams of chemical per kilogram of body weight per day (mg/kg/day). It is regarded as an estimate of daily exposure that the human population, including the most sensitive members, can tolerate over the course of a lifetime without appreciable risk of adverse effects.

The RfD is derived from an experimentally determined No-Observable-Adverse-Effect-Level (NOAEL) that is then adjusted based on uncertainty factors that reflect the various studies used to determine the NOAEL. These studies may involve human populations (epidemiologic investigations) and/or laboratory animals.

The Reference Dose is useful as a reference point from which to gauge the potential effects of the chemical at other doses. As the frequency and/or magnitude of the exposures exceeding the RfD increases, the probability of adverse effects in a human population increases.

3.4.2 THE AGENCY FOR TOXIC SUBSTANCES AND DISEASE REGISTRY'S MINIMAL RISK LEVEL¹⁷

Based in Atlanta, Georgia, the Agency for Toxic Substances and Disease Registry is an agency of the US Department of Health and Human Services, and is mandated to provide health information to prevent harmful exposures and disease related to toxic substances.

16. This section based on: United States Environmental Protection Agency. 1993. Reference Dose (RfD): Description and Use in Health Risk Assessments. Retrieved online February 25, 2003 from: <http://www.epa.gov/iris/rfd.htm>

17. This section based on: ATSDR. Toxicological Profiles. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/>

The ATSDR develops toxicological profiles for a wide range of substances. These profiles include oral Minimal Risk Levels (MRLs) that are determined using a method very similar to the US EPA's Reference Dose. Oral MRLs are expressed in milligrams per kilogram per day (mg/kg/day). The MRLs are determined from No-Observable-Adverse-Effect-Levels and are divided by a safety factor to protect the most sensitive members of the population. An MRL is an estimate of a level of hazardous substance intake that will likely be without appreciable risk of non-cancer health effects over a life-time.





Results

Cadmium and lead are being consumed by all age groups above intake guidelines.

Environmental Defence Canada determined that a number of metals foreign and toxic to human bodies - specifically cadmium (Cd) and lead (Pb) - are being consumed by all age groups above intake guidelines. Other metals that are required in small amounts for proper health - copper (Cu), magnesium (Mg), molybdenum (Mo), nickel (Ni), and zinc (Zn) - are being consumed above intake guidelines by some age groups. Table 4 outlines those metals for which consumption exceeded the intake guideline. The concentrations of these metals in food are low, but even at these low levels human consumption is exceeding established guidelines.

Table 4: Violations of Intake Guidelines in the Total Diet Study Data

Metal	Intake Guideline	Intake Guideline Violations
Cadmium	MRL 0.0002 mg Cd/kg/day	all age groups
Lead	RFD 0.0000785 mg Pb/kg/day	all age groups
Copper	MRL 0.02 mg Cu/kg/day	infants, children, males 12-39 years
Manganese	MRL 0.07 mg Mn/kg/day	infants, children, males of all ages
Molybdenum	RFD 0.005 mg Mo/kg/day	infants, children
Nickel	RFD 0.02 mg Ni/kg/day	infants
Zinc	MRL 0.2 mg Zn/kg/day	infants, children, males 12-19 years

4.1 CADMIUM

Health Canada has known that cadmium in our food is a potential health problem for decades. In the first Canadian Total Diet Study, carried out between 1969 and 1973, cadmium was identified as a contaminant close to the upper limit of the World Health Organization's Provisional Tolerable Daily Intake, and therefore of great concern.¹⁸

While cadmium is a natural part of the earth's crust, its presence in the wider environment is increased by human activity. Cadmium is used in the electroplating of other metals such as steel because it is especially resistant to corrosion. It is also used as a stabilizer in PVC plastics. It is a major component of rechargeable "nicad" (nickel-cadmium) batteries.

18. Conacher H, Mes J. 1993. Assessment of Human Exposure to Chemical Contaminants in Food. Food Additives and Contaminants, 10, 5-15.

