Benz[a]anthracene

Environmental estimates (circa 2011): Supplemental data

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1. Data for lifetime excess cancer risk estimates

Overview

The summary data used to calculate lifetime excess cancer risk and the results for benz[a]anthracene 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	0.00018	0.0009	
Indoor air	µg/m³	0.00009	0.00085	
Dust	µg/g	2.38	32.1	
Drinking water	µg/L	Insufficient data		
Foods and beverages		See detailed data		

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.000000004	0.000000021
Indoor air	0.000000029	0.00000028
Dust	0.0000016	0.000021
Drinking water	Insufficient data	
Foods and beverages	0.0000000096	Not estimated

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation	--	--	0.39
Ingestion	--	--	1.2

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	--	--	0.00162	0.00812
Indoor air	--	--	0.0114	0.108
Dust	--	--	1.876	25.30
Drinking water		Insufficient data		
Foods and beverages	--	--	0.0115	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)	17	0.000014	0.0009	0.00018	1.0

DF = Detection frequency

We assume benz[a]anthracene 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: 2 **Author:** Jung (2010) **Location:** New York City

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
203			2005 - 2010	µg/m³	14 days	0.00002	0.00086	0.000085	0.00007		
98							0.00038	0.00007	0.00005		

Notes: Values listed in the following order: heating season (Oct-Apr), non-heating season (May-Sept)
*DF = Detection frequency
**DL = Detection limit

Rank: 2 **Author:** Li (2005) **Location:** Chicago

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
10	~0.95		2000 - 2001	µg/m³	48h x 14 months	0.000001	0.0011		0.00008		10th 0.000005 25th 0.000025 75th 0.0002 90th 0.0003

Notes: non-smoking homes, sampled once a month for 14 months, total n = 115
*DF = Detection frequency
**DL = Detection limit

Rank: 3 **Author:** Gustafson (2008) **Location:** Hagfors, Sweden

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
13	0.615	0.00015	Feb-March 2003	µg/m³	24hr	<DL	0.0025	0.00059	0.00022		
10	0.2					<DL	0.00055		<DL		

Notes: Values listed in the following order: wood-burning, non-wood burning homes.
*DF = Detection frequency
**DL = Detection limit

Rank: 3 **Author:** Halsall (2008) **Location:** Lancaster, UK

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
7	0.14	0.00001 to .0015	2003	µg/m³	6 to 24 hours	<dl	0.00314	0.00093	0.00069		

Notes: 3 locations
*DF = Detection frequency
**DL = Detection limit

Rank: 4 **Author:** Sanderson (2004) **Location:** Beauharnois, PQ

Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
3	0.84	0.00001		µg/m³	24h			0.000021			
12								0.000018		0.000011	

Notes: near aluminum smelter, Values listed in the following order: with oil heating, with no oil heating
*DF = Detection frequency
**DL = Detection limit

Sources for indoor air data:

- Gustafson P, Östman C, Sällsten G. 2008. Indoor levels of polycyclic aromatic hydrocarbons in homes with or without wood burning for heating. Environ Sci Technol 42: 5074-5080.
- Halsall CJ, Maher BA, Karloukovski VV, Shah P, Watkins SJ. 2008. A novel approach to investigating indoor/outdoor pollution links: Combined magnetic and PAH measurements. Atmospheric Environment 42: 8902-8909.
- Jung K, Patel MM, Kinney PL, Chillrud SN, Whyatt R, Hoepner L, et al. 2010. 1. Effects of Season and Indoor Heating on Indoor and Outdoor Residential Levels of Airborne Polycyclic Aromatic Hydrocarbons, Absorbance and Particulate Matter 2.5 in an Inner City Cohort of Young Children. Journal of Allergy and Clinical Immunology 125: AB81.
- Li A, Schoonover TM, Zou QM, Norlock F, Conroy LM, Scheff PA, et al. 2005. Polycyclic aromatic hydrocarbons in residential air of ten Chicago area homes: Concentrations and influencing factors. Atmospheric Environment 39: 3491-3501.
- Sanderson EG, Farant JP. 2004. Indoor and outdoor polycyclic aromatic hydrocarbons in residences surrounding a Soderberg aluminum smelter in Canada. Environ Sci Technol 38: 5350-5356.

