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HUMAN EXPOSURE TO HARMFUL SUBSTANCES

CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

Canada

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CANADIAN ENVIRONMENTAL SUSTAINABILITY INDICATORS

HUMAN EXPOSURE TO HARMFUL SUBSTANCES

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Human exposure to harmful substances

Chemicals are present in air, soil, water, products and food. Humans are exposed to chemicals in many ways, including inhalation, ingestion and skin contact. These indicators present the average concentrations of selected environmental chemicals in Canadians.

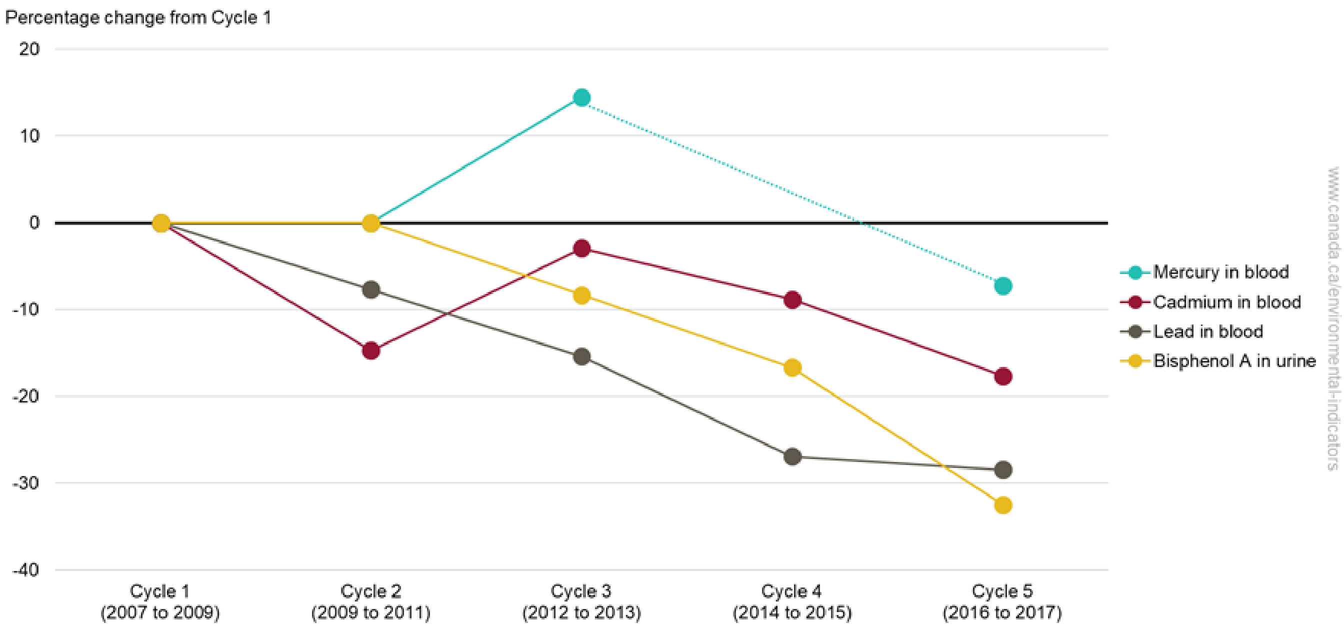
Summary

Key results

A decade of national biomonitoring conducted as part of the Canadian Health Measures Survey between 2007 and 2017 (cycles 1 to 5) showed that the average concentrations in Canadians of:

- bisphenol A (BPA), lead and cadmium generally decreased
- mercury remained stable

Figure 1. Changes in the average concentrations of selected substances in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)



Data for Figure 1

Note: The chart presents the percentage change in the average (geometric mean) concentrations of selected substances in Canadians relative to Cycle 1 (2007 to 2009). The concentrations of mercury, lead and cadmium in blood and bisphenol A in urine are from participants aged 3 to 79 years, except for Cycle 1 when there were no participants under the age of 6 years. For Cycle 4, the average (geometric mean) for mercury was not calculated since more than 40% of the samples were below the limit of detection.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

The average concentration of mercury in the blood of Canadians remained stable[1] from Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017).

[1] A statistical analysis of the biomonitoring data from Cycle 1 to Cycle 5 for mercury did not show a trend. A percentage decrease between Cycle 1 and Cycle 5 was calculated only when there was a statistically meaningful trend. For more information on this analysis, refer to the Data sources and methods.

There was a declining trend[2] in the average concentration of lead in the blood of Canadians from Cycle 1 to Cycle 5. It decreased 28% between Cycle 1 and Cycle 5 and 81% since 1978 to 1979.[3]

The average concentration of cadmium in the blood of Canadians showed a declining trend from Cycle 1 to Cycle 5. Between Cycle 1 and Cycle 5, the concentration decreased by 18%.

There was also a declining trend in the average concentration of BPA in urine of Canadians from Cycle 1 to Cycle 5. The concentration decreased by 33% during the period.