Cadmium is primarily associated with zinc ores, and its pure form is produced as a by-product of zinc-processing.¹⁹ Cadmium is released into the environment through the mining and smelting of zinc, lead and copper, the combustion of coal, wood and oil, waste incineration, and the application of phosphate fertilizers or sewage sludge to soil. Small amounts can be released to the environment through natural weathering processes, forest fires, and volcanic eruptions.²⁰

4.1.1 PATHWAY TO THE FOOD SUPPLY

Agricultural crops, such as potatoes, wheat, rice, and other grains absorb cadmium from their surrounding soils or directly through their leaves.²¹ Agricultural land can be contaminated by cadmium through the application of fertilizers and sewage sludge.²² Phosphate fertilizers applied directly to agricultural land to increase food production contain cadmium as a natural part of phosphate rock. Long-term application of phosphate fertilizers has been shown to increase cadmium levels in soil.²³ Over the last 30 years, an average of 4.75 million tonnes of phosphate fertilizer were used per year in North America.²⁴

How to Understand the Intake Guideline Units

The size of your body will affect how you react to the effects of toxic contamination in your food. That is why the intake guidelines are always expressed as "contamination level per kilogram of body weight." As a result, small children are more sensitive to contamination levels.

To calculate how an intake guideline translates into a daily intake per person, multiply the intake guideline by the person's body weight. For example, a 60 kilogram male can consume 0.0000785 mg Pb/kg/day, or a total of 0.00471 milligrams of lead per day.

19. Baird, C. 1995. Environmental Chemistry. New York: W.H. Freeman and Company.
20. ATSDR. 1999. Toxicological profile for cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp5.html>
21. Health Canada. 1998. Contaminant Profile - Cadmium. In The Health and Environment Handbook for Health Professionals. Available online at: http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/98ehd211/con_profiles.pdf
22. ATSDR. 1999. Toxicological profile for cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp5.html>
23. World Health Organization. Section 3: Sources of Human and Environmental Exposure. In Cadmium: Environmental Health Criteria. Geneva: 1992. Pages 36-45.
24. International Fertilizer Industry Association. Phosphate fertilizer nutrient consumption. Retrieved online February 12, 2003 from: <http://www.fertilizer.org/ifa/statistics/indicators/tablep.asp>



Results

*Cadmium in the
air eventually
settles on land,
including land
used for food
production.
Cadmium is not
used by the
body in any way
to maintain
health.*

Today, Ontario spreads approximately 200,000 tonnes of sludge on over 10,000 hectares of agricultural land. In 1997, the City of Toronto dedicated about half the sludge generated, or 53,000 tonnes, from their Ashbridges Bay wastewater treatment plant (ABTP) to land application.²⁵ The City intends to increase to 100 per cent land application. The average 1997 cadmium level in ABTP's sewage sludge was 5.8 mg/kg, with a maximum of 11.1 mg/kg.²⁶

Cadmium released into the air eventually settles on land, including land used for food production. In Ontario, industry reported cadmium releases of over 7,100 kg under Ontario Regulation 127 in 2001. Major companies responsible for cadmium releases to air under this regulation are Inco Limited (4,884 kg) and Falconbridge Ltd. (2,219 kg).²⁷

Total cadmium releases by Canadian industry are tracked by Environment Canada's National Pollutant Release Inventory (NPRI). In 2001, industry reported 204,000 kilograms of cadmium released on-site (including air pollution, water pollution, spills, leaks, and landfill disposal), and an additional 167,000 kg sent to outside waste dumps for disposal, for a total of 371,000 kg of cadmium released into the environment. This is up almost 25 per cent from the total of 301,000 kg reported in 2000.²⁸

25. Sidhwa, P. 2001. Biosolids research and demonstration field trials in Southern Ontario. Environmental Science & Engineering Magazine. Retrieved online February 24, 2003 from <http://www.esemag.com/1101/biosolids.html>.

26. City of Toronto. Metals in Biosolids. Retrieved online February 24, 2003 from <http://www.city.toronto.on.ca/sewers/metals.htm>.

27. Environmental Defence Canada. 2003. [OnAir 127 air emissions data]. Received through Freedom of Information request.

28. National Pollutant Release Inventory (2001). NPRI Data Search. Retrieved online February 25, 2003 from: <http://www.ec.gc.ca/pdb/querysite/html/queryform.cfm>.

Major companies responsible for releasing cadmium into the air and water, as reported to the NPRI in 2001, are Hudson Bay Mining & Smelting Company Ltd. (53,190 kg to air, 100 kg to water); Inco Limited's Copper Cliff Smelter Complex (4,840 kg to air); Noranda Inc.'s Brunswick Smelter facility in Belledune, NB (540 kg to air, 120 kg to water).²⁹

The 10 most cadmium-contaminated foods are listed in Table 5. Many of the 10 are plant in origin, including several fresh vegetables. This is likely due to the prominent role that soil pollution plays in cadmium contamination.

