The Health Effects of Air Pollution

MDEC CONFERENCE

October 3, 2007

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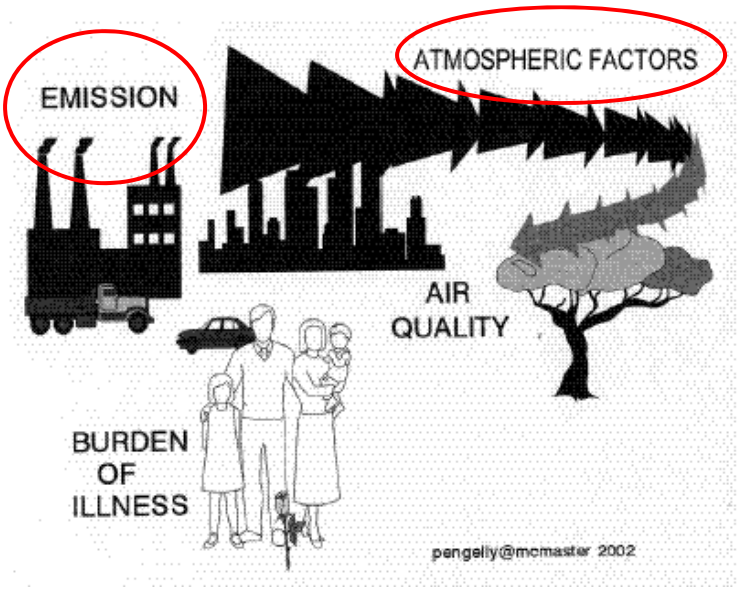
Has your or your family's health been affected by air pollution or smog?

Are we concerned?

61.0% of Canadians feel that their health is currently either affected "a great deal" or "a fair amount" by the environment

52.0% in 1992

Environmental Monitor, 2002-2003



Emissions

Combustion of fossil fuels
- Domestic heating
- Power generation

Transportation

Industrial processes

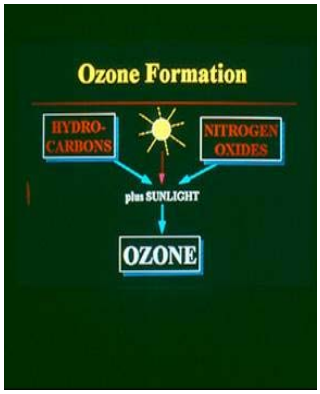
Residential wood burning

Smog

- Ozone
- Particulates

Ozone (O3)

- A secondary pollutant
- **NOx and VOCs**
- Sunlight and temperature
- Peaks late afternoon
- Maximum in hot, stagnant air
- vs. Stratospheric Ozone

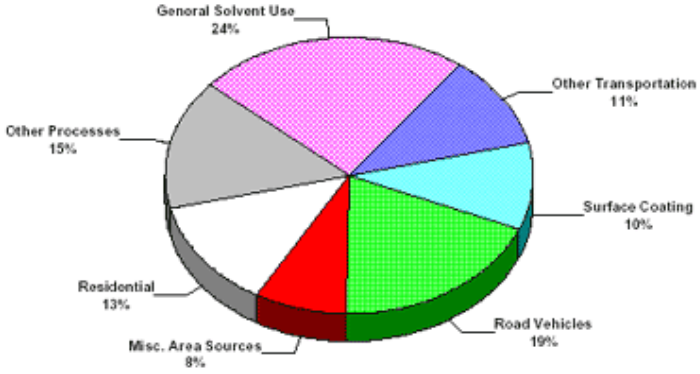


Ontario NOx Emissions by Sector 2001

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

Air Quality in Ontario: 2002 report: Ontario Ministry of the Environment

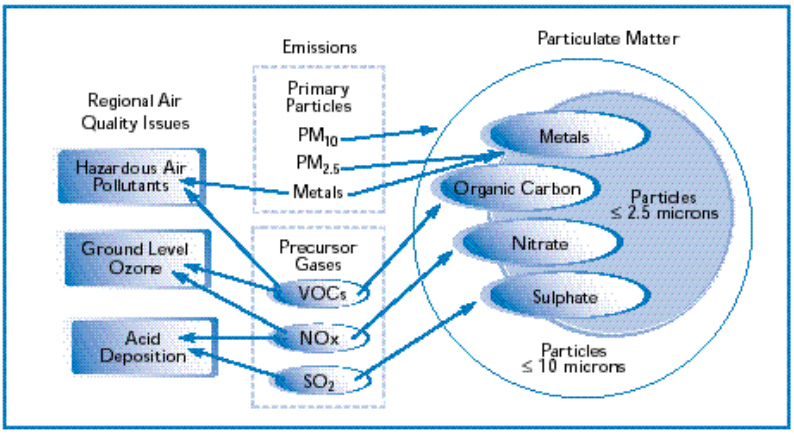
Ontario VOC Emissions by Sector 2000



www.airqualityontario.com/science/background.cfm

Particulate Matter (PM 2.5)