Mercury

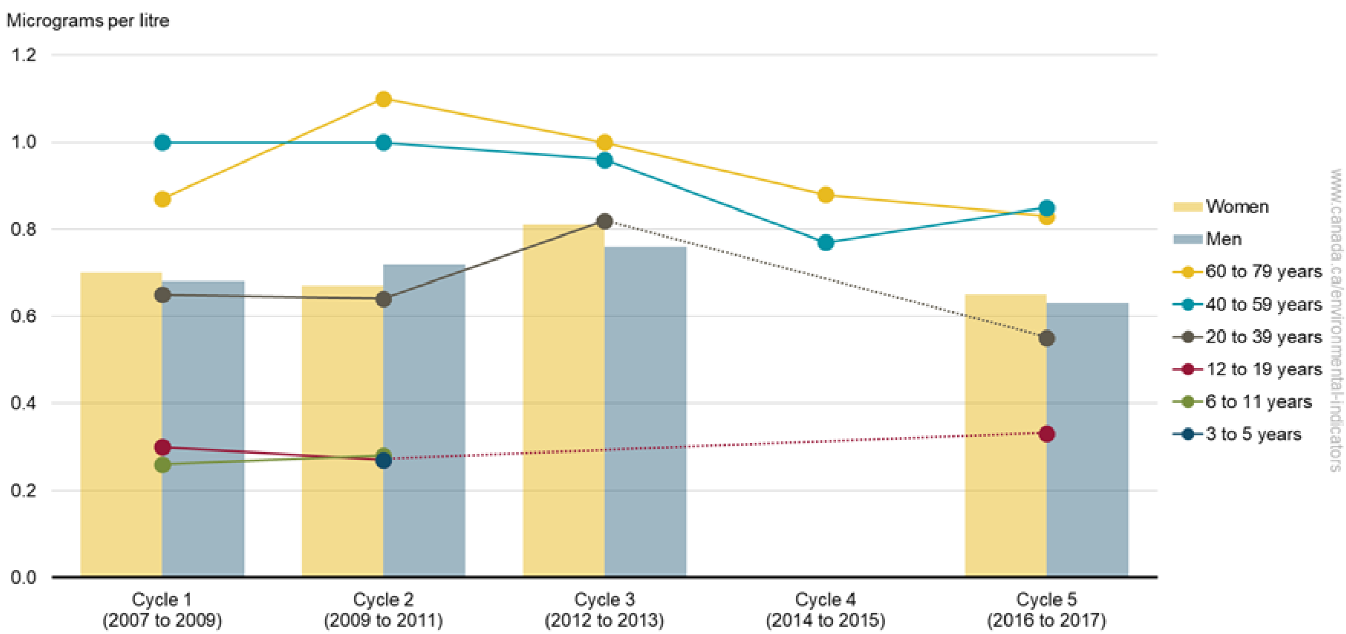
Exposure to mercury is of global concern because it can cause adverse health effects, such as neurological effects, gastrointestinal damage or kidney failure. Mercury is found throughout the environment, including the atmosphere, water, soil, sediments and biota. It occurs naturally in the Earth's crust and is released into the air during forest fires, volcanic episodes and other geological activities. Mercury is also used in, and released from, industrial processes and commercial products.

Key results

Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of mercury:

- remained stable[4]
- were higher in adults than in children
- were similar in women and men

Figure 2. Average concentration of mercury in blood in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)



[2] The declining trends for lead, cadmium and BPA are based on a statistical analysis of the biomonitoring data from Cycle 1 to Cycle 5. For more information on this analysis, refer to the Data sources and methods.

[3] The geometric mean was 47.9 micrograms per litre among people aged 6 to 79 years in 1978 to 1979 (Bushnik et al. 2010).

[4] A statistical analysis of the biomonitoring data from Cycle 1 to Cycle 5 for mercury did not show a trend. A percentage decrease between Cycle 1 and Cycle 5 was calculated only when there was a statistically meaningful trend. For more information on the trend analysis, refer to the Data sources and methods.

Data for Figure 2

Note: For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. For cycles 3 to 5, averages (geometric means) were not calculated for some age groups, since more than 40% of the samples were below the limit of detection. Mercury is shown as total mercury (organic and inorganic).
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Adults aged 40 to 59 years and 60 to 79 years consistently presented higher average concentrations of mercury compared to other age groups due to mercury accumulation in the body.

Mercury is widespread in the environment. It is a naturally occurring metal and is also released by many industrial processes, such as chemical manufacturing operations, metal mining and coal combustion. It can travel long distances in the atmosphere and settles everywhere in Canada, including sensitive areas such as the Canadian Arctic and the Great Lakes. Mercury exists in 3 forms: elemental mercury, inorganic mercury compounds and organic mercury compounds, such as methylmercury. Mercury is toxic to humans and accumulates in terrestrial and aquatic food chains over time.

Humans are exposed to methylmercury (neurotoxicant) primarily through consumption of contaminated fish and seafood. Marine mammals or fish that are long-lived and feed on other fish can accumulate high levels of methylmercury. To a much lesser extent, the general population is also exposed to inorganic mercury from improper disposal of products containing mercury such as switches, batteries, thermometers and fluorescent lamps and from the use of dental amalgam.

The human health effects depend on various factors, such as the form and amount of mercury encountered, the length of exposure, and the age of the person exposed. Oral exposure to organic mercury compounds can cause neurological damage and developmental neurotoxicity. Exposure of a fetus or young child to organic mercury can affect the development of the nervous system, including fine-motor function, attention, verbal learning and memory. High exposure to inorganic mercury can cause damage to the gastrointestinal tract and kidneys. Exposure to elemental mercury inhaled as mercury vapour may cause adverse neurological, respiratory and kidney effects.

Mercury is listed on the Toxic substances list (Schedule 1) of the *Canadian Environmental Protection Act, 1999*. It is also subject to numerous federal risk management initiatives directed towards consumer products, cosmetics, drinking water, food, therapeutic products and environmental media, including water and air.

Lead

Lead released from natural processes, such as weathering, erosion and volcanic activity, and from industrial emissions can be deposited on land or water surfaces and then build up in soils, sediments, humans and wildlife. Canadians are exposed to low levels of lead through food, drinking water, air, household dust, soil and various products. Exposure to lead, even in small amounts, can be hazardous to both humans and wildlife.