Table 5: Ten Foods Most Contaminated with Cadmium

Foods (most contaminated)	Cadmium (ppm)
1 Shelled seeds	0.48
2 Organ meats, liver, and kidney	0.15
3 Cabbage	0.11
4 Potato Chips	0.10
5 Peanut butter and peanuts	0.07
6 French fries	0.06
7 Celery	0.06
8 Cookies	0.06
9 Cereals, wheat and bran	0.05
10 Potatoes, boiled with skin on	0.04



29. Ibid.



Results

*Cadmium
concentrates
in the kidney
and liver,
and the US
EPA has
designated
cadmium as
a probable
carcinogen.*

4.1.2 TOXICOLOGICAL ASSESSMENT

Cadmium is not used by the body in any way to maintain health. Cadmium is a health concern because it accumulates in the body even when only a small amount is ingested over time. Cadmium concentrates in the kidney and liver. Concentrations in these organs are zero at birth and rise with age. Kidney levels peak at around 50-60 years of age, and liver levels peak at around 20-25 years of age. Cadmium's major target organ is the kidney, and chronic exposure can lead to kidney disease. The US EPA has designated cadmium as a probable carcinogen.³⁰

For the general population, the primary sources of cadmium exposure are food and cigarettes. The Canadian Total Diet Study data shows levels of cadmium in vegetables and grains equal to and exceeding those of animal products (Table 6). Because the average Canadian consumes a greater amount of cereal and vegetable products, these are the greatest sources of cadmium for the general population.

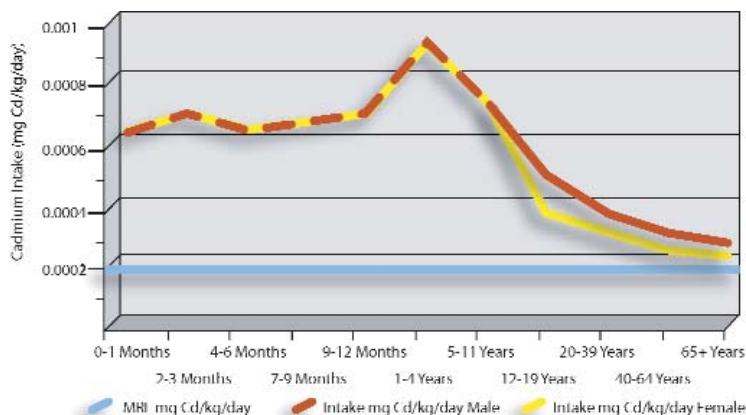
Table 6: Cadmium Contamination Levels in Canadian Food

Food Category	mg Cd/Kg food (ppm)
Dairy Products	0.005
Meat and Meat Products	0.020
Poultry and Poultry Products	0.006
Fish and Fish Products	0.008
Soups	0.006
Cereal and Cereal Products	0.021
Vegetables and Veg. Products	0.027
Fruit and Fruit Products	0.007
Fats and Oils	0.038
Miscellaneous	0.078
Beverages	0.001
Baby Foods	0.006
Packaged cookable Foods	0.020
Fast Foods	0.022

30. Meranger, J., Conacher, H., Cunningham, H, and Krewski, D. 1981. Levels of cadmium in human kidney cortex in Canada. Canadian Journal of Public Health, 72, 269-272.

A Minimal Risk Level (MRL) of 0.0002 mg Cd/kg/day has been developed by the Agency for Toxic Substances and Disease Registry for the protection from kidney toxicity of the most sensitive individuals of the general population.³¹ The TDS performed by Health Canada indicates that cadmium intake levels exceed the MRL in every age group (Figure 1). Canadians of all ages are at risk of increased kidney problems due to unhealthy levels of cadmium in their diet.

Figure 1: Dietary Intake of Cadmium Compared to the Intake Guideline



4.2 LEAD

Lead is released into the wider environment primarily through human activity. It is a major component of the mineral "galena" which has been mined for thousands of years. Lead's low melting point allows it to be readily worked and shaped.³²

31. ATSDR. 1999. Toxicological profile for cadmium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp5.html>

32. ATSDR. 1999. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp13.html>





Results



It was used in ancient Rome as a structural support metal, for water ducts, and for cooking vessels. Various salts of lead have been used as pigments in paints, and as colouring agents in food. It is a component of batteries, solder used in the electronics industry, and is also found in ammunition.³³

Human activities that contribute to the environmental release of lead into the air include mining, smelting, and other industrial applications. Disposal of batteries and other lead-containing materials can release lead to the soil.³⁴ The use of leaded gasoline in the past has significantly increased the presence of lead in the environment. Lead in gas was released into the atmosphere and eventually settled in the soil.

