Outdoor Air Pollution

Environmental estimates (circa 2011): Supplemental data

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1. Data for lifetime excess cancer risk estimates

Overview

Calculating lifetime excess cancer risk requires an estimate of intake and a cancer potency factor. No published cancer potency factors for inhalation of particulate air pollution are available from Health Canada, the California Office of Environmental Health Hazard Assessment (OEHHA), or the US Environmental Protection Agency (US EPA) during our review. An estimate of lifetime excess cancer risk for inhalation of diesel engine exhaust, which is a source of particulate air pollution, is available.

Particulates $_{2.5}$ μm in diameter or less (PM$_{2.5}$) are most often associated with adverse health effects. Particles of this size can be inhaled deeply into the lungs and a wide range of known or suspected carcinogens may be adhered to them. PM$_{2.5}$ is measured in outdoor air by National Air Pollution Surveillance monitors, and several Canadian studies have measured levels in indoor air.

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 2011.

Source	Stations (n)	Min	Max	Mean	DF
NAPS 2011 (μg/m³)	204*	1.7	16.1	6.9	1.0

* adjusted TEOM levels

DF = Detection frequency

We assume PM$_{2.5}$ 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. The following table summarizes measurements of $PM_{2.5}$ in indoor air in Canada:

Data Source(s):	Min	Max	Mean	DF
Allen (2009); Heroux (2010); Hystad (2007); Loo (2010); Wheeler (2011); Miller (2007)	1.0	136.0	9.2	1.0

DF = Detection frequency

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.

We assume $PM_{2.5}$ is present at these levels in all indoor air, although concentrations may vary from one location to another.

Rank: 1	Author:	Allen (2009)						Location:	Smithers, British Columbia		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
9			2007-	µg/m³	6 days	1.3	35.2	10.9	6.9		95th 31.1
9			2008			0.8	60.6	14.6	9.6		95th 52.4

Notes: Values listed in the following order: pre-wood stove upgrade, post-wood stove upgrade

*DF = Detection frequency

**DL = Detection limit

Rank: 1	Author:	Heroux (2010)						Location:	Regina, Saskatchewan		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
95			2007	µg/m³	10	0.88	92.12	9.42		5.46	95th 36.34
105					weeks	1.00	82.09	9.51		6.43	95th 33.93
76						0.88	27.91	5.47		4.13	95th 15.37
91						1.00	24.92	6.18		5.32	95th 13.30

Notes: Values listed in the following order: winter, summer, non-smoking winter, non-smoking summer

*DF = Detection frequency

**DL = Detection limit

Rank: 1	Author:	Hystad (2007)						Location:	Victoria, British Columbia		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
73			2007	µg/m³	5 days			7.90	6.94		10th 3.64
											25th 5.30
											75th 10.55
											90th 13.14

*DF = Detection frequency

**DL = Detection limit

Rank: 1	Author:	Loo (2010)						Location:	Toronto, Ontario		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
60			2006- 2007	µg/m³	6 days			9.2	7.8		

*DF = Detection frequency

**DL = Detection limit

Rank: 1	Author:	Wheeler (2011)						Location:	Toronto, Ontario		
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
230			2005/	µg/m³	5 days	2.4	136	7.9	5.8	6.4	95th 27.3
202			2006			3.2	49	10.2	8.6	8.9	95th 23.0
228						2.8	53	8.0	6.3	6.9	95th 19.2
218						2.9	70	8.4	6.9	7.3	95th 22.2

*DF = Detection frequency

**DL = Detection limit

Rank:	1	Author:	Miller (2007)					Location:	Ottawa, Ontario			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
20			2002	µg/m³	7 days	2.9	27.2	8.9	6.7	7.0	

Notes: 10 urban and 10 rural homes measured during a period of snow cover (-10 degrees celsius)
*DF = Detection frequency
**DL = Detection limit