iii. Dust

Indoor dust 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:	Maertens (2008)					Location:	Ottawa, Canada			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
51	1.0	0.021	2002 - 2003	µg/g		0.11	32.1	2.38	0.7	1.0	

Notes: Analyzed using GC/MS
*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author:	Whitehead (2011)					Location:	California, USA			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
583	0.991	0.002	2001-2007	µg/g		<DL	0.834		0.025		

Notes: Analyzed using GC/MS
*DF = Detection frequency
**DL = Detection limit

Rank: 2	Author:	Hoh (2012)					Location:	San Diego County, CA, USA			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
43	1.0	0.002	2005-2007	µg/g		0.00415	0.214		0.0192		25th 0.0133 75th 0.0372
89	1.0					0.00360	0.210		0.0311		25th 0.0175 75th 0.0572

Notes: Analyzed using GC/MS
*DF = Detection frequency
**DL = Detection limit

Sources for dust data:

- Hoh E, Hunt RN, Quintana PJE, Zakarian JM, Chatfield DA, Wittry BC, Rodriguez E, Matt GE. 2012. Environmental tobacco smoke as a source of polycyclic aromatic hydrocarbons in settled house dust. Environ Sci Technol 46: 4174-4183.
- Maertens RM, Yang XF, Zhu JP, Gagne RW, Douglas GR, White PA. 2008. Mutagenic and carcinogenic hazards of settled house dust I: Polycyclic aromatic hydrocarbon content and excess lifetime cancer risk from preschool exposure. Environmental Science & Technology 42: 1747-1753.
- Whitehead T, Metayer C, Gunier RB, Ward MH, Nishioka MG, Buffler P, Rappaport SM. 2011. Determinants of polycyclic aromatic hydrocarbon levels in house dust. J Expo Sci Environ Epidemiol 21(2): 123-132.

iv. Drinking water

No recent data or studies were identified.

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 7% of total meat consumed, and 1% of total fruit consumed.

Food or Beverage	Concentration (µg/g)	DF
Beef		
Chicken	0.00034	0.15400
Mutton and lamb	0.00037	0.07100
Offal		
Oils and fats		
Pork		
Salad oils		
Shortening and shortening oils		
Stewing hen		
Turkey		
Veal		
Fish fresh and frozen seafish		
Fish freshwater		
Fish processed seafish		
Apple pie filling		
Apple sauce		
Apples canned		
Apples dried		
Apples fresh		
Apples frozen		
Apricots canned		
Apricots fresh		
Bananas fresh		
Berries other fresh		
Blueberries canned		
Blueberries fresh		
Blueberries frozen		
Cherries fresh		
Cherries frozen		
Citrus other fresh		
Coconut fresh		
Cranberries fresh		
Dates fresh		
Figs fresh		
Fruit dried		
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		
Papayas fresh		
Peaches canned		