A growing concern over the health effects of lead, especially in children, has caused the federal government to act by instituting a number of policies and regulations, including the elimination of leaded gasoline, banning of lead solder in the food canning process, and a ban on lead-based paint. Although lead exposure has been reduced, the results of the TDS show food remains a hidden pathway.

4.2.1 PATHWAY TO THE FOOD SUPPLY

Atmospheric deposition of lead on agricultural lands can result in its absorption into plants. Lead in soil does not dissipate, biodegrade, or break down, and so the past practice of using leaded gasoline is still a cause for elevated lead levels in soil.³⁵

33. Baird, C. 1995. Environmental Chemistry. New York: W.H. Freeman and Company.

34. Health Canada. 1998. Contaminant Profile - Lead. In The Health and Environment Handbook for Health Professionals. Retrieved online February 25, 2003 from:

http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/98ehd211/con_profiles.pdf

35. New South Wales Environmental Protection Agency. 2001. Pathways of exposure to lead. Retrieved online February 25, 2003 from:

<http://www.epa.nsw.gov.au/leadsafe/leadinf8.htm#food>.

Atmospheric releases of lead reported under Ontario Regulation 127 in 2001 amounted to 371,774 kg. The main companies contributing to this pollution are:

· St. Marys Cement Inc.	202,760 kg
· Inco Limited	73,002 kg
· Falconbridge Ltd.	37,870 kg
· Philips Lighting Company	26,087 kg
· Archie McCoy Hamilton Ltd	15,780 kg
· Ingot Metal Company Limited	6,280 kg
· Siemens Milltronics Process Instruments Inc.	3,104 kg

Lead can leach from older plumbing into drinking water or water used for food manufacturing or processing.³⁶ While lead is not allowed for sealing canned goods in North America, it is still practiced in other parts of the world. Improperly glazed ceramic containers can also leach lead into stored food.³⁷

According to the National Pollutant Release Inventory, Canadian industries released 2,223,000 kg of lead on their sites, and sent an additional 1,711,000 kg to waste dumps for disposal, for a total of 3,934,000 kg of lead released into the environment.³⁸

Canadian industries released at least 3.9 million kg of lead into the environment in 2001.

36. Health Canada. 1998. Contaminant Profile - Lead. In The Health and Environment Handbook for Health Professionals. Retrieved online February 25, 2003 from: http://www.hc-sc.gc.ca/ehp/ehd/catalogue/bch_pubs/98ehd211/con_profiles.pdf
37. Kessel, Irene, John T. O'Conner. 1997. Getting the lead out: The complete resource on how to prevent and cope with lead poisoning. New York: Plenum Trade, 135-140.
38. National Pollutant Release Inventory (2001). NPRI Data Search. Retrieved online February 25, 2003 from: <http://www.ec.gc.ca/pdb/querysite/html/queryform.cfm>.



Results



Major companies responsible for lead released into the air and water, as reported to the NPRI in 2001, are Hudson Bay Mining & Smelting Company Ltd. (176,900 kg to air, 400 kg to water); St Marys Cement Company (101,000 kg to air); Noranda Inc.'s Brunswick Smelter facility in Belledune, NB (8,050 kg to air, 240 kg to water); Stelco McMaster Ltée (1540 kg to air); Safety-Kleen Ltd.'s Lambton Facility (70 kg to air).³⁹

The 10 most lead contaminated foods are listed in Table 7. Note that most require a certain amount of processing.

Table 7: Ten Foods Most Contaminated with Lead

Foods (most contaminated)	Lead (ppm)
1 Frozen dinner consisting of meat, vegetables and dessert	0.70
2 Fish Burger	0.40
3 Raisins	0.08
4 Organ meats, liver and kidney	0.04
5 Frozen entrée - boiled	0.04
6 Muffins	0.04
7 Peaches	0.04
8 Wine	0.03
9 Ground Beef	0.03
10 Danish and Donuts	0.03

4.2.2 TOXICOLOGICAL ASSESSMENT

Negative effects may be caused by lead at any concentration, especially in children. The United States Environmental Protection Agency has determined that

it would be inappropriate to develop a reference dose (RfD) for inorganic lead (and lead compounds) because some of the health effects associated with exposure to lead occur at blood lead levels as low as to be essentially without a threshold.⁴⁰

39. Ibid.

40. ATSDR. 1999. Toxicological profile for lead. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service, page 449. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp13.html>.