Rank:	3	Author:	Raaschou-Nielsen (2010)					Location:	Copenhagen, Denmark			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
327			1999-2003	µg/m³	7 days			17.7	12.7		95th 53.3

*DF = Detection frequency
**DL = Detection limit

Rank:	4	Author:	Brown (2008)					Location:	Boston, MA			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
25			1999-2000	µg/m³	7 days	2.4	28.0	10.1		7.3	95th 19.3
25						1.1	45.0	12.0		10.3	95th 26.6

Notes: Values listed in the following order: winter, summer
*DF = Detection frequency
**DL = Detection limit

Rank:	4	Author:	Kim (2006)					Location:	Toronto, ON			
Samples (n)	DF*	DL**	Sample Date	Units	Sample Duration	Min	Max	Mean (AM)	Med	Geomean (GM)	Percentile
259			1999-2001	µg/m³	24 hrs	4.0	503.0	22.0	14.0		95th 106.0

*DF = Detection frequency
**DL = Detection limit

Sources for indoor air data:

- Allen R.W., Leckie S., Millar G., Brauer M. 2009. The impact of woode stove technology upgrades on indoor residential air quality. Atmospheric Environment, 43(37) : 5908-5915.
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- Hystad P.W. 2007. Modeling residential fine particulate matter infiltration: implications for exposure assessment. Masters of Science Thesis, Department of Geography, University of Victoria, BC, Canada.

- Kim D., Sass-Kortsak A., Purdham J.T., Dales R.E., Brook J.R. 2006. Associations between personal exposures and fixed-site ambient measurements of fine particulate matter, nitrogen dioxide, and carbon monoxide in Toronto, Canada. Journal of Exposure Science and Environmental Epidemiology, 16(2): 172-183.
- Loo C.K.J., Foty R.G., Wheeler A.J., Miller D.J., Evans G., Stieb D.M., Dell S.D. 2010. Do questions reflecting indoor air pollutant exposure from a questionnaire predict direct measure of exposure in owner-occupied houses? Int. J. Environ. Res. Public Health, 7: 3270-3297.
- Miller J.D., Dugandzic R., Frescura A-M, Salares V. 2007. Indoor- and outdoor-derived contaminants in urban and rural homes in Ottawa, Ontario, Canada. Journal of Air & Waste Management Association, 57(3): 297-302.
- Raaschou-Nielsen O., Hermansen M.N., Loland L., Buchvald F., Pipper C.B., Sørensen M., Loft S., Bisgaard H. 2010. Long-term exposure to indoor air pollution and wheezing symptoms in infants. Indoor Air, 20: 159-167.
- Wheeler A.J., Wallace L.A., Kearney J., Van Ryswyk K., You H., Kulka R., Brook J.R., Xu X. 2011. Personal, indoor, and outdoor concentrations of fine and ultrafine particles using continuous monitors in multiple residences. Aerosol Science and Technology, 45: 1078-1089.

2. Data quality for lifetime excess cancer risk estimates

Only publicly available data were used to determine average and maximum concentrations in outdoor and indoor air.

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	• $PM_{2.5}$ is regularly measured in outdoor air at 204 monitoring stations across Canada using accepted protocols.
Indoor air	Moderate	• Five recent Canadian studies were identified (Smithers BC, Regina SK, Victoria BC, Toronto ON, and Ottawa ON) which had similar mean concentration levels.

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 $PM_{2.5}$ 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 $PM_{2.5}$ concentrations by province based on data at the health region level. The median concentration of $PM_{2.5}$ measured in outdoor air in 2011 at the health region level was 6.630 μg/m^3, while the mean concentration was 6.854 μg/m^3. Concentrations of $PM_{2.5}$ can be higher or lower than average in many locations.

i.   Provincial averages of predicted $PM_{2.5}$ concentrations (μg/m^3) in outdoor air in 2011 based on health regions

Province	Median	Mean
BC	6.891	6.961
AB	7.396	7.649
SK	5.743	5.884
MB	6.379	6.466
ON	6.692	6.693
QC	7.591	8.004
NB	6.838	6.879
PE	6.377	6.377
NS	6.250	6.211
NL	6.144	6.358
YK	6.971	6.971
NT	5.929	5.929
NU	6.703	6.703
Canada	**6.630**	**6.854**

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.