Links of $PM_{2.5}$ and PM_{10} to Precursor Emissions and Other Air Quality Issues



Ontario Anti-Smog Action Plan 2000

Ontario PM2.5 Emissions by Sector 2001

QuickTime™ and a
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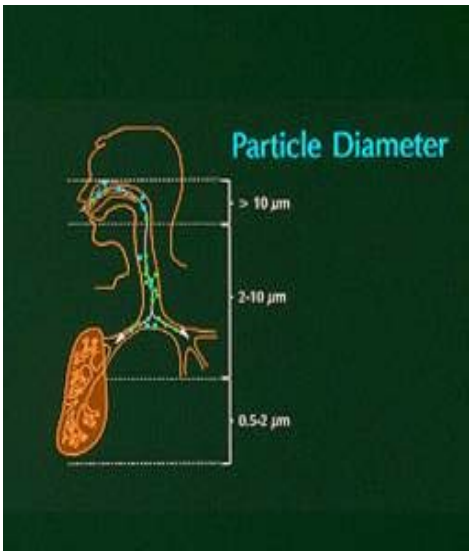
are needed to see this picture.

Air Quality in Ontario: 2002 report: Ontario Ministry of the Environment

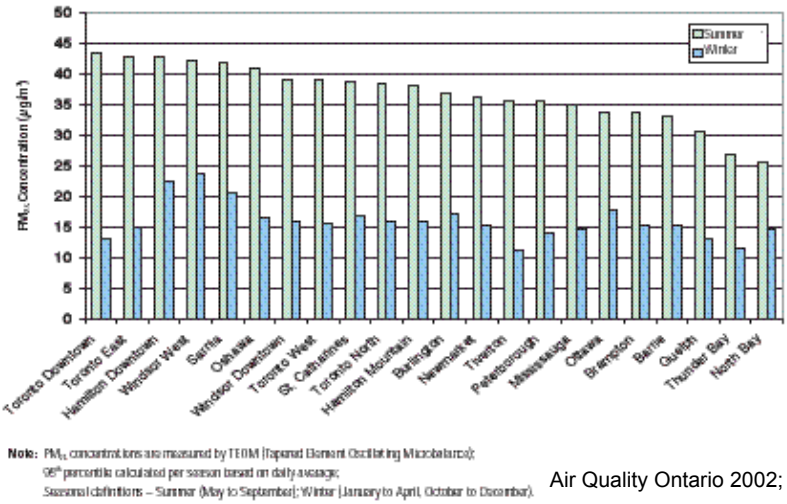
Particulates - Size Matters

- **Human hair** 40microns
- **PM 10** Coarse particles (2.5–10 microns) deposited in the upper respiratory tract and large airways
- **PM 2.5** Fine particles (< 2.5 microns) reach terminal bronchioles and alveoli
- **Ultrafine-Particles** (<0.1ug)



PM 10 In Ontario: Summer And Winter

Figure 3.3: Seasonal Distribution of $PM_{2.5}$ at Sites Across Ontario (2002)



Note: $PM_{2.5}$ concentrations are measured by TEOM (Tapered Element Oscillating Microbalance); 98th percentile calculated per season based on daily average; Seasonal definitions – Summer (May to September); Winter (January to April, October to December).