Major food groups containing lead are prepared foods, fast foods, fats and oils, and meat. A break down of lead contamination in different food categories is located in Table 8.

Lead has no known biological function in humans. It is poorly absorbed by the body from the digestive system, though children can absorb lead much more readily than adults. The slow rate at which it is eliminated from the body leads to a build up of lead in the bones and red blood cells.⁴¹

Table 8: Lead Contamination Levels in Canadian Food

Food Category	mg Pb/Kg food (ppm)
Dairy Products	0.006
Meat and Meat Products	0.018
Poultry and Poultry Products	0.002
Fish and Fish Products	0.012
Soups	0.005
Cereal and Cereal Products	0.013
Vegetables and Veg. Products	0.007
Fruit and Fruit Products	0.013
Fats and Oils	0.021
Miscellaneous	0.010
Beverages	0.009
Baby Foods	0.004
Packaged cookable Foods	0.131
Fast Foods	0.068



41. Ibid.



Results



Lead is associated with a number of adverse health effects. It can interfere with the creation of oxygen-carrying hemoglobin, leading to anemia, and it is also known to cause neurobehavioural problems in developing fetuses and young children. Lead has negative effects on children's behaviour, attentiveness, and their IQs.⁴²

While the US EPA has determined that there is no safe limit of lead exposure, for the sake of analysis Environmental Defence Canada used an intake guideline of 0.0000785 mg Pb/kg/day developed by Environmental Defense (USA) based on information developed by the California Environmental Protection Agency.⁴³

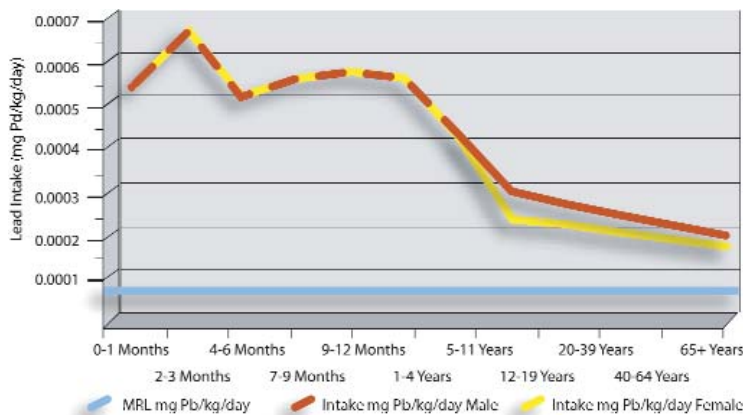
The TDS performed by Health Canada indicates that lead intake levels exceed this RfD in every age group (Figure 2). Canadians of all ages are at risk of negative health effects due to these levels of lead in their diet. It is clear that current lead exposure reduction activities are not sufficiently protecting the health of Canadians. Further precautionary measures are required to reduce industrial releases of lead into the environment.

4.3 OTHER METALS

There are a number of metals tested in the Canadian Total Diet Study program that exceed applicable RfDs or MRLs in the diets of infants and children, but whose levels gradually fall within the guidelines as the diets of Canadians change with age (Figures 3-7). These metals include copper, manganese, molybdenum, nickel, and zinc. The 10 most contaminated foods for these metals can be found in Table 9.

42. Ibid.

43. Environmental Defense. 2002. References for Scorecard Risk Assessment Values. Retrieved online February 25, 2003 from: http://scorecard.org/chemical-profiles/ref/rav_edf.html

Figure 2: Dietary Intakes of Lead Compared to the Intake Guideline**Table 9: Ten Foods Most Contaminated with Various Heavy Metals**

