



Formaldehyde

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 formaldehyde 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/m ³	1.4	3.0	
Indoor air	µg/m ³	33.3	86	

ii. Calculated Lifetime Daily Intake

Exposure pathway	Average intake (mg/kg bodyweight per day)	Maximum intake (mg/kg bodyweight per day)
Outdoor air	0.000032	0.000069
Indoor air	0.011	0.028

iii. Cancer Potency Factors

Exposure route	Health Canada	US EPA	CA OEHHA
Inhalation	--	0.0455	0.021

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)

Exposure pathway	Average ¹			Maximum ²
	Health Canada	US EPA	CA OEHHA ³	
Outdoor air	--	1.474	0.68	3.16
Indoor air	--	492.23	227.18	1271.22

¹Lifetime excess cancer risk based on average intake x cancer potency factor from each agency

²Lifetime excess cancer risk based on maximum intake x highest cancer potency factor

³California 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 ($\mu\text{g}/\text{m}^3$)	11	0.6	3.0	1.4	1.0

DF = Detection frequency

We assume formaldehyde 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: Gilbert (2005)				Location: Prince Edward Island					
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
59	1.0 assumed		2002 (winter)	µg/m ³	24h	5.5	87.5	39	29.6	33.2	

*DF = Detection frequency
 **DL = Detection limit

Rank: 1		Author: Gilbert (2006)				Location: Québec					
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
96		1	2005	µg/m ³	24h	9.6	90	32.7		29.5	

Notes: 96 homes PQ (includes smokers)
 *DF = Detection frequency
 **DL = Detection limit

Rank: 1		Author: Héroux (2010)				Location: Regina, SK					
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
111			2007	µg/m ³	24h	5.09	93.88	35.6		31.08	
104		7.46				72.48	25.73		23.39		
96		5.09				93.88	36.82		32.12		
83		7.46				72.48	26.33		23.83		

Notes: Values listed in the following order: Summer, Winter, Non-smoking Summer, Non-smoking winter
 *DF = Detection frequency
 **DL = Detection limit

Rank: 3		Author: Clarisse (2003)				Location: Paris, France					
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
61	1.0	6.15	2008- 2010	µg/m ³	30 min					21.7	
										24.3	
										24.5	

Notes: Values listed in the following order: Kitchen, living room, bedroom
 *DF = Detection frequency
 **DL = Detection limit

Rank: 4		Author: Liu (2007)				Location: RIOPA – 3 US Cities					
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
353	> 0.95		1999 - 2000	µg/m ³	48h			21.6	20.1		5th 12.5, 95th 32.5

*DF = Detection frequency
 **DL = Detection limit

Rank:	4	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	30 pg	2000-	$\mu\text{g}/\text{m}^3$	24h					18.7	10th 7.18
21			2001							12.4	90th 71.5 10th 5.69 90th 25.9

Notes: Values listed in following order: Summer, Winter

*DF = Detection frequency

**DL = Detection limit

Rank:	4	Author:	Park (2006)	Location:	Japan						
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
292	~1.0	0.2 to	2000 -	$\mu\text{g}/\text{m}^3$	24h			134			
108		0.5	2002					112			
60								86			
1125								88			
375								89			
191								90			

Notes: Values listed in following order: New homes year 1, year 2, year 3, Old homes year 1, year 2, year 3

*DF = Detection frequency

**DL = Detection limit

Rank:	4	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-	$\mu\text{g}/\text{m}^3$	48h		46	17.7	15.6		
41			2000		weekday		35.9	19.3	58.9		

Notes: Values listed in following order: NYC – non-smoking homes, LA – non-smoking homes

*DF = Detection frequency

**DL = Detection limit

Rank:	5	Author:	Feng (2004)	Location:	Ottawa, ON						
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
30		1	unknown	$\mu\text{g}/\text{m}^3$	100 minutes	5.8	85	28			

*DF = Detection frequency

**DL = Detection limit

Rank:	5	Author:	Dannemiller (2013)	Location:	Boston, MA, USA						
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
70	1.0	6.15	2008-2010	$\mu\text{g}/\text{m}^3$	30 min	6.15	162.36			43.173	

