Chloroform

Environmental estimates (circa 2011): Supplemental data

Table of Contents

1. Data for lifetime excess cancer risk estimates 2

Overview 2

i. Environmental Concentrations 2

ii. Calculated Lifetime Daily Intake 2

iii. Cancer Potency Factors 2

iv. Lifetime Excess Cancer Risk (per million people) 3

Supporting data by exposure pathway 3

i. Outdoor air 3

ii. Indoor air 3

iii. Dust 7

iv. Drinking water 7

v. Food and Beverages 7

2. Data quality for lifetime excess cancer risk estimates 11

3. Data for mapping concentrations 12

Estimates by health region 12

Estimates by census block 12

1. Data for lifetime excess cancer risk estimates

Overview

The summary data used to calculate lifetime excess cancer risk and the results for chloroform are provided in the tables below. For more detailed information on supporting data and sources, see below for each exposure pathway.

i. Environmental Concentrations

Exposure pathway	Units	Average	Maximum	Notes
Outdoor air	µg/m³	0.15	2.3	
Indoor air	µg/m³	2.53	33	
Drinking water	µg/L	31.9	151	
Foods and beverages		See detailed data	Not estimated	

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.0000035	0.000053
Indoor air	0.00082	0.011
Drinking water	0.00083	0.0039
Foods and beverages	0.0000047	Not estimated

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation	--	0.0805	0.019
Ingestion	--	--	0.031

Sources for Cancer Potency Factors:

- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part I: Guidance on Human Health Preliminary Quantitative Risk Assessment. Version 2.0.
- Health Canada, 2010. Federal Contaminated Site Risk Assessment in Canada, Part II: Health Canada Toxicological Reference Values (TRVs) and Chemical-Specific Factors. Version 2.0.
- United States Environmental Protection Agency Integrated Risk Information System
- California Office of Environmental Health Hazard Assessment, 2009. Air Toxics Hot Spots Risk Assessment Guidelines Part II: Technical Support Document for Cancer Potency Factors, Appendix A. (Updated 2011)

iv. Lifetime Excess Cancer Risk (per million people)

	Average[1]			Maximum[2]
Exposure pathway	Health Canada	US EPA	CA OEHHA[3]	
Outdoor air	--	0.27941	0.066	1.01
Indoor air	--	66.165	15.6	863.02
Drinking water	--	--	25.6	121.55
Foods and beverages	--	--	0.146	Not estimated

[1]Lifetime excess cancer risk based on average intake x cancer potency factor from each agency
[2]Lifetime excess cancer risk based on maximum intake x highest cancer potency factor
[3]California Office of Environmental Health Hazard Assessment

Supporting data by exposure pathway

i. Outdoor air

Outdoor air concentrations are from the National Air Pollution Surveillance monitoring network operated by Environment Canada, for the year 2010.

Source	Stations (n)	Min	Max	Mean	DF
NAPS 2010 (µg/m³)	53	0.012	1.2	0.073	1.0

DF = Detection frequency

We assume chloroform is present at these levels in all outdoor air, although concentrations may vary from one location to another.

ii. Indoor air

Indoor air concentrations are based on data published in peer-reviewed literature since 2000. A ranking system was used to select data most representative of Canadian conditions circa 2011:

1. Canadian data collected in 2000 or more recently, sample duration of 24 hours or longer;
2. US studies of similar currency and sample duration;
3. Studies from northern European countries of similar currency and sample duration;
4. Canadian, US or European studies with data collected prior to 2000 and similar sample duration; and
5. Studies with sample duration of less than 24 hours regardless of country or collection date, or studies from countries not comparable to Canada.