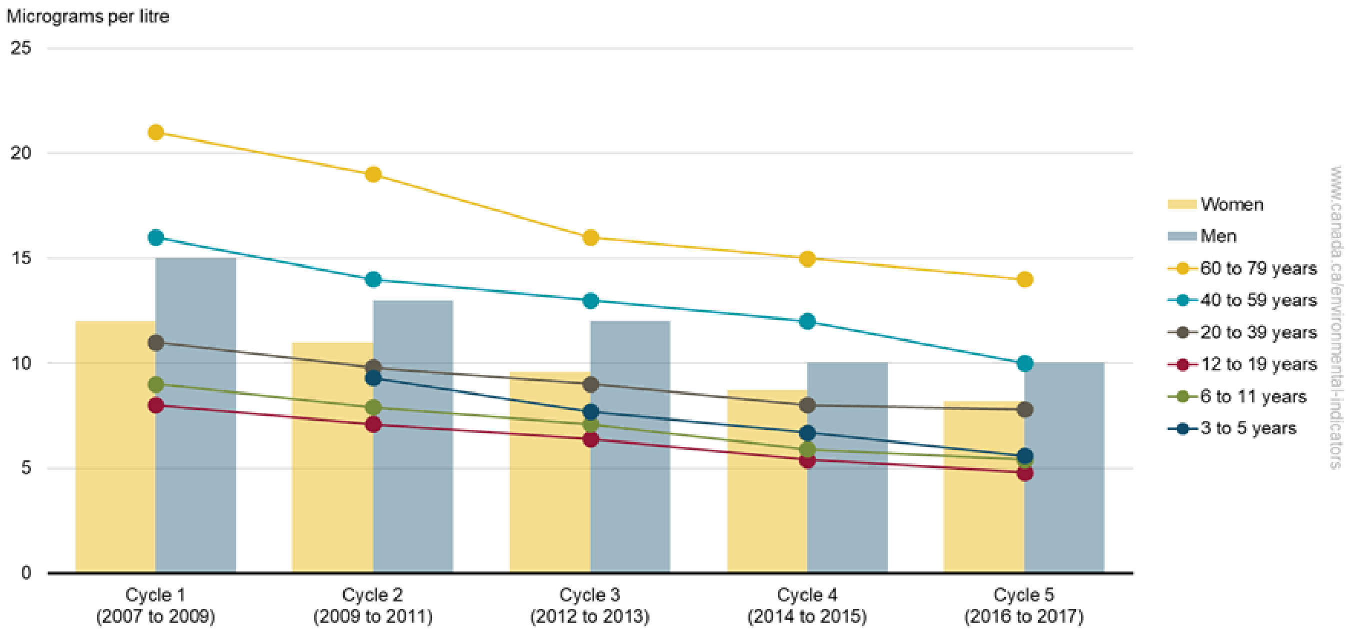
Key results

Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of lead:

- showed a declining trend,[5] with a decrease of 28% between Cycle 1 and Cycle 5
- were lower in children than in adults
- were highest in adults aged 60 to 79 years
- were higher in men than in women

[5] The declining trend for lead was based on a statistical analysis of the biomonitoring data from Cycle 1 to Cycle 5. For more information on this analysis, refer to the Data sources and methods.

Figure 3. Average concentration of lead in blood in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)



Data for Figure 3

Note: For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. Average refers to geometric mean.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Adults aged 60 to 79 years consistently presented the highest concentrations of lead due to accumulation in teeth and bones over time. Children (especially 3 to 5 years) could be more vulnerable to exposure because of their hand-to-mouth behaviour, which increases their exposure to lead from dust and soil.

On average, men have greater concentrations of lead in their blood than women. This may be due in part to men having a higher volume of red blood cells, to which lead binds in the body.

Lead exposure in Canada has decreased by approximately 80% over the past 40 years.[6] This decrease is largely attributed to the phase-out of leaded gasoline, restrictions on the use of lead in consumer paints and other coatings on children's products, and elimination of lead solder in food cans.

Lead is a naturally occurring element found in rock, water and soil. It is used in the refining and manufacturing of products such as lead acid car batteries, lead shot and fishing weights, sheet lead, solder, some brass and bronze products, pipes, paints and some ceramic glazes. Exposure to trace amounts of lead occurs through soil, household dust, consumer products, food, drinking water and air because of its natural abundance in the environment and its widespread use for much of the 20th century.

Exposure to very high levels of lead may result in vomiting, diarrhea, convulsions, coma and death. Chronic exposure to relatively low levels may affect the central and peripheral nervous systems, blood pressure, and renal function and may result in reproductive problems and developmental neurotoxicity.

Lead is listed on the Toxic substances list (Schedule 1) of the *Canadian Environmental Protection Act, 1999*. It is also subject to numerous federal risk management initiatives directed towards consumer products, cosmetics, drinking water, food, natural health products, therapeutic products, tobacco and environmental media, including household dust, soil, and air.

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[6] Bushnik et al. (2010) Lead and bisphenol A concentrations in the Canadian population. Health Report (3):7-18. Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Cadmium

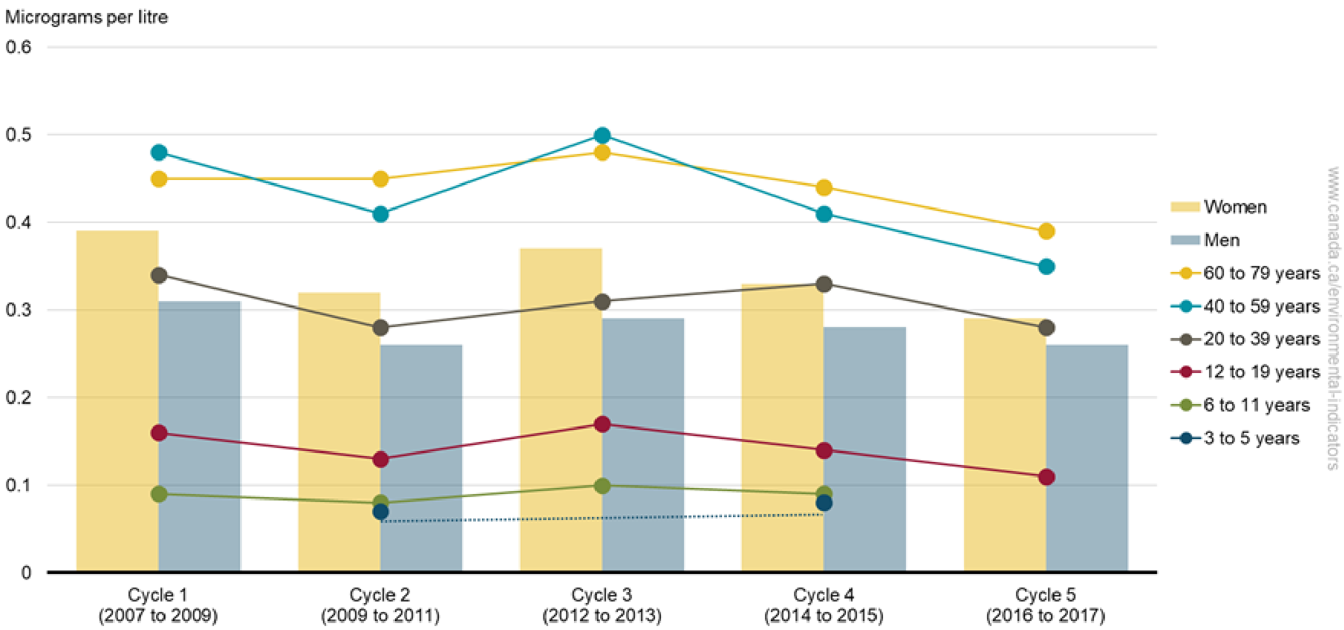
Cadmium is a naturally occurring metal. It is used in batteries and in electroplating to protect other metals from corrosion. Exposure to cadmium can be hazardous to both humans and wildlife since it accumulates in the food chain over time.