Air Quality Ontario 2002; MOE

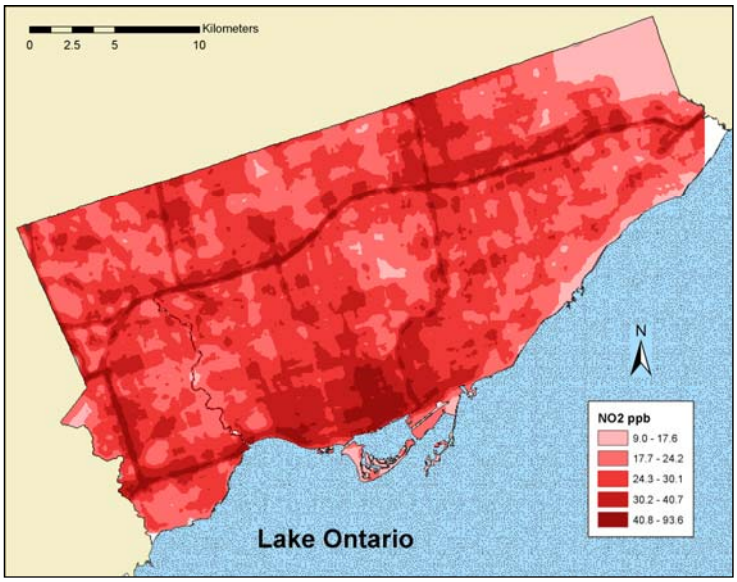
Local vs. Regional

Local Air Pollution

- •Microenvironments
- •Near highway
- •Canyon effect
- •Inside car
- •Inside school bus

Regional Air Pollution

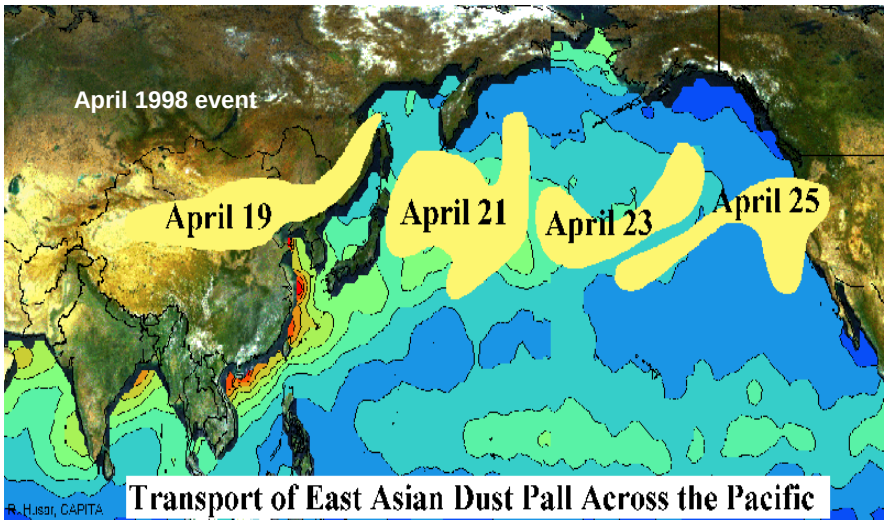
Predicted Surface of NO_2



Canadian Smog Hot Spots

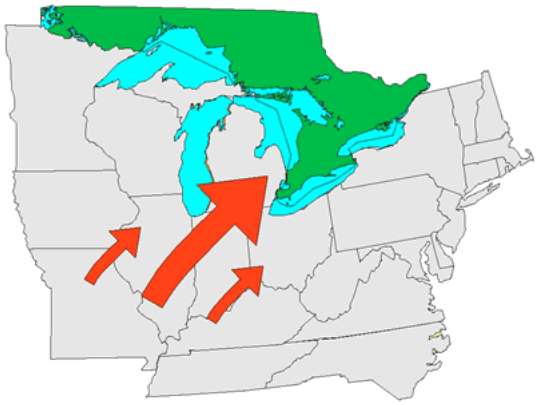
- Fraser Valley, BC
- **Windsor-Quebec Corridor**
- Southern Atlantic

Transpacific Transport Of Asian Dust



R. Husar

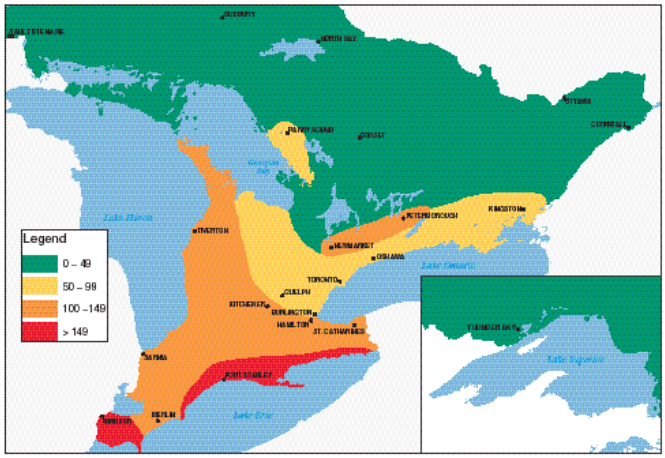
Prevailing Winds and Transboundary Air Pollution



www.airqualityontario.com/science/background.cfm

Ozone Exceedance Days 2002

Figure 2.2: Geographical Distribution of Number of One-Hour Ozone Exceedances Across Ontario (2002)