	Copper		Manganese		Molybdenum		Nickel		Zinc	
	Food	ppm	Food	ppm	Food	ppm	Food	ppm	Food	ppm
1	Organ meats, liver and kidney	32	Cereals, wheat and bran	40.6	Cabbage	1.7	Cookies	3.3	Roast and stewing beef	89.7
2	Shelled seeds	15.6	Shelled seeds	28.1	Peanut butter and peanuts	1.4	Shelled seeds	2.4	Beef steak	77.5
3	Peanut butter and peanuts	6.1	Peanut butter and peanuts	20.9	Organ meats, liver and kidney	1	Cured pork	2.3	Ground beef	62.1
4	Cereals, wheat and bran	5	Muffins	20.3	Cereals, wheat and bran	0.6	Peanut butter and peanuts	1.5	Lamb	60.8
5	Raisins	3.9	Canned Pineapple	19	Cooking fats and Salad Oils	0.5	Baby food - vegetables	1.4	Organ meats, liver and kidney	57.3
6	Canned mushrooms	3.9	Whole wheat bread	18.9	Shelled Seeds	0.5	Danish and donuts	1.3	Shelled Seeds	53.1
7	Cookies	3.2	Oatmeal	12.4	Peas	0.4	Muffins	1.1	Veal	46.2
8	Chocolate bars	2.9	Microwave popcorn	11.1	Baked beans	0.4	Crackers	0.8	Cereals, wheat and bran	44.4
9	Potato chips	2.9	Pie	10.8	Rice	0.3	Ground beef	0.8	Cheese	39
10	Baked beans	2.3	Crackers	9.9	Plums, dried prunes and canned plums	0.3	Oatmeal	0.7	Hamburger (fast food)	38.9



Results



Figure 3: Dietary Intake of Copper Compared to the Intake Guideline

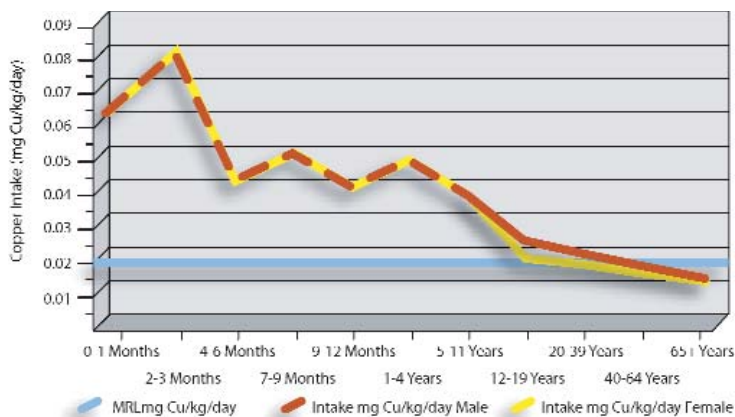


Figure 4: Dietary Intake of Manganese Compared to the Intake Guideline

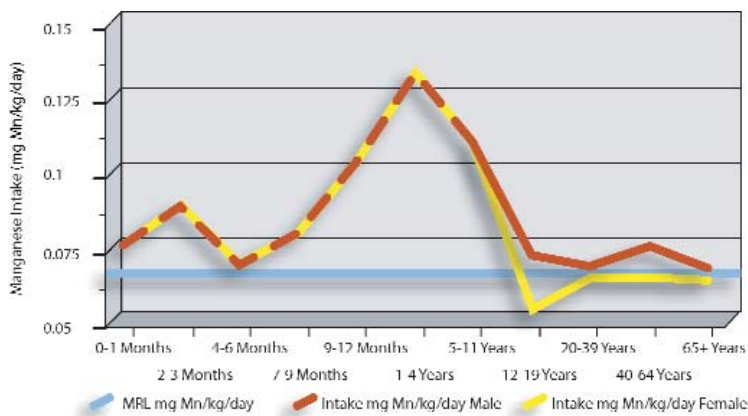


Figure 5: Dietary Intake of Molybdenum Compared to the Intake Guideline

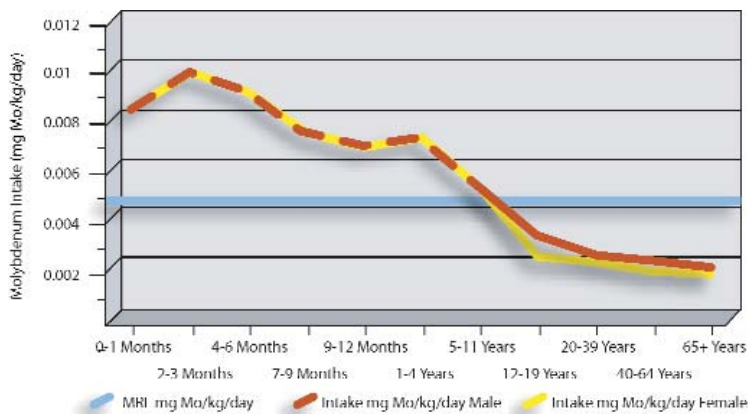
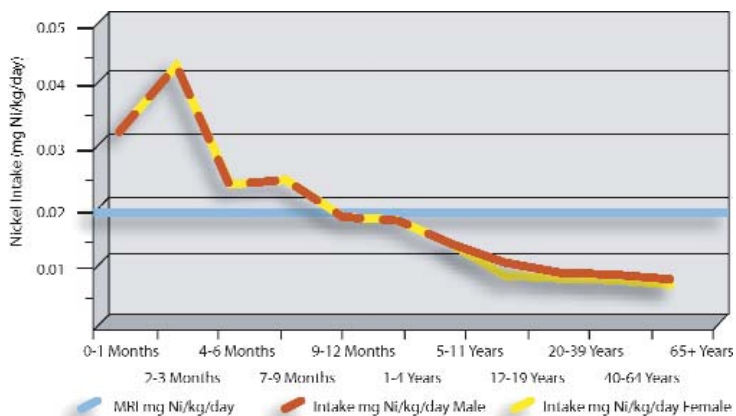