Rank: 1	Author:	Health Canada (2012)					Location:	Halifax, NS			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
331	1.0	0.022	2009 summer	µg/m³	24hr	0.116	17.18	2.453	1.384	1.452	25th 0.812 75th 2.956 90th 6.020 95th 9.716
312	0.997		winter			<DL	26.42	1.986	1.388	1.319	25th 0.805 75th 2.289 90th 4.283 95th 6.030

*DF = Detection frequency
**DL = Detection limit

Rank: 1	Author:	Health Canada (2010)					Location:	Regina, SK			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
105	1.0	0.030	2007 Summer	µg/m³	24hr	0.127	34.930	3.240	1.565	1.748	25th 0.975 75th 3.865 90th 7.530 95th 11.640
101	1.0				5 day	0.323	20.484	3.644	2.285	2.314	25th 1.230 75th 8.880 90th 0.445 95th 11.480
105	1.0		winter		24hr	0.307	7.087	2.166	1.900	1.781	25th 1.140 75th 2.650 90th 4.143 95th 4.897
89	1.0				5 day	0.247	7.027	2.388	2.097	1.920	25th 0.100 75th 0.393 90th 1.317 95th 2.143

*DF = Detection frequency
**DL = Detection limit

Rank: 1	Author:	Health Canada (2010)					Location:	Windsor, ON			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
217	1.0	0.089	2005 summer	µg/m³	24hr	0.100	59.885	4.023	2.675	2.552	25th 1.545 75th 4.995 90th 7.350 95th 11.230
232	1.0		winter			0.165	47.930	1.678	1.097	1.114	25th 0.660 75th 1.870 90th 2.945 95th 3.945
211	1.0	0.082	2006 summer		24hr	0.223	18.947	3.104	2.117	2.105	25th 1.207 75th 3.670 90th 6.570 95th 8.747
224	1.0		winter			0.140	8.587	1.127	0.815	0.802	25th 0.462 75th 1.310 90th 2.320 95th 3.267

*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author:	Batterman (2007)					Location:	Ann Arbor and Ypsilanti, Michigan			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
15	0.8	0.045		µg/m³	4 days		0.9	0.3			

Notes: homes with attached garages, not detected outdoors or in garages
*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author:	Jia (2008)					Location:	Michigan			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
40	0.88		2004-2005	µg/m³	3-4 days, weekday		2.51	0.06	0.06		
30								0.04	0.04		
40								0.05	0.04		
42								0.06	0. 06		
29								0.06	0.06		
45								0.14	0.07		
226								0.07	0.06		

Notes: Values listed in the following order: Ann Arbour (suburban) SUMMER, Ypsilanti (urban/commercial) SUMMER, Dearborn (industrial) SUMMER, Ann Arbour (suburban) WINTER, Ypsilanti (urban/commercial) WINTER, Dearborn (industrial) FALL, Three cities above overall stats
*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author: Johnson (2010)						Location: Detroit, MI				
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
41	0.93	0.2	2006	µg/m³	7-day	0.1	2.9	0.8			25th 0.5 50th 0.6 75th 0.9 95th 1.9

*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author: Weisel (2008)						Location: New Jersey				
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
100	0.29	2.4 or 0.98	2003 - 2006	µg/m³	24h	0.98	5.9	2.05			25th 0.98 50th 2.4 75th 2.4 90th 2.62 95th 4.05

*DF = Detection frequency
**DL = Detection limit

Rank: 3	Author: Ohura (2006)						Location: Shimuzu, Japan				
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
25	1.0	0.14 pg	2000-2001	µg/m³	24h					0.25	10th 0.12 90th 0.55
21										0.92	10th 0.41 90th 1.94

Notes: Values listed in following order: Summer, Winter
*DF = Detection frequency
**DL = Detection limit

Rank: 5	Author: Sax (2006)						Location: New York City, Los Angeles				
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
46	1.0	<1	1999-2000	µg/m³	48h		8.17	2.96	2.4		
41	0.93				weekday		4.19	0.63	0.45		

Notes: Values listed in following order: NYC – non-smoking homes, LA – non-smoking homes
*DF = Detection frequency
**DL = Detection limit