Ontario Air Quality Report 2002. OMOE

PM Exceedance Days 2005

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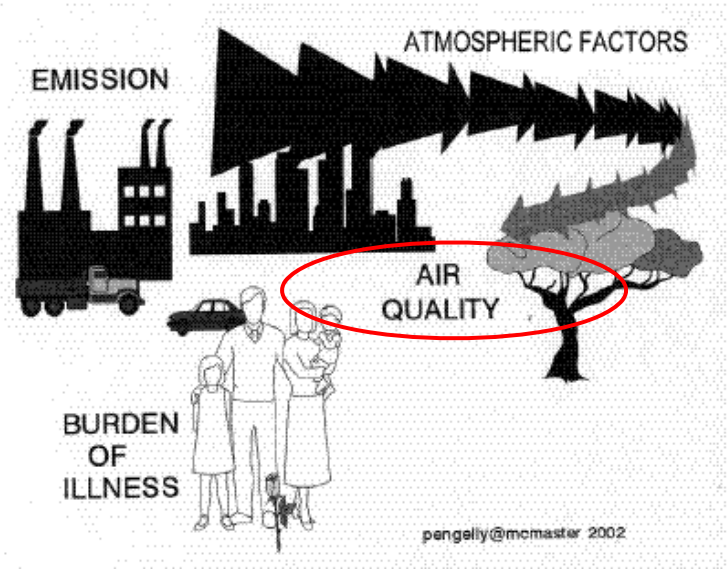
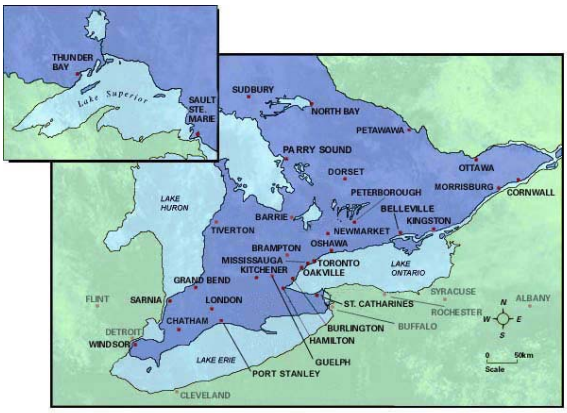
Ontario Air Quality Report 2002. OMOE



Air Quality Monitoring Sites



http://www.airqualityontario.com

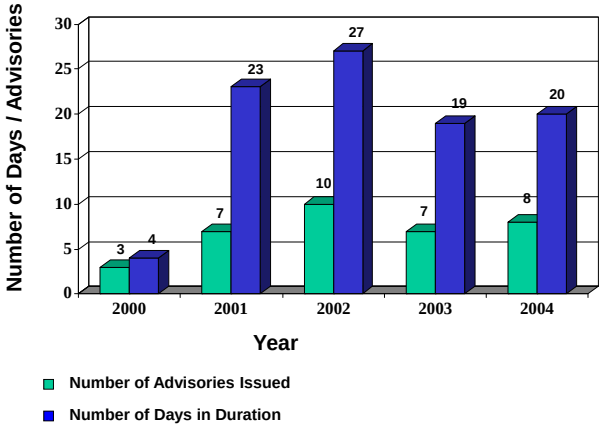
English 1-800-387-7768
Toronto 416-246-0411
French 1-800-221-8852).
www.airqualityontario.com

AQI

"AQI of 20, reason: ozone."

www.airqualityontario.com/science/background.cfm

Summary of Smog Advisories in Ontario (2000 – 2004)



The number and duration of smog advisories are highly dependent on weather conditions and vary from year to year.

Ontario
Total Smog Days 2005

53

15 advisories

And 2007???

Air Quality Index(AQI)

Based on a specific level of an individual air pollutant

Usually Ozone or PM

Air Quality Health Index (AQHI)