Key results

Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of cadmium:

- showed a declining trend[7] in the total population, with a decrease of 18% between Cycle 1 and Cycle 5
- were highest in adults aged 40 to 59 years and 60 to 79 years
- were higher in women than in men

Figure 4. Average concentration of cadmium in blood in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)



Data for Figure 4

Note: For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. For cycles 3 and 5, averages (geometric means) were not calculated for some age groups, since more than 40% of the samples were below the limit of detection.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Adults aged 40 to 59 years and 60 to 79 years consistently had the highest average concentrations of cadmium. Cadmium has a biological half-life (the time it takes to reduce the concentration by half) of about 10 to 12 years in the kidney and accumulates with age.

Women on average have greater concentrations of cadmium in their blood than men. This is due in part to the average rate of gastrointestinal absorption of dietary cadmium. The gastrointestinal absorption rate in women is estimated to be 10% or higher, while in men it is estimated to be 5%.

Cadmium is released into the environment as a result of natural processes, including forest fires, volcanic emissions, and weathering of soil and bedrock. It is a metal used in batteries and in electroplating to protect other metals from corrosion. It may be released directly into air from human activities such as non-ferrous smelting and

[7] The declining trend for cadmium was based on a statistical analysis of the biomonitoring data from Cycle 1 to Cycle 5. For more information on this analysis, refer to the Data sources and methods.

refining, and fuel consumption for electricity generation or heating. Inhalation of cigarette smoke is a major source of cadmium exposure in smokers. Non-smokers are exposed to cadmium through food, breathing in second-hand smoke and for some, occupational exposure can also be a source. Other minor sources of exposure include drinking water, soil or dust, as well as inhalation and releases from consumer products.

Exposure to cadmium has been associated with gastrointestinal irritation and harmful effects to the kidneys and lungs. Cadmium and its compounds have been classified by Environment and Climate Change Canada and Health Canada as a probable carcinogen in humans when inhaled. Inorganic cadmium compounds are listed on the Toxic substances list (Schedule 1) of the *Canadian Environmental Protection Act, 1999*. It is also subject to a number of federal risk management initiatives directed towards consumer products, cosmetics, drinking water, food and environmental media, including water and air.

Bisphenol A

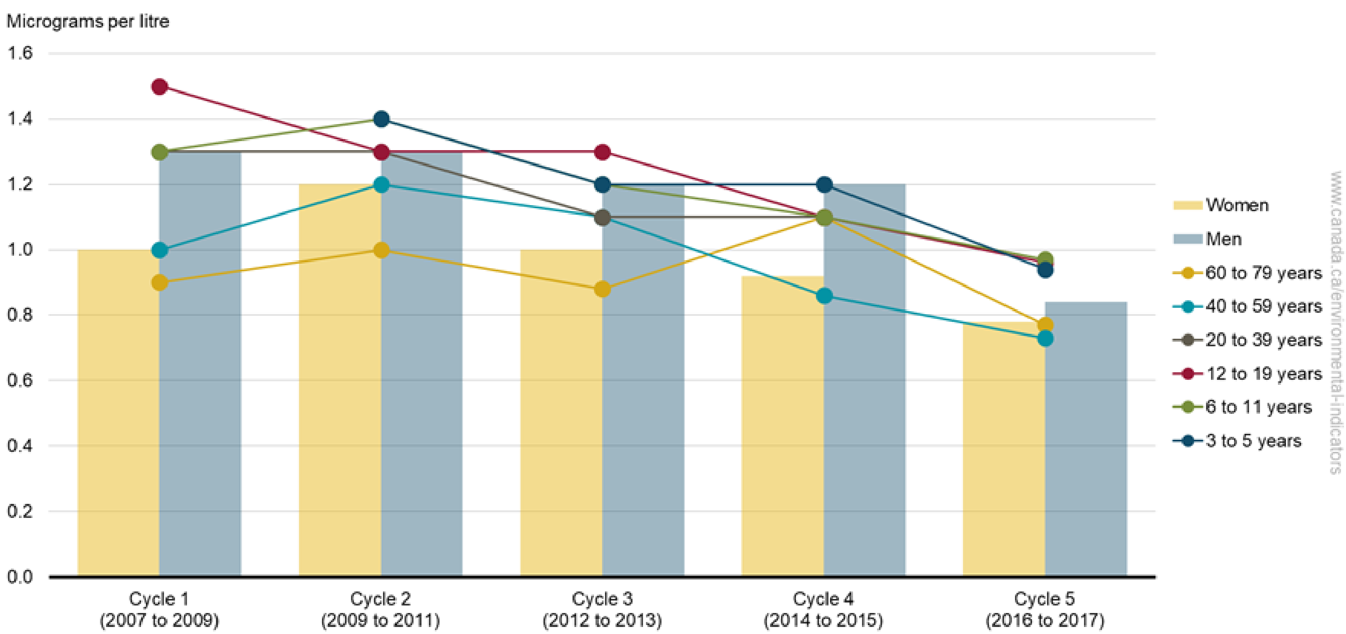
Bisphenol A (BPA) is a synthetic chemical used in plastics, epoxy resins and thermal paper, that poses environmental and health concerns; it is known as a potential hormone disruptor and it can adversely affect reproduction, growth, and development in humans and wildlife.