Sources for indoor air data:

- Batterman S, Jia CR, Hatzivasilis G. 2007. Migration of volatile organic compounds from attached garages to residences: A major exposure source. Environmental Research 104: 224-240.
- Health Canada. 2012. Halifax Indoor Air Quality Study (2009) – Volitile Organic Compounds (VOC) Data Summary. Available online at http://www.healthcanada.gc.ca.
- Health Canada. 2010. Regina Indoor Air Quality Study (2007) : Data Summary for Volatile Organic Compound Sampling. Available online at http://www.healthcanada.gc.ca.

- Health Canada. 2010. Windsor Exposure Assessment Study (2005-2006) : Data Summary for Volatile Organic Compound Sampling. Available online at : http://www.healthcanada.gc.
- Jia C, Batterman S, Godwin C. 2008. VOCs in industrial, urban and suburban neighborhoods, Part 1: Indoor and outdoor concentrations, variation, and risk drivers. Atmospheric Environment 42: 2083-2100.
- Johnson MM, Williams R, Fan Z, Lin L, Hudgens E, Gallagher J, et al. 2010. Participant-based monitoring of indoor and outdoor nitrogen dioxide, volatile organic compounds, and polycyclic aromatic hydrocarbons among MICA-Air households. Atmospheric Environment In Press: 1-10.
- Ohura T, Amagai T, Senga Y, Fusaya M. 2006. Organic air pollutants inside and outside residences in Shimizu, Japan: Levels, sources and risks. Science of the Total Environment 366: 485-499.
- Sax SN, Bennett DH, Chillrud SN, Ross J, Kinney PL, Spengler JD. 2006. A cancer risk assessment of inner-city teenagers living in New York City and Los Angeles. Environmental Health Perspectives 114: 1558-1566.
- Weisel CP, Alimokhtari S, Sanders PF. 2008. Indoor Air VOC Concentrations in Suburban and Rural New Jersey. Environmental Science & Technology 42: 8231-8238.

iii. Dust

Chloroform is not expected to be present in indoor dust in significant amounts.

iv. Drinking water

Drinking water data are from the Ontario Drinking Water Surveillance Program (DWSP) for 2011. A review of published reports was also conducted in order to compare how well the Ontario data represented other regions in Canada.

Source	Units	DL							
Ontario DWSP 2011	(µg/L)	0.1							
Sample Type	Parameter	Mean	SD	Min	25th	50th	75th	Max	N
Distribution		31.9	27.1	0.5	7.13	26.0	51.2	151.0	342

DL = Detection limit
SD = Standard Deviation

v. Food and Beverages

Food consumption data are from the Statistics Canada Food Survey (2006) - Food available, adjusted for losses tables, and from the Nutrition Canada Survey (1970-1972).

Food concentration data are primarily from the US-FDA Total Diet Study (2003-2004), with additional data on metals and several PAHs from the Canadian Food Inspection Agency (CFIA) - National Chemical Residue Monitoring Program: 2009-2010 Annual Report and the US-FDA (TDS Statistics on Element Results - 2008).

In order to better represent actual intake, we incorporated data for cooked and/or processed foods, as in some cases, this can either add to or diminish the amount measured in raw food.

Concentration data were obtained for 70% of total meat consumed, 46% of total seafood consumed, 35% of total fruit consumed, 27% of total vegetables consumed, 59% of total dairy and eggs consumed, 1% of total grains consumed, and 52% of total beverages consumed.