Sum of **health** risk

A mixture of pollutants

– Ozone, PM, NO2

Reported twice a day

Health messages

www.ec.gc.ca/cas-aqhi

1-3 Low health risk

4-6 Moderate health risk

7-10 High health risk

10 + Very high health risk

At Risk Groups

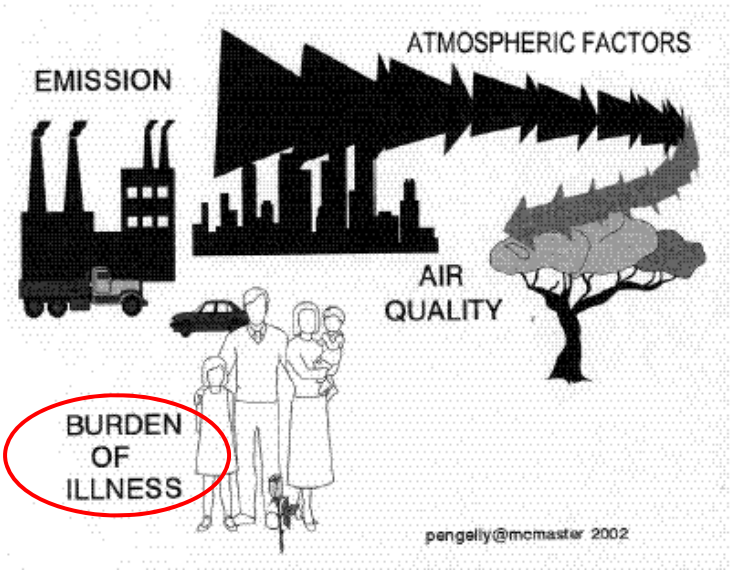
- Existing respiratory or cardiovascular conditions
- Children
- The elderly
- Those active outdoors
  - Sports
  - Strenuous work
- Sensitivity varies

AQHI Health Messages

Health risk	AQHI	At Risk population	General population
Low	1-3	Enjoy your usual outdoor activities. Follow your doctor's advice for exercise	Ideal conditions for outdoor activities
Moderate	4-6	Consider reducing physical exertion outdoors or rescheduling activities to times when the index is lower	No need to modify your usual outdoor activities, unless you experience symptoms

AQHI Health Messages

Health risk	AQHI	At Risk population	General population
High	7-10	Children, the elderly and people with heart or breathing problems should reduce physical exertion outdoors or reschedule activities, especially if they experience symptoms.	Anyone experiencing discomfort such as coughing or throat irritation should consider reducing
Very High	10+		Everyone should reduce