Key results

Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of BPA:

- showed a declining trend[8] in the total population, with a decrease of 33% between Cycle 1 and Cycle 5
- were higher in children than in adults
- were higher in men than in women

Figure 5. Average concentration of bisphenol A in urine in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)



Data for Figure 5

Note: For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. Average refers to geometric mean.

[8] The declining trend for BPA was based on a statistical analysis of the biomonitoring data from Cycle 1 to Cycle 5. For more information on this analysis, refer to the Data sources and methods.

Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

The average concentration of BPA was lower in adults aged 40 to 59 years and 60 to 79 years and higher in the younger age groups. Overall, men have a higher concentration of BPA than women possibly due to differences in hormone levels. Further research is ongoing to better understand how BPA is absorbed, distributed, metabolized and excreted by the body.

BPA is found in food packaging and repeat-use plastic containers; it migrates from the packaging into food and drinks. Exposure can also occur from air, drinking water, soil, dust and the use of consumer products. The Government of Canada has concluded that current dietary exposure to BPA through food packaging is not expected to pose a health risk to the general population, including newborns and infants.

Bisphenol A is known as a hormone disruptor and can adversely affect the liver, the kidneys and reproduction, including fertility and development. Although dietary exposure to BPA through food packaging is not expected to pose a health risk to Canadians, a precautionary approach has been taken to limit exposure of infants and newborns to BPA from food packaging. As part of these efforts, BPA has been prohibited in baby bottles sold in Canada since 2010. It is listed on the Toxic substances list (Schedule 1) of the *Canadian Environmental Protection Act, 1999* and is subject to federal risk management initiatives directed towards cosmetics, foods and industrial effluents.

About the indicators

What the indicators measure

These indicators present the concentrations of 4 substances (mercury, lead, cadmium and bisphenol A) in Canadians for the 5 survey cycles from 2007 to 2017 based on data collected as part of the Canadian Health Measures Survey. These substances were chosen from the Canadian Health Measures Survey because they complement other indicators from the Canadian Environmental Sustainability Indicators program. For each substance, the concentration in blood or urine is provided by age group and by sex when data are available.

Why these indicators are important

Chemical substances are everywhere, including in the air, soil, water, products and food, and can enter the body through ingestion, inhalation and skin contact. Mercury and its compounds, lead, inorganic cadmium compounds and bisphenol A are on the Toxic substances list under Schedule 1 of the *Canadian Environmental Protection Act, 1999*. This means that these substances are "entering or may enter the environment in a quantity or concentration or under conditions that (a) have or may have an immediate or long-term harmful effect on the environment or its biological diversity; (b) constitute or may constitute a danger to the environment on which life depends; or (c) constitute or may constitute a danger in Canada to human life or health."

The Government of Canada uses a variety of methods, tools and models to assess human exposure to environmental chemicals and their potential health effects. Human exposure to chemicals can be estimated indirectly by measuring chemicals in the environment, food or products, or directly by biomonitoring. The Canadian Health Measures Survey measures environmental chemicals and/or their metabolites in blood and urine of participants. These indicators provide a snapshot of the survey results.

Through biomonitoring, the government can identify priorities, develop or revise risk management strategies, and track progress on policies put in place to reduce or control these substances.

Safe and healthy communities

These indicators support the measurement of progress towards the following 2019 to 2022 Federal Sustainable Development Strategy long-term goal: All Canadians live in clean, sustainable communities that contribute to their health and well-being.

In addition, the indicators contribute to the Sustainable Development Goals of the 2030 Agenda for Sustainable Development. They are linked to Goal 12, Responsible consumption and production and Target 12.4, "By 2020, achieve the environmentally sound management of chemicals and all wastes throughout their life cycle, in accordance with agreed international frameworks, and significantly reduce their release to air, water and soil in order to minimize their adverse impacts on human health and the environment."

Related indicators

The Air pollutant emissions indicators track emissions from human activities of 6 key air pollutants: sulphur oxides (SO_X), nitrogen oxides (NO_X), volatile organic compounds (VOC), ammonia (NH_3), carbon monoxide (CO) and fine particulate matter ($PM_{2.5}$). Black carbon, which is a component of $PM_{2.5}$, is also reported. For each air pollutant, data are provided at the national, provincial/territorial and facility level and by source.

The Emissions of harmful substances to air indicators track human-related emissions to air of 3 toxic substances, namely mercury, lead and cadmium, and their compounds. For each substance, data are provided at the national, provincial/territorial and facility level and by source. Global emissions to air are also provided for mercury.

The Releases of harmful substances to water indicators track human-related releases to water of 3 toxic substances, namely mercury, lead and cadmium, and their compounds. For each substance, data are provided at the national, provincial/territorial and facility level and by source.

Data sources and methods

Data sources

These indicators are based on data from Health Canada's reports on Human Biomonitoring of Environmental Chemicals in Canada. The reports provide results from the Canadian Health Measures Survey (the survey). The survey started in 2007 and data are collected in 2-year cycles.

More information

Statistics Canada, in partnership with Health Canada and the Public Health Agency of Canada, launched the survey to collect national-level data on important indicators of Canadians' health status, including those pertaining to environmental chemical exposure. The survey is representative of approximately 96% of the Canadian population aged 6 to 79 years (Cycle 1) and 3 to 79 years (Cycle 2 to Cycle 5).