Food or Beverage	Concentration (µg/g)	DF
Beef	0.00323	0.20455
Chicken		
Mutton and lamb	0.00170	0.02273
Offal	0.01500	0.02273
Oils and fats	0.02025	0.75000
Pork	0.03000	0.02273
Salad oils		
Shortening and shortening oils		
Stewing hen		
Turkey	0.02000	0.02273
Veal		
Fish fresh and frozen seafish		
Fish freshwater		
Fish processed seafish	0.00250	0.50000
Apple pie filling		
Apple sauce	0.01100	0.02273
Apples canned		
Apples dried		
Apples fresh	0.00027	0.09091
Apples frozen		
Apricots canned		
Apricots fresh		
Bananas fresh	0.00091	0.09091
Berries other fresh		
Blueberries canned		
Blueberries fresh		
Blueberries frozen		
Cherries fresh	0.01100	0.02941
Cherries frozen		
Citrus other fresh		
Coconut fresh		
Cranberries fresh		
Dates fresh		
Figs fresh		
Fruit dried	0.00255	0.29546
Grapefruit fresh		
Grapes fresh		
Guava and mangoes fresh		
Kiwi fresh		
Lemons fresh		
Limes fresh		
Mandarins fresh		
Melons musk, cantaloupe fresh		
Melons other fresh		
Melons watermelons fresh		
Melons, winter melons fresh		
Nectarines fresh		
Oranges fresh	0.00055	0.15909
Papayas fresh		
Peaches canned		

Food or Beverage	Concentration (µg/g)	DF
Peaches fresh		
Pears canned		
Pears fresh	0.01000	0.02273
Pineapples canned		
Pineapples fresh		
Plums total fresh		
Quinces fresh		
Raspberries frozen		
Strawberries canned		
Strawberries fresh	0.00012	0.04651
Strawberries frozen		
Sugar maple		
Sugar refined		
Honey		
Artichokes fresh		
Asparagus canned		
Asparagus fresh		
Avocados fresh	0.00364	0.31818
Beans baked and canned		
Beans dry		
Beans green and wax canned		
Beans green and wax fresh	0.01100	0.02273
Beans green and wax frozen		
Beets canned		
Beets fresh		
Broccoli fresh	0.01400	0.02273
Broccoli frozen		
Brussels sprouts fresh		
Brussels sprouts frozen		
Cabbage Chinese fresh		
Cabbage fresh		
Carrots canned		
Carrots fresh		
Carrots frozen		
Cauliflower fresh	0.01500	0.02273
Cauliflower frozen		
Celery fresh		
Corn canned		
Corn flour and meal		
Corn fresh	0.0290	0.02273
Corn frozen		
Cucumbers fresh		
Eggplant fresh		
Garlic fresh		
Kohlrabi fresh		
Leeks fresh		
Lettuce fresh		
Lima beans frozen		
Manioc fresh		
Mushrooms canned		

Food or Beverage	Concentration (µg/g)	DF
Mushrooms fresh		
Okra fresh	0.01100	0.02273
Olives fresh	0.01100	0.02273
Onions and shallots fresh		
Parsley fresh		
Parsnips fresh		
Peas canned		
Peas dry		
Peas fresh	0.01100	0.02273
Peas frozen		
Peppers fresh		
Potatoes chips	0.00220	0.22727
Potatoes frozen		
Potatoes other processed		
Potatoes sweet fresh	0.02700	0.02500
Potatoes white fresh	0.01200	0.02273
Potatoes white fresh and processed		
Pumpkins and squash fresh	0.03000	0.02273
Radishes fresh		
Rappini fresh		
Rutabagas and turnip fresh		
Spinach fresh	0.00084	0.04546
Spinach frozen		
Tomatoes canned		
Tomatoes fresh	0.00132	0.15909
Tomatoes pulp, paste and puree		
Vegetables other edible root fresh		
Vegetables other leguminous fresh		
Vegetables unspecified canned		
Vegetables unspecified fresh		
Vegetables unspecified frozen		
Butter	0.03645	0.70455
Cheese cheddar	0.02582	0.61364
Cheese cottage		
Cheese processed	0.01720	0.61364
Cheese variety	0.02298	0.50000
Cream cereal 10%	0.01200	0.02273
Cream sour	0.02873	0.65909
Cream table 18%		
Cream whipping 32% or 35%		
Eggs	0.02300	0.02273
Ice cream	0.01884	0.63636
Ice milk		
Margarine	0.00239	0.31818