Figure 6: Dietary Intake of Nickel Compared to the Intake Guideline

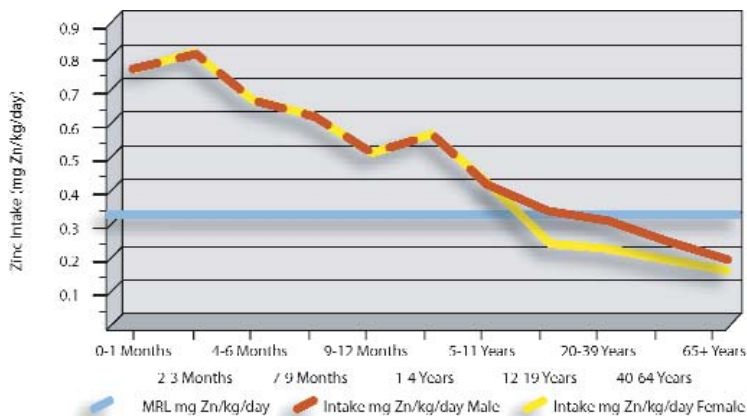




Results

Industry was responsible for releasing 2,290,000 kg of copper, 10,180,000 kg of manganese, 111,000 kg of molybdenum, 1,900,000 kg of nickel, and 18,840,000 kg of zinc both on-site and through transfers for disposal in 2001.

Figure 7: Dietary Intake of Zinc Compared to the Intake Guideline



Most of these metals are important parts of maintaining good health and are thus essential dietary nutrients. In fact, manganese, molybdenum, and zinc have Recommended Daily Allowances for adults of 2.0 - 5.0 mg/day, 0.075 - 0.25 mg/day, and 15 mg/day, respectively.⁴⁴ While too little of these metals can lead to negative effects, so can too much.

These metals are present in the earth's crust and their presence in the environment is increased by human activity. Copper, for example, is released through mining activities, the application of sewage sludge to land, and the use of agricultural chemicals.⁴⁵

All told, industry was responsible for releasing 2,290,000 kg of copper, 10,180,000 kg of manganese, 111,000 kg of molybdenum, 1,900,000 kg of nickel, and 18,840,000 kg of zinc both on-site and through transfers for disposal in 2001 (Table 10).⁴⁶

44. ATSDR. 2000. Toxicological profile for manganese. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp151.html>; and ATSDR. 1994. Toxicological profile for zinc. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp60.html>.

Table 10: Industrial Releases of Selected Heavy Metals to the Environment in 2001

Metal	On-Site Releases (tonnes)	Transfers for disposal (tonnes)	Total Releases to the environment (tonnes)
Copper	1170	1120	2290
Manganese	5050	5130	10180
Molybdenum	3	108	111
Nickel	940	960	1900
Zinc	9550	9290	18840

There are adverse human health effects associated with excess dietary exposure to each of these metals. For example, molybdenum has been associated with a gout-like sickness, and some members of the population are especially sensitive to nickel, suffering a form of skin dermatitis when exposed to the metal orally.⁴⁷

In the case of excess exposure to manganese, neurotoxic effects include weakness, slow and clumsy gait, speech disturbances, and tremors.⁴⁸ Zinc is required for the proper functioning of hundreds of enzymes, and is therefore the most abundant metal in humans. It can be found in all tissues and tissue fluids, but overexposure to zinc has been shown to cause anemia.⁴⁹

Children are at risk of negative health effects due to intake of these heavy metals above the intake guidelines.



45. ATSDR. 2002. Toxicological profile for copper - draft for public comment. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp132.html>
 46. National Pollutant Release Inventory (2001). NPRI Data Search. Retrieved online February 25, 2003 from: <http://www.ec.gc.ca/pdb/querysite/html/queryform.cfm>.