Food or Beverage	Concentration (µg/g)	DF
Peaches fresh		
Pears canned		
Pears fresh		
Pineapples canned		
Pineapples fresh		
Plums total fresh		
Quinces fresh		
Raspberries frozen		
Strawberries canned		
Strawberries fresh		
Strawberries frozen		
Sugar maple		
Sugar refined		
Honey	0.00011	0.27800
Artichokes fresh		
Asparagus canned		
Asparagus fresh		
Avocados fresh		
Beans baked and canned		
Beans dry		
Beans green and wax canned		
Beans green and wax fresh		
Beans green and wax frozen		
Beets canned		
Beets fresh		
Broccoli fresh		
Broccoli frozen		
Brussels sprouts fresh		
Brussels sprouts frozen		
Cabbage Chinese fresh		
Cabbage fresh		
Carrots canned		
Carrots fresh		
Carrots frozen		
Cauliflower fresh		
Cauliflower frozen		
Celery fresh		
Corn canned		
Corn flour and meal		
Corn fresh		
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	Food or Beverage	Concentration (µg/g)	DF
Mushrooms fresh			Milk buttermilk		
Okra fresh			Milk chocolate drink		
Olives fresh			Milk concentrated skim		
Onions and shallots fresh			Milk concentrated whole		
Parsley fresh			Milk other whole milk products		
Parsnips fresh			Milk partly skimmed 2%		
Peas canned			Milk skim		
Peas dry			Milk standard		
Peas fresh			Milk sweetened concentrated skim		
Peas frozen			Milkshake		
Peppers fresh			Powder buttermilk		
Potatoes chips			Powder skim milk		
Potatoes frozen			Powder whey		
Potatoes other processed			Sherbet		
Potatoes sweet fresh			Yogurt		
Potatoes white fresh			Cereal products		
Potatoes white fresh and processed			Oatmeal and rolled oats		
Pumpkins and squash fresh			Peanuts		
Radishes fresh			Pot and pearl barley		
Rappini fresh			Pulses and nuts		
Rutabagas and turnip fresh			Rice		
Spinach fresh			Rye flour		
Spinach frozen			Tree nuts		
Tomatoes canned			Wheat flour		
Tomatoes fresh			Ale, beer, stout and porter		
Tomatoes pulp, paste and puree			Beverages alcoholic		
Vegetables other edible root fresh			Coffee		
Vegetables other leguminous fresh			Distilled spirits		
Vegetables unspecified canned			Juice apple		
Vegetables unspecified fresh			Juice grape		
Vegetables unspecified frozen			Juice tomato		
Butter			Juice fruit		
Cheese cheddar			Juice grapefruit		
Cheese cottage			Juice lemon		
Cheese processed			Juice orange		
Cheese variety			Juice pineapple		
Cream cereal 10%			Juice vegetable		
Cream sour			Soft drinks		
Cream table 18%			Tea		
Cream whipping 32% or 35%			Water bottled		
Eggs			Wines		
Ice cream			Cocoa		
Ice milk					
Margarine					

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	Low	• Benz[a]anthracene is regularly measured in outdoor air at 17 monitoring stations across Canada using accepted protocols.
Indoor air	Very Low	• One recent US study identified (New York City). Levels reported agree reasonably with a smaller US study in Chicago, but are higher than those in an older Canadian study using a small sample of homes near an aluminum smelter in Québec.
Indoor dust	Low	• Measured levels from one recent Canadian study (Ottawa, ON) are considerably higher than 2 recent studies conducted in California, USA using the same analytical methods.
Drinking water	Gap	• Only 1 distribution sample was analyzed for benz[a]anthracene in Ontario in 2009. No recent data or studies identified.
Foods and beverages	Very Low	• Very limited data from CFIA (National Chemical Residue Monitoring Program: 2009-2010 Annual Report) for benz[a]anthracene in foods and beverages were identified.

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 benz[a]anthracene 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 benz[a]anthracene concentrations by province based on data at the health region level. The median concentration of benz[a]anthracene measured in outdoor air in 2011 at the health region level was 0.00021 µg/m^3, while the mean concentration was 0.00026 µg/m^3. Concentrations of benz[a]anthracene can be higher or lower than average in many locations.

i. Provincial averages of predicted benz[a]anthracene concentrations (µg/m^3) in outdoor air in 2011 based on health regions

Province	Median	Mean
BC	0.00030	0.00030
AB	0.00014	0.00015
SK	0.00012	0.00013
MB	0.00013	0.00012
ON	0.00025	0.00032
QC	0.00025	0.00030
NB	0.00022	0.00022
PE	0.00020	0.00020
NS	0.00027	0.00028
NL	0.00012	0.00013
YK	0.00020	0.00020
NT	0.00013	0.00013
NU	0.00017	0.00017
Canada	**0.00021**	**0.00026**