Table 1. Characteristics of the Canadian Health Measures Survey cycles

Cycle	Temporal coverage	Spatial coverage	Sample size	Age of Canadians in the sample
Cycle 1	March 2007 to February 2009	15 sites across Canada	5 604	6 to 79 years
Cycle 2	August 2009 to November 2011	18 sites across Canada	6 395	3 to 79 years
Cycle 3	January 2012 to December 2013	16 sites across Canada	5 785	3 to 79 years
Cycle 4	January 2014 to December 2015	16 sites across Canada	5 794	3 to 79 years
Cycle 5	January 2016 to December 2017	16 sites across Canada	5 786	3 to 79 years

Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

The collection sites (Table 2) were selected from within the 5 standard regional boundaries used by Statistics Canada (Atlantic, Quebec, Ontario, the Prairies and British Columbia). The collection sites varied between each survey cycle. The survey design does not target specific exposure scenarios, meaning that participants are not selected or excluded on the basis of their potential for low or high exposures to environmental chemicals.

Table 2. Collection sites of the Canadian Health Measures Survey, Canada, 2007 to 2017

Cycle	Atlantic	Quebec	Ontario	Prairies	British Columbia
Cycle 1 (2007 to 2009)	Moncton, New Brunswick	Montérégie Montréal Québec City South Mauricie	Clarington Don Valley Kitchener-Waterloo North York Northumberland County St. Catherine's-Niagara	Edmonton, Alberta Red Deer, Alberta	Vancouver Williams Lake and Quesnel
Cycle 2 (2009 to 2011)	Colchester and Pictou Counties, Nova Scotia St. John's, Newfoundland and Labrador	Gaspésie Laval North Shore Montréal South Montérégie	Central and East Ottawa East Toronto Kingston Oakville South of Brantford Southwest Toronto	Calgary, Alberta Edmonton, Alberta Winnipeg, Manitoba	Central and East Kootney Coquitlam Richmond
Cycle 3 (2012 to 2013)	Kent County, New Brunswick Halifax, Nova Scotia	South-central Laurentians Southwest Montérégie East Montréal West Montréal	Brampton Brantford-Brant County Orillia Oshawa-Whitby North Toronto Windsor	Southwest Calgary, Alberta Lethbridge, Alberta	Victoria-Saanich Vancouver
Cycle 4 (2014 to 2015)	Shelburne-Argyle, Nova Scotia South Fredericton, New Brunswick	Saguenay Sainte-Hyacinthe West Laval West Montréal	Kitchener-Waterloo Leeds-Grenville North Toronto Thunder Bay West Hamilton West Toronto	Central and East Edmonton, Alberta East Regina, Saskatchewan	Kelowna Terrace-Kitimat
Cycle 5 (2016 to 2017)	Montague, Prince Edward Island Saint John, New Brunswick	Montréal Centre Rimouski Sherbrooke West Longueuil/ Boucherville	Brampton Cambridge Petawawa/Pembroke Peterborough Pickering/Ajax Toronto West	Calgary South, Alberta Humboldt, Saskatchewan	Coquitlam Trail

Source: Health Canada (2010) Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 1 (2007-2009). Health Canada (2013) Second Report on Human Biomonitoring of Environmental Chemicals. Results of the Canadian Health Measures Survey Cycle 2 (2009-2011). Health Canada (2015) Third Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 3 (2012-2013). Health Canada (2017) Fourth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 4 (2014-2015). Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Methods

Selected environmental chemicals were measured in the blood and/or urine of survey participants. For the national summary, the geometric mean was calculated for each substance for all results. The geometric mean was also calculated for results within the different age and sex groupings. A trend analysis was done to support statements regarding change over time.

More information

The geometric mean (or average) was used because it is less influenced by extreme values and provides a better estimate of central tendency compared to the arithmetic mean. It uses the product of a set of values, whereas an arithmetic mean uses the sum. The geometric mean is defined as the *n*th root of the product of *n* numbers.

For the laboratory methods used, there is a limit of detection. This is the lowest concentration of the substance that can be detected with 99% confidence. Results that fell below the limit of detection were assigned a value equal to half the limit of detection. If more than 40% of results were below the limit of detection, the geometric mean was not calculated.

There are some variations between cycles in analytical methods and limits of detection.

Table 3. Limit of detection of the Canadian Health Measures Survey by chemical substance

Substance	Limit of detection Cycle 1 (micrograms per litre)	Limit of detection Cycle 2 (micrograms per litre)	Limit of detection Cycle 3 (micrograms per litre)	Limit of detection Cycle 4 (micrograms per litre)	Limit of detection Cycle 5 (micrograms per litre)
Mercury	0.1	0.1	0.42	0.42	0.2
Lead	0.2	1.0	1.6	1.6	1.7
Cadmium	0.04	0.04	0.08	0.08	0.097
Bisphenol A	0.2	0.2	0.23	0.23	0.32

Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

The following tables provide a summary of the data characteristics for the selected substances by survey cycle.

The geometric mean is calculated along with its 95% confidence interval. Mercury is shown as total mercury (organic and inorganic). Owing to the high cost of laboratory analyses, bisphenol A (BPA) was not measured for in all survey participants starting in Cycle 2. In this case, the sample size differs and is less than the total sample size for the survey.

Table 4. Characteristics of the selected substances from Cycle 1 (2007 to 2009) of the Canadian Health Measures Survey

Substance	Sample size	Detection frequency	Geometric mean (micrograms per litre)	95% confidence interval (micrograms per litre)
Mercury	5 319	n/a	0.69	0.55 to 0.86
Lead	5 319	n/a	13	12 to 14
Cadmium	5 319	n/a	0.34	0.31 to 0.37
Bisphenol A	5 476	n/a	1.2	1.1 to 1.2

Note: n/a = not available.
Source: Health Canada (2010) Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 1 (2007-2009).