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ii. Provincial population distribution by estimated average concentration (μg/m³) of particulate matter (PM$_{2.5}$) in outdoor air in 2011 based on NAPS data at the census block

Estimated annual average concentration (μg/m³)	Less than 2.30	2.3 to 2.76	2.76 to 3.45	3.45 to 4.6	4.6 to 6.9	6.9 to 10.35	10.35 to 13.8	13.8 to 17.25	17.25 to 20.7	More than 20.7
Compared to national average (6.90μg/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	--	--	10,306 (0.2%)	942,965 (21.4%)	2,035,840 (46.3%)	1,104,554 (25.1%)	149,813 (3.4%)	109,128 (2.5%)	34,827 (0.8%)	12,624 (0.3%)
AB	5 (<0.1%)	--	4,896 (0.1%)	111,927 (3.1%)	848,997 (23.3%)	1,920,933 (52.7%)	461,634 (12.7%)	228,210 (6.3%)	37,251 (1.0%)	31,404 (0.9%)
SK	--	--	--	--	622,782 (60.3%)	398,536 (38.6%)	7,096 (0.7%)	490 (<0.1%)	2,014 (0.2%)	2,463 (0.2%)
MB	--	--	--	--	647,572 (53.6%)	539,029 (44.6%)	9,979 (0.8%)	10,959 (0.9%)	729 (0.1%)	--
ON	--	--	27,346 (0.2%)	488,689 (3.8%)	7,226,123 (56.2%)	4,473,985 (34.8%)	407,269 (31.7%)	85,178 (0.7%)	96,703 (0.8%)	46,528 (0.4%)
QC	--	10,622 (0.1%)	3,117 (<0.1%)	126,036 (1.6%)	1,306,717 (16.5%)	3,601,313 (45.6%)	2,138,800 (27.1%)	524,493 (6.6%)	89,713 (1.1%)	102,190 (1.3%)
NB	--	--	--	83,475 (11.1%)	512,834 (68.3%)	118,219 (15.7%)	7,944 (1.1%)	13,841 (1.8%)	10,578 (1.4%)	4,280 (0.6%)
NS	--	--	--	140,534 (15.2%)	648,579 (70.4%)	114,770 (12.5%)	7,992 (0.8%)	4,992 (0.5%)	3,550 (0.4%)	1,310 (0.1%)
PE	--	--	--	--	84,787 (60.5%)	55,087 (39.3%)	330 (0.2%)	--	--	--
NL	--	--	--	23,121 (4.5%)	386,881 (75.2%)	90,782 (17.6%)	4,512 (0.9%)	5,147 (1.0%)	4,093 (0.8%)	0 (<0.1%)
NU	--	--	--	--	25,207 (79.0%)	--	5,525 (17.3%)	1,174 (3.7%)		
NT	--	--	50 (0.1%)	1,502 (3.6%)	25,063 (60.4%)	14,388 (3.5%)	459 (1.1%)	--	--	--
YT	--	--	--	--	8,207 (24.2%)	23,025 (67.9%)	2,648 (7.8%)	17 (<0.1%)	--	--
CANADA	5	10,622	45,715	1,918,249	14,379,589	12,454,621	3,204,001	983,629	279,458	200,799
% of pop.	(<0.1%)	(<0.1%)	(0.1%)	(5.7%)	(42.9%)	(37.2%)	(9.6%)	(2.9%)	(0.8%)	(0.6%)

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

* measured at National Air Pollution Surveillance (NAPS) monitors in 2011