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 benz[a]anthracene in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (µg/m³)	Less than 0.00006	0.00006 to 0.000072	0.000072 to 0.00009	0.00009 to 0.00012	0.00012 to 0.00018	0.00018 to 0.00027	0.00027 to 0.00036	0.00036 to 0.00045	0.00045 to 0.00054	More than 0.00054
Compared to national average (0.00018µg/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	--	439,590 (10.0%)	22,599 (0.5%)	16,486 (0.4%)	34,756 (0.8%)	2,413,960 (54.9%)	347,423 (7.9%)	377,690 (8.6%)	411,282 (9.3%)	336,271 (7.6%)
AB	--	1,687,684 (46.3%)	602,272 (16.5%)	183,806 (5.0%)	408,659 (11.2%)	623,603 (17.1%)	48,883 (1.3%)	31,801 (0.9%)	24,816 (0.7%)	33,733 (0.9%)
SK	--	328,930 (31.8%)	16,364 (1.6%)	9,984 (1.0%)	22,625 (2.2%)	418,833 (40.5%)	39,762 (3.8%)	39,914 (3.9%)	56,592 (5.5%)	100,377 (9.7%)
MB	--	271,233 (22.4%)	566,228 (46.9%)	75,538 (6.3%)	119,691 (9.9%)	142,776 (11.8%)	10,586 (0.9%)	5,914 (0.5%)	6,376 (0.5%)	9,926 (0.8%)
ON	973,670 (7.6%)	940,266 (7.3%)	58,137 0.4%)	1,281,057 (10.0%)	2,428,552 (18.9%)	3,713,027 (28.9%)	1,073,551 (8.4%)	418,178 (3.3%)	369,013 (2.9%)	1,596,370 (12.4%)
QC	--	1,008,790 (12.8%)	52,067 (0.6%)	42,323 (0.5%)	1,889,598 (23.9%)	2,808,985 (35.5%)	710,066 (9.0%)	345,086 (4.4%)	309,193 (3.9%)	736,893 (9.3%)
NB	91,624 (12.2%)	233,844 (31.1%)	7,989 (1.1%)	16,563 (2.2%)	45,795 (6.1%)	269,596 (35.9%)	14,576 (1.9%)	15,772 (2.1%)	14,665 (2.0%)	40,747 (5.4%)
NS	--	263,792 (28.6%)	9,386 (1.0%)	9,400 (1.0%)	15,764 (1.7%)	421,291 (45.7%)	53,276 (5.8%)	39,873 (4.3%)	34,817 (3.8%)	74,128 (8.0%)
PE	--	49,274 (35.1%)	936 (0.7%)	2,034 (1.5%)	3,291 (2.3%)	65,647 (46.8%)	3,117 (2.2%)	3,160 (2.3%)	3,217 (2.3%)	9,528 (6.8%)
NL	--	199,291 (38.7%)	5,004 (1.0%)	8,697 (1.7%)	44,237 (8.6%)	183,726 (35.7%)	21,427 (4.2%)	21,385 (4.2%)	15,486 (3.0%)	15,283 (3.0%)
NU	--	31,906 (100.0%)	--	--	--	--	--	--	--	--
NT	--	20,107 (48.5%)	243 (0.5%)	488 (1.1%)	559 (1.3%)	17,059 (41.1%)	1,024 (2.5%)	670 (1.6%)	1,312 (3.2%)	0 (<0.1%)
YT	--	6,918 (20.4%)	103 (0.3%)	150 (0.4%)	310 (10.9%)	17,908 (52.8%)	1,952 (5.8%)	1,805 (5.3%)	3,062 (9.0%)	1,689 (5.0%)
CANADA	1,065,294	5,481,625	1,341,328	1,646,526	5,013,837	11,096,411	2,325,643	1,301,248	1,249,831	2,954,945
% of pop.	(31.8%)	(16.4%)	(4.0%)	(4.9%)	(15.0%)	(33.1%)	(6.9%)	(3.9%)	(3.7%)	(8.8%)

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: 0.39	< 0.0005	0.0005 to < 0.0006	0.0006 to <0.0008	0.0008 to < 0.0011	0.0011 to < 0.0016	0.0016 to < 0.0024	0.0024 to < 0.0032	0.0032 to < 0.0041	0.0041 to < 0.0049	> 0.0049
US EPA CPF: No CPF										

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