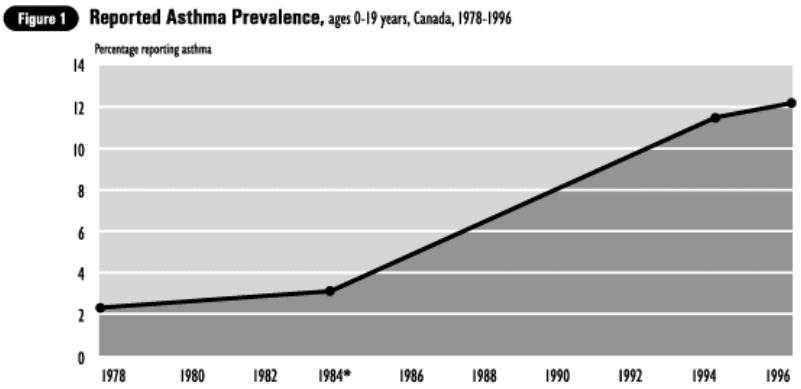


Air Pollution and Health Literature

studies 1990-2004

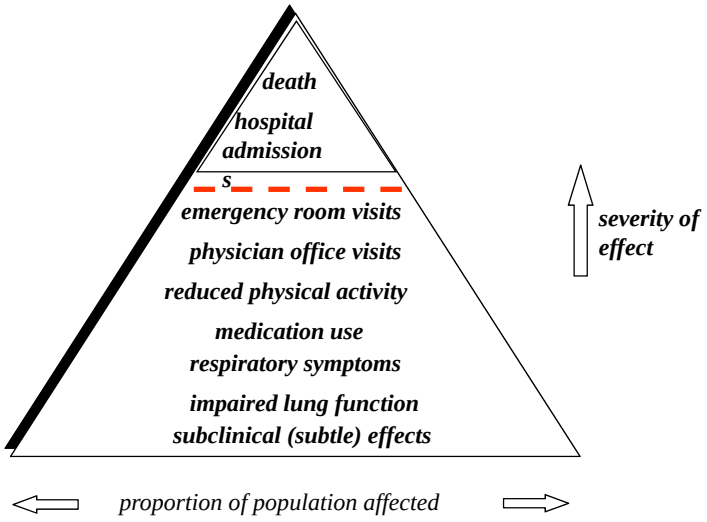
APBIT 2004. Toronto Public Health

Asthma Prevalence In Canada



Measuring up. PHAC 2005

Health Effects of Air Pollution



Acute Effects Of Smog

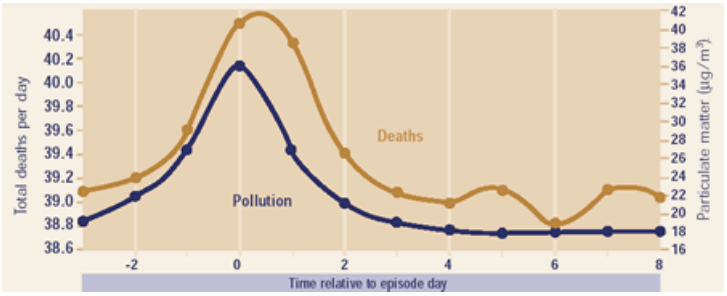
Respiratory

- hospitalization
- asthma
- allergies
- infections

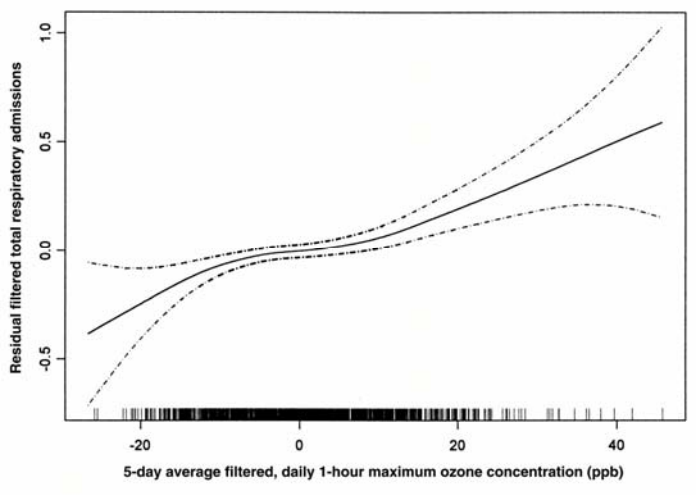
Cardiovascular

Health Effects Of Smog

How do we do research?



Ozone And Respiratory Hospitalizations For Children (< 2 Years), Toronto, 1980-1994



Burnett, R. T. Am. J. Epidemiol. 2001

Asthma

Ozone exacerbates asthma

May cause an asthma episode in a known asthmatic

St. John, New Brunswick

Ozone – associated with asthma emergency department visits

Stieb DM Environ Health Perspect 1996.

Asthma

Atlanta Olympics

Decreased levels of ozone pollution

Acute asthma events decreased by 42%

Friedman. JAMA 2001.

Traffic and Myocardial Infarction

Table 2. Odds Ratios for the Onset of Myocardial Infarction (MI) after Time Spent in Traffic, According to the Means of Transportation.*

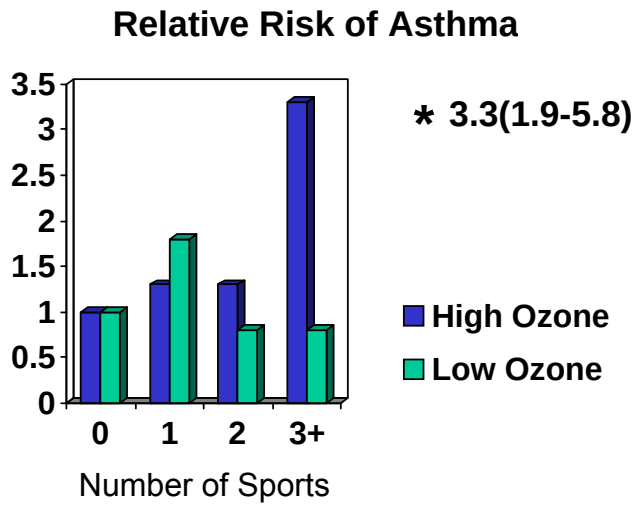
Type of Transportation and Hours before MI	No. of Subjects	Frequency of Exposure in Case Period on Day of MI (%)	Odds Ratio (95% CI)	P Value
Any means of transportation†				
Concurrent	585	8.0	1.50 (1.07–2.09)	0.02
1 hr	625	12.1	2.92 (2.22–3.83)	<0.001
2 hr	634	8.9	2.01 (1.49–2.72)	<0.001
3 hr	635	5.5	1.15 (0.79–1.66)	0.47
4 hr	638	5.6	1.27 (0.89–1.83)	0.19
5 hr	639	6.8	1.64 (1.17–2.30)	0.004
6 hr	640	6.1	1.34 (0.93–1.92)	0.11

Peters, NEJM, 2004

Chronic Effects Of Air Pollution

- Respiratory
  - Asthma causation?
  - Lung development
- Mortality
- Cancer
- Reproductive Outcomes

Ozone and ? New Onset Asthma



McConnell, Lancet 2002

Lung Development

“Dirty air stunts growth of lungs”

- Particulates, NOx
- 3000 children in California since 1993
- ? linked to asthma and emphysema in adults

Gauderman. Am J Respir Crit Care Med, 2000

Lung Cancer and Air Pollution

Particulate Matter PM 2.5

8% increase lung cancer mortality risk for males for each 10 µg/m3 increase in PM2.5 concentration

Pope CA, JAMA. 2002.