*DF = Detection frequency

**DL = Detection limit

Rank:	5	Author:	Marchand (2008)				Location:	Strasbourg, France				
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile	
162	1.0 assumed		2004- 2005	µg/m ³	30 to 95 minutes	7	83	32.2	29.2			

*DF = Detection frequency

**DL = Detection limit

Rank:	5	Author:	Marchand (2006)				Location:	Strasbourg, France				
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile	
16	1.0 assumed	0.32	2004- 2005	µg/m ³	20 to 90 minutes			LR 35.7 BDR 46.1				

*DF = Detection frequency

**DL = Detection limit

Sources for indoor air data:

- Clarisse B, Laurent AM, Seta N, Le Moullec Y, El Hasnaoui A, Momas I. 2003. Indoor aldehydes: measurement of contamination levels and identification of their determinants in Paris dwellings. *Environmental Research* 92: 245-253.
- Dannemiller KC, Murphy JS, Dixon SL, Pennell KG, Suuberg EM, Jacobs DE, Sandel M. 2013. Formaldehyde concentrations in household air of asthma patients determined using colorimetric detector tubes. *Indoor Air* 23: 285-294.
- Feng YL, Zhu JP. 2004. Separation and determination of carbonyl compounds in indoor air using two-step gradient capillary electrochromatography. *Analytical Sciences* 20: 1691-1695.
- Gilbert NL, Guay M, David MJ, Judek S, Chan CC, Dales RE. 2005. Levels and determinants of formaldehyde, acetaldehyde, and acrolein in residential indoor air in Prince Edward Island, Canada. *Environ Res* 99: 11-17.
- Gilbert NL, Gauvin D, Guay M, roux ME, Dupuis G, Legris M, et al. 2006. Housing characteristics and indoor concentrations of nitrogen dioxide and formaldehyde in Quebec City, Canada. *Environmental Research* 102: 1-8.
- Héroux ME, Clark N, Van Ryswyk K, Mallick R, Gilbert NL, Harrison I, et al. 2010. Predictors of Indoor Air Concentrations in Smoking and Non-Smoking Residences. *International Journal of Environmental Research and Public Health* 7: 3080-3099.
- Liu X, Zhao YY, Chan K, Hrudehy SE, Li XF, Li J. 2007. Analysis of nitrosamines by capillary electrospray-high-field asymmetric waveform ion mobility spectrometry-MS with programmed compensation voltage. *Electrophoresis* 28: 1327-1334.
- Marchand C, Bulliot B, Le Calve S, Mirabel P. 2006. Aldehyde measurements in indoor environments in Strasbourg (France). *Atmospheric Environment* 40: 1336-1345.
- Marchand C, Le Calve S, Mirabel P, Glasser N, Casset A, Schneider N, et al. 2008. Concentrations and determinants of gaseous aldehydes in 162 homes in Strasbourg (France). *Atmospheric Environment* 42: 505-516.
- 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.

- Park JS, Ikeda K. 2006. Variations of formaldehyde and VOC levels during 3 years in new and older homes. *Indoor Air* 16: 129-135.
- 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.

iii. Dust

Formaldehyde is not expected to be present in indoor dust in significant amounts, or carcinogenic via ingestion

iv. Drinking water

Formaldehyde is not expected to be carcinogenic via ingestion.

v. Food and Beverages

Formaldehyde is not expected to be carcinogenic via ingestion.

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	• Formaldehyde is regularly measured in outdoor air at 11 monitoring stations across Canada using accepted protocols.
Indoor air	Low - Moderate	• Three recent Canadian studies were identified (PEI, QC, and SK), with good agreement among studies.