Food or Beverage	Concentration (µg/g)	DF
Milk buttermilk		
Milk chocolate drink		
Milk concentrated skim		
Milk concentrated whole		
Milk other whole milk products		
Milk partly skimmed 2%		
Milk skim		
Milk standard	0.00389	0.43182
Milk sweetened concentrated skim		
Milkshake		
Powder buttermilk		
Powder skim milk		
Powder whey		
Sherbet		
Yogurt		
Cereal products		
Oatmeal and rolled oats		
Peanuts	0.00298	0.18182
Pot and pearl barley		
Pulses and nuts		
Rice		
Rye flour		
Tree nuts		
Wheat flour		
Ale, beer, stout and porter		
Beverages alcoholic		
Coffee		
Distilled spirits		
Juice apple	0.01200	0.02273
Juice grape		
Juice tomato		
Juice fruit	0.00275	0.50000
Juice grapefruit		
Juice lemon		
Juice orange	0.00100	0.22727
Juice pineapple		
Juice vegetable		
Soft drinks	0.00595	0.40909
Tea	0.01500	0.02273
Water bottled	0.00500	0.25000
Wines		
Cocoa		

2. Data quality for lifetime excess cancer risk estimates

Only publicly available data were used to calculate these indicators. Data that are not publicly available may produce different results.

No systematic method for measuring data quality was possible, so we provide the following assessments of how well the data used may represent the actual Canadian average levels. Quality is rated higher when there are data from a number of Canadian monitors, or from Canadian studies that show results similar to other comparable studies. Quality is rated lower when data from few monitors or studies were available, and lowest when estimates are based on non-Canadian data. Others may rate data quality differently.

Exposure Pathway	Data Quality	Notes
Outdoor air	High	• Chloroform is regularly measured in outdoor air at 53 monitoring stations across Canada using accepted protocols.
Indoor air	Moderate	• Good agreement in mean concentrations measured in three recent Canadian studies (Halifax NS, Regina SK, Windsor ON).
Drinking water	Moderate	• All samples (n=342) from the Ontario Drinking Water Surveillance Program contained chloroform in 2011, and there is reasonable agreement with a national survey of drinking water distribution systems (1994-2000) and a smaller study conducted in ON and NS.
Foods and beverages	Very Low	• No Canadian data on concentrations of chloroform in foods and beverages were identified. Data from the US-FDA (TDS-2003-2004) were used for this estimate.

3. Data for mapping concentrations

The maps use geographic coordinates at the census block level to represent residential locations. Concentration estimates are mapped at the health region level, which are created with aggregated census block data.

We used a model to predict annual average concentrations of chloroform in outdoor air at residential locations for 2011. These are predicted using levels measured from the National Air Pollution Surveillance (NAPS) monitors and estimated concentrations from known emitters. For more information on how these estimates were created, please see the Mapping Methods document on the Environmental Approach section of our website.

Estimates by health region

The table below shows predicted chloroform concentrations by province based on data at the health region level. The median concentration of chloroform measured in outdoor air in 2011 at the health region level was 0.085 µg/m^3, while the mean concentration was 0.091 µg/m^3. Concentrations of chloroform can be higher or lower than average in many locations.

i. Provincial averages of predicted chloroform concentrations (µg/m^3) in outdoor air in 2011 based on health regions

Province	Median	Mean
BC	0.091	0.098
AB	0.081	0.082
SK	0.072	0.075
MB	0.083	0.084
ON	0.085	0.090
QC	0.088	0.096
NB	0.090	0.122
PE	0.086	0.086
NS	0.089	0.104
NL	0.077	0.079
YK	0.086	0.086
NT	0.078	0.078
NU	0.070	0.070
Canada	**0.085**	**0.091**