Footnotes continue on next page.



Conclusions and Recommendations

Industry continues to release toxic metals into the environment despite evidence that they reaches our food supply.

Through this straight comparison of heavy metal intakes and their corresponding intake guidelines, it is clear that Canadians are being subjected to unhealthy levels of these toxic substances.

Cadmium, which can cause kidney disease and cancer, is being eaten by Canadians of all ages above intake guidelines. Lead, which can cause negative health effects no matter how little is consumed, is in the diets of Canadians of all ages. Children are being exposed to potentially unsafe levels of copper, manganese, molybdenum, nickel, and zinc.

Industry continues to release these toxic metals into the environment despite evidence that they reaches our food supply. The TDS are an indicator that our food safety system is failing to protect Canadians from the effects of toxic pollution.

Cadmium, which has been identified as a problem since the first TDS was conducted in 1969, is still released into the environment through industrial practices. Industry reported releases of 371,000 kilograms of cadmium in 2001. Despite numerous efforts to curb lead exposure, industry still reports releases of lead in the millions of kilograms, and this pollution is still reaching Canada's food. Industry reported releases totalling 3,934,000 kilograms of lead in 2001.

The TDS has revealed food as an important exposure pathway, but this critical part of the food safety system is not designed to trigger action. The federal government does not currently have the capacity to address the issue of chronic over-exposure to heavy metal contamination in our food.

47. ATSDR. 1997. Toxicological profile for nickel. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp15.html>

48. ATSDR. 2000. Toxicological profile for manganese. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp151.html>

49. ATSDR. 1994. Toxicological profile for zinc. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service. Retrieved online February 25, 2003 from: <http://www.atsdr.cdc.gov/toxprofiles/tp60.html>

Environment Canada, Health Canada, the CFIA, and Agriculture and Agri-Food Canada must take precautionary action, working together for long-term policy and legislative changes that will eliminate the release of heavy metals into the environment. As steps towards achieving this goal, Environmental Defence Canada recommends the following actions to ensure that the health of Canadians is not endangered:

1. Environment Canada must enact regulations for the phase-out of heavy metal releases to air and water under the *Canadian Environmental Protection Act*.
2. *The Food and Drugs Act* and *Regulations* must be reviewed and updated. Under the *Act*, toxic food residue standards, called Maximum Residue Limits, must be developed, enacted, and legally enforceable for all heavy metals.
3. The Canadian Food Inspection Agency must carry out effective monitoring of all heavy metal contamination of food, and must pull all foods exceeding the Maximum Residue Limits off the shelves.
4. The Total Diet Study program must continue to monitor and analyze Canadian food pollution data, and communicate all results to the public in a timely and accessible manner.
5. Health Canada must produce an online registry of food contamination data modeled after Environment Canada's National Pollutant Release Inventory
6. Agriculture and Agri-Food Canada must set national farm management standards that protect food from heavy metal contamination, such as regulating the land application of phosphate fertilizers and sewage sludge.

*Environment
Canada must
enact
regulations for
the phase-out
of heavy metal
releases to air
and water
under the
Canadian
Environmental
Protection Act.*



Glossary

ATSDR

Agency for Toxic Substances and Disease Registry (United States)

Cd - Cadmium

Cu - Copper

Mg - Magnesium

mg/kg/day - Milligrams of a substance consumed per kilogram of a person's body weight per day. A unit for expressing intake levels of a contaminant. It measures a certain number of milligrams of a substance for every kilogram of a person's body weight per day.

Mo - Molybdenum

MRL - Minimum Risk Level

National Pollutant Release Inventory (NPRI) - Canada's national pollution registry. Polluters meeting certain criteria must report all pollutant releases to the NPRI annually. This information is made available through an online search tool at the following URL:

<http://www.ec.gc.ca/pdb/querysite/html/queryform.cfm>.

Ni - Nickel

Pb - Lead

ppm, parts per million - A measure of concentration. The number of parts of a particular substance are present in every million parts of the complete mixture.

PTDI - Provisional Tolerable Daily Intake

Recommended Daily Allowance - An amount of a substance recommended for daily intake to maintain proper health

RfD - Reference Dose

TDS, Total Diet Study

A type of scientific study conducted by Health Canada that calculates the daily intake of contaminants for an average diet.

US EPA - United States Environmental Protection Agency

Zn - Zinc

Visit Environmental Defence Canada's
Food Safety Website:



www.foodwatch.ca

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