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 formaldehyde 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 formaldehyde concentrations by province based on data at the health region level. The median concentration of formaldehyde measured in outdoor air in 2011 at the health region level was 1.772 µg/m³, while the mean concentration was 1.912 µg/m³. Concentrations of formaldehyde can be higher or lower than average in many locations.

i. Provincial averages of predicted formaldehyde concentrations (µg/m³) in outdoor air in 2011 based on health regions

Province	Median	Mean
BC	1.735	2.125
AB	1.767	1.872
SK	1.515	1.544
MB	1.636	1.773
ON	1.936	2.035
QC	1.841	1.916
NB	1.728	1.808
PE	1.759	1.759
NS	1.813	1.794
NL	1.615	1.625
YK	1.999	1.999
NT	1.956	1.956
NU	2.262	2.262
Canada	1.772	1.912

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 ($\mu\text{g}/\text{m}^3$) of formaldehyde in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration ($\mu\text{g}/\text{m}^3$)	Less than 0.47	0.47 to 0.56	0.56 to 0.70	0.70 to 0.93	0.93 to 1.40	1.40 to 2.10	2.10 to 2.80	2.80 to 3.50	3.50 to 4.20	More than 4.20
Compared to national average ($1.40\mu\text{g}/\text{m}^3$)*	> 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	--	--	--	218,956 (5.0%)	62,977 (1.4%)	1,386,072 (31.5%)	1,367,867 (31.1%)	672,716 (15.3%)	229,553 (5.2%)	461,916 (10.5%)
AB	--	--	--	--	--	3,090,307 (84.8%)	250,282 (6.9%)	159,686 (4.4%)	71,935 (2.0%)	73,047 (2.0%)
SK	--	--	--	--	102,706 (9.9%)	792,415 (76.7%)	100,827 (9.8%)	25,610 (2.5%)	7,595 (0.7%)	4,228 (0.4%)
MB	--	--	--	--	664,956 (55.0%)	448,220 (37.1%)	53,690 (4.4%)	13,057 (1.1%)	9,664 (0.8%)	18,681 (1.5%)
ON	--	--	--	--	365,527 (2.8%)	10,411,166 (81.0%)	544,778 (4.3%)	1,090,103 (8.5%)	200,068 (1.6%)	230,179 (1.8%)
QC	--	--	--	--	--	6,641,822 (84.0%)	858,144 (10.9%)	231,099 (2.9%)	64,125 (0.8%)	107,811 (1.4%)
NB	--	--	5,318 (0.7%)	4,813 (0.6%)	110,605 (14.7%)	535,602 (71.3%)	72,709 (9.7%)	13,240 (1.8%)	4,336 (0.5%)	4,548 (0.6%)
NS	--	--	--	--	--	830,173 (90.0%)	81,585 (8.9%)	9,708 (1.1%)	125 (<0.1%)	136 (<0.1%)
PE	--	--	--	--	--	116,960 (83.4%)	18,206 (13.0%)	3,612 (2.6%)	1,117 (0.8%)	309 (0.2%)
NL	--	--	--	--	--	438,134 (85.2%)	51,484 (10.0%)	13,849 (2.3%)	6,205 (1.2%)	4,864 (0.9%)
NU	--	--	--	--	--	24,539 (76.9%)	3,353 (10.5%)	2,141 (6.7%)	1,041 (3.3%)	832 (2.6%)
NT	--	--	--	--	--	26,677 (64.3%)	9,169 (22.1%)	2,000 (4.8%)	893 (2.1%)	2,723 (6.6%)
YT	--	--	--	--	--	19,893 (58.7%)	8,409 (24.8%)	2,215 (6.5%)	700 (2.1%)	2,680 (7.9%)
CANADA	--	--	5,318 (<0.1%)	223,769 (0.7%)	1,306,771 (3.9%)	24,761,980 (74.0%)	3,430,503 (10.2%)	2,239,036 (6.7%)	597,357 (1.8%)	911,954 (2.7%)
% of pop.										

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	< 0.23	0.23 to < 0.27	0.27 to < 0.34	0.34 to < 0.45	0.45 to < 0.68	0.68 to < 1.02	1.02 to < 1.36	1.36 to < 1.7	1.7 to < 2.04	> 2.04
California OEHHA CPF: 0.021										
US EPA CPF: 0.045										

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