Table 5. Characteristics of the selected substances from Cycle 2 (2009 to 2011) of the Canadian Health Measures Survey

Substance	Sample size	Detection frequency	Geometric mean (micrograms per litre)	95% confidence interval (micrograms per litre)
Mercury	6 070	88.6	0.69	0.56 to 0.87
Lead	6 070	100	12	11 to 12
Cadmium	6 070	97.1	0.29	0.26 to 0.32
Bisphenol A	2 560	93.8	1.2	1.1 to 1.3

Note: Bisphenol A was measured for only a subset of the survey participants in Cycle 2.
Source: Health Canada (2013) Second Report on Human Biomonitoring of Environmental Chemicals: Results of the Canadian Health Measures Survey Cycle 2 (2009-2011).

Table 6. Characteristics of the selected substances from Cycle 3 (2012 to 2013) of the Canadian Health Measures Survey

Substance	Sample size	Detection frequency	Geometric mean (micrograms per litre)	95% confidence interval (micrograms per litre)
Mercury	5 538	71.2	0.79	0.64 to 0.97
Lead	5 538	99.8	11	10 to 11
Cadmium	5 538	94.4	0.33	0.30 to 0.36
Bisphenol A	5 670	91.7	1.1	1.0 to 1.2

Source: Health Canada (2015) Third Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 3 (2012-2013).

Table 7. Characteristics of the selected substances from Cycle 4 (2014 to 2015) of the Canadian Health Measures Survey

Substance	Sample size	Detection frequency	Geometric mean (micrograms per litre)	95% confidence interval (micrograms per litre)
Mercury	5 498	61.5	n/a	n/a
Lead	5 498	99.9	9.5	9.0 to 10
Cadmium	5 497	94.9	0.31	0.29 to 0.32
Bisphenol A	2 560	91.9	1.0	0.95 to 1.1

Note: n/a = not available. The geometric mean and 95% confidence interval for mercury were not calculated since more than 40% of the samples were below the limit of detection. Bisphenol A was measured for only a subset of the survey participants in Cycle 4.
Source: Health Canada (2017) Fourth Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 4 (2014-2015).

Table 8. Characteristics of the selected substances from Cycle 5 (2016 to 2017) of the Canadian Health Measures Survey

Substance	Sample size	Detection frequency	Geometric mean (micrograms per litre)	95% confidence interval (micrograms per litre)
Mercury	4 488	82.9	0.64	0.54 to 0.75
Lead	4 517	99.7	9.3	8.5 to 10
Cadmium	4 517	87.9	0.28	0.25 to 0.30
Bisphenol A	2 647	81.5	0.81	0.71 to 0.93

Note: Bisphenol A was measured for only a subset of the survey participants in Cycle 5.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada: Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Further information on survey methodology can be obtained directly from the surveys.

Trend analysis

The trend analysis was conducted using the statistical analysis software tools SAS (EG 5.1 2012) and SUDAAN (RTI, 2008) incorporating the survey sample weights (taking into account the unequal probability of selection into the survey as well as non-response). All data considered in this analysis were log normally distributed; therefore, the results are based on the natural log transformation of the data. Data for each chemical were re-screened at the maximum detection limit across all cycles by applying half the highest analytical limit of detection. Chemical trends over time were evaluated using analysis of variance models that included the natural log-transformed chemical concentrations (continuous) as the dependent variable and cycle (categorical) as the predictor variable.

Caveats and limitations

The Canadian Health Measures Survey (the survey) is designed to provide national-level estimates, or regional level estimates when data from multiple cycles are combined, but it does not permit further breakdown of data by collection site. In addition, the survey design does not target specific exposure scenarios and consequently does not select or exclude participants based on their potential for low or high exposures to environmental chemicals.

More information

People living on reserves or in other Indigenous settlements in the provinces, residents of institutions, full-time members of the Canadian Forces, people living in certain remote areas, and people living in areas with a low population density were excluded from the survey.

Concentrations of total mercury, lead, and cadmium in blood and total bisphenol A in urine differ between cycles, owing in part to changes in the limit of detection. These changes were accounted for in the statistical testing of trends across cycles. Chemicals may be present and detectable in a person without causing an adverse health effect. Detection of a chemical indicates that exposure has occurred. However, biomonitoring alone cannot predict the health effects, if any, that may result from exposure. Factors such as age, health status, dosage, duration, frequency and timing of exposure and toxicity of the chemical must be considered in order to predict whether adverse health effects may occur.

Biomonitoring cannot tell us the source or route of exposure. The amount of chemical measured in a person's blood or urine is representative of the total amount present in the body at a given time from all sources (air, water, soil, food and consumer products) and all routes of exposure (ingestion, inhalation, skin contact).

Resources

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Related information

Bisphenol A (BPA)

Human Biomonitoring of Environmental Chemicals

Lead

Mercury

Annex

Annex A. Data tables for the figures presented in this document

Table A.1. Data for Figure 1. Changes in the average concentrations of selected substances in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)

Survey period	Mercury in blood (percentage change from Cycle 1)	Lead in blood (percentage change from Cycle 1)	Cadmium in blood (percentage change from Cycle 1)	Bisphenol A in urine (percentage change from Cycle 1)
Cycle 1 2007 to 2009	0	0	0	0
Cycle 2 2009 to 2011	0	-8	-15	0
Cycle 3 2012 to 2013	14	-15	-3	-8
Cycle 4 2014 to 2015	n/a	-27	-9	-17
Cycle 5 2016 to 2017	-7	-28	-18	-33

Note: n/a = not available. The table presents the percentage change in the average (geometric mean) concentrations of selected substances in Canadians relative to Cycle 1 (2007 to 2009). The concentrations of mercury, lead and cadmium in blood and bisphenol A in urine are from participants aged 3 to 79 years, except for Cycle 1 when there were no participants under the age of 6 years. For Cycle 4, the average (geometric mean) for mercury was not calculated since more than 40% of the samples were below the limit of detection.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Table A.2. Data for Figure 1. Average concentrations of selected substances in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to2017)

Survey period	Mercury in blood (micrograms per litre)	Lead in blood (micrograms per litre)	Cadmium in blood (micrograms per litre)	Bisphenol A in urine (micrograms per litre)
Cycle 1 2007 to 2009	0.69	13	0.34	1.2
Cycle 2 2009 to 2011	0.69	12	0.29	1.2
Cycle 3 2012 to 2013	0.79	11	0.33	1.1
Cycle 4 2014 to 2015	n/a	9.5	0.31	1.0
Cycle 5 2016 to 2017	0.64	9.3	0.28	0.81

