



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 $2.5 \mu\text{m}$ in diameter or less ($\text{PM}_{2.5}$) 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. $\text{PM}_{2.5}$ 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 ($\mu\text{g}/\text{m}^3$)	204*	1.7	16.1	6.9	1.0

* adjusted TEOM levels

DF = Detection frequency

We assume $\text{PM}_{2.5}$ 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/m ³	6 days	1.3	35.2	10.9	6.9		95 th 31.1
9			2008			0.8	60.6	14.6	9.6		95 th 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/m ³	10 weeks	0.88	92.12	9.42		5.46	95 th 36.34
105						1.00	82.09	9.51		6.43	95 th 33.93
76						0.88	27.91	5.47		4.13	95 th 15.37
91						1.00	24.92	6.18		5.32	95 th 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/m ³	5 days			7.90	6.94		10 th 3.64 25 th 5.30 75 th 10.55 90 th 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/m ³	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/m ³	5 days	2.4	136	7.9	5.8	6.4	95 th 27.3
202			2006			3.2	49	10.2	8.6	8.9	95 th 23.0
228						2.8	53	8.0	6.3	6.9	95 th 19.2
218						2.9	70	8.4	6.9	7.3	95 th 22.2

*DF = Detection frequency

**DL = Detection limit

1

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/m ³	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/m ³	7 days			17.7	12.7		95 th 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-	µg/m ³	7 days	2.4	28.0	10.1		7.3	95 th 19.3
25			2000			1.1	45.0	12.0		10.3	95 th 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/m ³	24 hrs	4.0	503.0	22.0	14.0		95 th 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 wood stove technology upgrades on indoor residential air quality. *Atmospheric Environment*, 43(37) : 5908-5915.
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- 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., Pippert 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.
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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

Provincial estimates

i. Range of Predicted Concentrations ($\mu\text{g}/\text{m}^3$) by region

Canada: minimum 1.71 to maximum 77.90

BC: minimum 3.28 to maximum 44.26

AB: minimum 1.70 to maximum 64.38

SK: minimum 4.61 to maximum 30.32

MB: minimum 4.61 to maximum 31.90

ON: minimum 3.37 to maximum 77.90

QC: minimum 2.45 to maximum 49.92

NB: minimum 3.55 to maximum 33.45:

PEI: minimum 5.37 to maximum 10.68

NS: minimum 4.14 to maximum 30.62

NFL: minimum 4.22 to maximum 30.28

YT: minimum 5.37 to maximum 14.74

NT: minimum 3.42 to maximum 18.26

NU: minimum 5.37 to maximum 16.84

ii. Provincial tables

The average concentration of $\text{PM}_{2.5}$ measured in outdoor air in 2011 was $6.9 \mu\text{g}/\text{m}^3$, but concentrations of $\text{PM}_{2.5}$ can be higher or lower than average in many locations. We used a model to predict annual average concentrations of $\text{PM}_{2.5}$ in outdoor air at residential locations for the year 2011 in order to calculate the number of people in each exposure level by province or territory.

The tables below show provincial populations by concentration levels (either annual average or number of times above/below the national average).

Population by Estimated Concentration of Fine Particulate Matter (PM_{2.5}) in Outdoor Air – 2011

Estimated annual average concentration (µg/m ³)	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
	> 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
Compared to national average (6.90µg/m ³)*	← 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 (<0.1%)	10,622 (<0.1%)	45,715 (0.1%)	1,918,249 (5.7%)	14,379,589 (42.9%)	12,454,621 (37.2%)	3,204,001 (9.6%)	983,629 (2.9%)	279,458 (0.8%)	200,799 (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