Estimates by census block

The table below shows provincial populations by concentration levels (either annual average or number of times above/below the national average) based on the census block data and the associated potential lifetime excess risk given different cancer potency factors.

i. Provincial population distribution by estimated average concentration (µg/m3) of chloroform in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (µg/m³)	Less than 0.05	0.05 to 0.06	0.06 to 0.08	0.08 to 0.010	0.10 to 0.15	0.15 to 0.23	0.23 to 0.3	0.3 to 0.38	0.38 to 0.45	More than 0.45
Compared to national average (0.15µg/m³)*	>3x lower	2.5 to 3x lower	2 to 2.5x lower	1.5 to 2x lower	1 to 1.5x lower	1 to 1.5x higher	1.5 to 2x higher	2 to 2.5x higher	2.5 to 3x higher	>3.0x higher
	← Below Average					Above Average →				
BC	--	--	660,244 (15.0%)	561,513 (12.8%)	2,262,643 (51.4%)	810,065 (18.4%)	--	--	--	105,592 (23.4%)
AB	--	--	--	3,104,584 (85.2%)	42,069 (1.2%)	498,604 (13.7%)	--	--	--	--
SK	--	4,425 ()0.4%)	--	610,544 (59.0%)	--	418,412 (40.5%)	--	--	--	--
MB	--	--	--	1,113,078 (92.1%)	--	95,190 (7.9%)	--	--	--	--
ON	--	--	673,251 (5.2%)	5,310,762 (41.3%)	2,459,460 (19.1%)	4,327,767 (33.7%)	79,139 (.06%)	--	--	1,442 (<0.1%)
QC	--	--	680,388 (8.6%)	1,431,666 (18.1%)	2,188,799 (27.7%)	3,596,060 (45.6%)	--	--	--	6,088 (<0.1%)
NB	--	--	--	288,659 (38.4%)	131,533 (17.5%)	310,140 (41.3%)	--	--	--	20,839 (2.8%)
NS	--	--	--	288,734 (31.3%)	--	569,951 (61.8%)	-- -	63,042 (6.8%)	--	--
PE	--	--	--	55,830 (39.8%)	--	80,975 (57.8%)	--	3,399 (2.4%)	--	--
NL	--	--	--	237,900 (46.2%)	235,709 (45.8%)	40,927 (8.0%)	--	--	--	--
NU	--	--	--	31,906 (100.0%)	--	--	--	--	--	--
NT	--	--	--	22,228 (53.6%)	--	19,234 (46.4%)	--	--	--	--
YT	--	--	--	7,869 (23.2%)	--	26,028 (76.8%)	--	--	--	--
CANADA	--	4,425	2,013,883	13,065,273	7,320,213	10,793,353	79,139	66,441	--	133,961
% of pop.		(<0.1%)	(6.0%)	(39.0%)	(21.9%)	(32.2%)	(0.2%)	(0.2%)		(0.4%)

ASSOCIATED LIFETIME EXCESS CANCER RISK (per million people):
RED = POTENTIAL LIFETIME EXCESS RISK IS GREATER THAN 1 PER MILLION PEOPLE

Health Canada CPF: No CPF										
California OEHHA CPF: 0.019	< 0.049	0.049 to < 0.059	0.059 to < 0.073	0.073 to < 0.098	0.098 to < 0.15	0.15 to < 0.225	0.225 to < 0.295	0.295 to < 0.37	0.37 to < 0.44	> 0.44
US EPA CPF: 0.081	< 0.09	0.09 to < 0.11	0.11 to < 0.14	0.14 to < 0.19	0.19 to < 0.28	0.28 to < 0.42	0.42 to < 0.56	0.56 to < 0.70	0.70 to < 0.84	> 0.84

* measured at National Air Pollution Surveillance (NAPS) monitors in 2011
CPF: Cancer Potency Factor