Note: n/a = not available. The table presents changes in the average (geometric mean) concentrations of selected substances in Canadians. The concentrations of mercury, lead and cadmium in blood and bisphenol A in urine are from participants aged 3 to 79 years, except for Cycle 1 when there were no participants under the age of 6 years. For Cycle 4, the average (geometric mean) for mercury was not calculated since more than 40% of the samples were below the limit of detection.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Table A.3. Data for Figure 2. Average concentration of mercury in blood in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)

Survey period	3 to 5 years (micrograms per litre)	6 to 11 years (micrograms per litre)	12 to 19 years (micrograms per litre)	20 to 39 years (micrograms per litre)	40 to 59 years (micrograms per litre)	60 to 79 years (micrograms per litre)	Women (micrograms per litre)	Men (micrograms per litre)
Cycle 1 2007 to 2009	n/a	0.26	0.30	0.65	1.0	0.87	0.70	0.68
Cycle 2 2009 to 2011	0.27	0.28	0.27	0.64	1.0	1.1	0.67	0.72
Cycle 3 2012 to 2013	n/a	n/a	n/a	0.82	0.96	1.0	0.81	0.76
Cycle 4 2014 to 2015	n/a	n/a	n/a	n/a	0.77	0.88	n/a	n/a
Cycle 5 2016 to 2017	n/a	n/a	0.33	0.55	0.85	0.83	0.65	0.63

Note: n/a = not available. For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. For cycles 3 to 5, averages (geometric means) were not calculated for some age groups, since more than 40% of the samples were below the limit of detection. Mercury is shown as total mercury (organic and inorganic).
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Table A.4. Data for Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of lead:

showed a declining trend, with a decrease of 28% between Cycle 1 and Cycle 5

- were lower in children than in adults
- were highest in adults aged 60 to 79 years
- were higher in men than in women

Figure 3. Average concentration of lead in blood in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)

Survey period	3 to 5 years (micrograms per litre)	6 to 11 years (micrograms per litre)	12 to 19 years (micrograms per litre)	20 to 39 years (micrograms per litre)	40 to 59 years (micrograms per litre)	60 to 79 years (micrograms per litre)	Women (micrograms per litre)	Men (micrograms per litre)
Cycle 1 2007 to 2009	n/a	9	8	11	16	21	12	15
Cycle 2 2009 to 2011	9.3	7.9	7.1	9.8	14	19	11	13
Cycle 3 2012 to 2013	7.7	7.1	6.4	9	13	16	9.6	12
Cycle 4 2014 to 2015	6.7	5.9	5.4	8	12	15	8.7	10

Cycle 5 2016 to 2017	5.6	5.4	4.8	7.8	10	14	8.2	10

Note: n/a = not available. For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. Average refers to geometric mean.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Table A.5. Data for Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of cadmium:

showed a declining trend in the total population, with a decrease of 18% between Cycle 1 and Cycle 5

- were highest in adults aged 40 to 59 years and 60 to 79 years
- were higher in women than in men

Figure 4. Average concentration of cadmium in blood in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)

Survey period	3 to 5 years (micrograms per litre)	6 to 11 years (micrograms per litre)	12 to 19 years (micrograms per litre)	20 to 39 years (micrograms per litre)	40 to 59 years (micrograms per litre)	60 to 79 years (micrograms per litre)	Women (micrograms per litre)	Men (micrograms per litre)
Cycle 1 2007 to 2009	n/a	0.091	0.16	0.34	0.48	0.45	0.38	0.30
Cycle 2 2009 to 2011	0.073	0.083	0.13	0.28	0.41	0.45	0.32	0.26
Cycle 3 2012 to 2013	n/a	0.095	0.17	0.31	0.50	0.48	0.37	0.29
Cycle 4 2014 to 2015	0.082	0.094	0.14	0.33	0.41	0.44	0.33	0.28
Cycle 5 2016 to 2017	n/a	n/a	0.11	0.28	0.35	0.39	0.29	0.26

Note: n/a = not available. For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. For cycles 3 and 5, averages (geometric means) were not calculated for some age groups, since more than 40% of the samples were below the limit of detection.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

Table A.6. Data for Over the 5 cycles (2007 to 2017) of the Canadian Health Measures Survey, the average concentrations of BPA:

- showed a declining trend in the total population, with a decrease of 33% between Cycle 1 and Cycle 5
- were higher in children than in adults
- were higher in men than in women

Figure 5. Average concentration of bisphenol A in urine in Canadians, Cycle 1 (2007 to 2009) to Cycle 5 (2016 to 2017)

Survey period	3 to 5 years (micrograms per litre)	6 to 11 years (micrograms per litre)	12 to 19 years (micrograms per litre)	20 to 39 years (micrograms per litre)	40 to 59 years (micrograms per litre)	60 to 79 years (micrograms per litre)	Women (micrograms per litre)	Men (micrograms per litre)

Cycle 1 2007 to 2009	n/a	1.3	1.5	1.3	1.0	0.90	1.0	1.3
Cycle 2 2009 to 2011	1.4	1.4	1.3	1.3	1.2	1.0	1.2	1.3
Cycle 3 2012 to 2013	1.2	1.2	1.3	1.1	1.1	0.88	1.0	1.2
Cycle 4 2014 to 2015	1.2	1.1	1.1	1.1	0.86	1.1	0.92	1.2
Cycle 5 2016 to 2017	0.94	0.97	0.96	0.84	0.73	0.77	0.78	0.84

Note: n/a = not available. For Cycle 1, data were not available for children under the age of 6 years, as they were not included in the survey. Average refers to geometric mean.
Source: Health Canada (2019) Fifth Report on Human Biomonitoring of Environmental Chemicals in Canada. Results of the Canadian Health Measures Survey Cycle 5 (2016-2017).

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