Traffic Air Pollution And Mortality

TABLE 3. Rate advancement period for mortality from all natural causes in relation to residence close to a major road and common chronic diseases, Hamilton, Ontario, Canada, 1992–2001

Risk factor	RAP*,† (years)	95% CI*
Residence within a road/highway buffer	2.5	0.2, 4.8
Diagnosis of chronic pulmonary disease (excluding asthma)	3.4	0.8, 6.0
Diagnosis of chronic ischemic heart disease	3.1	0.8, 5.4
Diagnosis of diabetes mellitus	4.4	1.8, 7.0

* RAP, rate advancement period; CI, confidence interval.
† The rate advancement period is the number of years older the comparison subjects would have to be in order to have the same attrition rates as subjects with the indicated risk factor exposure.

Finkelstein Am J Epidem 2002

Adverse Pregnancy Outcomes in Canada

Low Birth Weight

Preterm Birth

O_3 – no adverse pregnancy outcomes

Liu S, Environ Health Perspect 2003.

Air Toxics

PAHs at levels in New York City air may adversely affect children's cognitive development at 3 years of age, with implications for school performance.

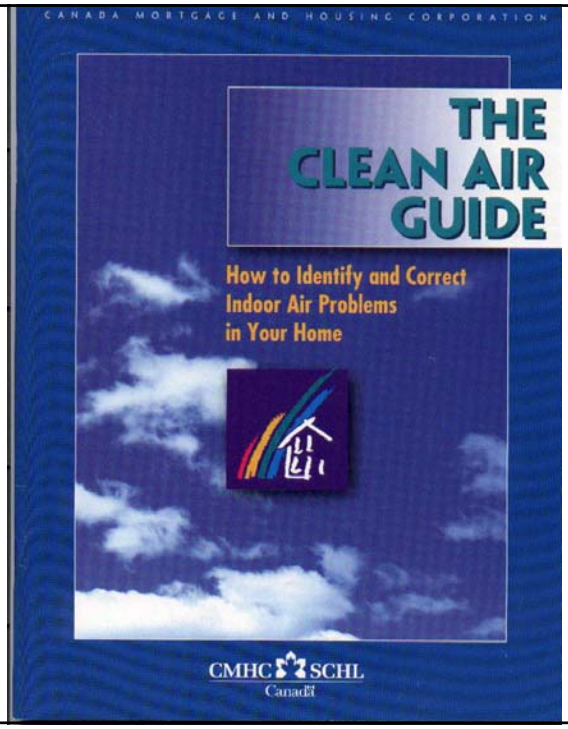
Perera FP Environ Health Perspect 2006.

Indoor Air

Environmental Tobacco Smoke

Allergens and asthma

- Cats
- Mould
- House Dust Mites



Diesel Exhaust

- Very small ultrafine particles
- Complex chemistry

- Health effects
  - Probable carcinogen
  - Heart disease
  - Asthma

Risk of Lung Cancer in Workers

	Unexposed to Diesel	Exposed to Diesel
Never smokers	1.0	1.8
Smokers	15.7	22.6

Parent ME. American Journal of Epidemiology 2007

Diesel Exhaust

Exposure to diesel exhaust in the workplace
is associated with
increased risk for ischemic heart disease
In construction workers in Sweden

Toren BMJ 2007

Diesel Exhaust

How does diesel exhaust contribute to heart disease?

Particles promotes myocardial ischemia

- Blood vessel dysfunction
- Clotting disturbance

(Mills N. Circulation 2005; NEJM 2007)

Diesel: Who is Exposed?

- Bus Drivers (and children in school buses)
- Truck Drivers
- Motor vehicle mechanics
- Railroad workers
- Excavators and Pavers
- Miners and quarrymen
- Firefighters
- Dockworkers

School Buses, Air Pollution and Children's Health

Heavy Duty Diesel Buses
- 15,000 in Ontario
- Self polluting
- On board exposures to kids
  - Idling, queuing, windows closed
  - 4x level of diesel exhaust as nearby car
  - Cancer risk
  - Asthma risk

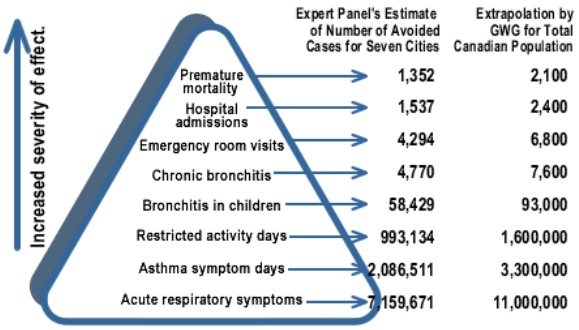
Report of The Ontario Public Health Association Nov 2005

Diesel exhaust

Recommendations
- Driving patterns
- Buses
  - New diesel buses
  - Replace pre-1994
  - Retrofit or replace 1994-2003
- Other interventions
  - Lower sulphur in diesel
  - New diesel engine and emission technology

Low Sulphur Fuels

Estimated Health Effects Avoided Over the Study Period 2001 - 2020, By Reducing Sulphur in Gasoline to an Average of 30 ppm



	Expert Panel's Estimate of Number of Avoided Cases for Seven Cities	Extrapolation by GWG for Total Canadian Population
Premature mortality	1,352	2,100
Hospital admissions	1,537	2,400
Emergency room visits	4,294	6,800
Chronic bronchitis	4,770	7,600
Bronchitis in children	58,429	93,000
Restricted activity days	993,134	1,600,000
Asthma symptom days	2,086,511	3,300,000
Acute respiratory symptoms	7,159,671	11,000,000

Burden of Illness from Air Pollution

Ontario Medical Association

- Illness Cost of Air Pollution (ICAP)

Ontario Health Damage Summary for Three Example Years

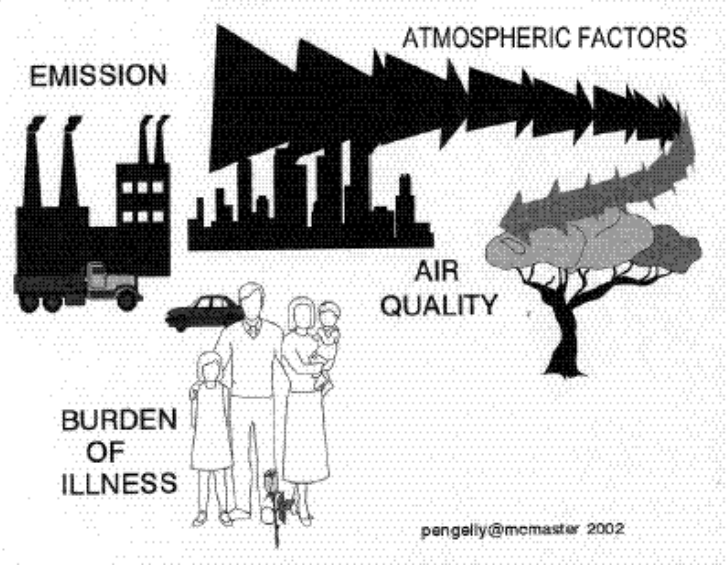
	Example Years		
	2005	2015	2026
Premature Deaths	**5,829**	7,436	10,061
Hospital Admissions	**16,807**	20,067	24,587
Emergency Room Visits	59,696	71,548	87,963
Minor Illnesses	29,292,100	31,962,200	38,549,300

(OMA 2005)

Economic Damages for Three Example Years

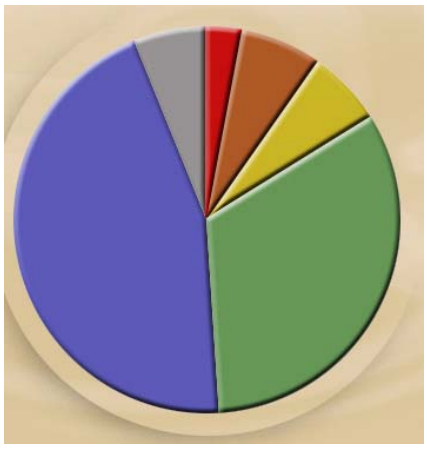
	Example Years		
	2005	2015	2026
Lost Productivity	$374,342,400	$402,883,900	$466,508,500
Healthcare Costs	$506,612,700	$571,089,400	$701,988,500
Pain and Suffering	$536,546,600	$593,149,400	$718,341,300
Loss of Life	$6,391,700,000	$8,279,400,000	$11,027,400,000
Total	**$7,809,201,700**	**$9,846,522,700**	**$12,914,238,300**

(OMA 2005)



Climate Change

Our Carbon Footprint



Thank you!