

Outdoor Air Quality

A Primer for B.C. Physicians and Resource for Informing Patients

PURPOSE

Air pollution affects the health of British Columbians.¹⁻⁴ Despite significant progress, air quality remains sub-optimal in many parts of the province. Its health effects have been demonstrated repeatedly even in areas where air quality is commonly thought to be good.

This primer provides a synthesis of current medical understanding of outdoor air pollutants. It aims to update physicians on the major health effects of air pollution on British Columbians and assist them in responding to patient concerns on the issue. It is not intended as a tool for patient management.

This primer is also available in an electronic version at <http://www.bc.lung.ca/pdf/appendix-guide.pdf>, where links to all references and appendices can be found. The appendices provide detailed information on the Air Quality Health Index and Air Quality Advisories.

OVERVIEW - Outdoor Air Pollution: 9 Key Points

This overview is intended as a quick reference for topics covered in this primer. For a more thorough discussion, see the inside pages.

What is air pollution? Where does it come from? How is it measured?

- 1 Air pollutants include gases and particles, which can be harmful to human beings or the environment. Primary air pollutants are those directly emitted to the atmosphere. Secondary air pollutants like ozone are formed in the atmosphere from reactions involving other pollutants.
- 2 Levels of air pollutants vary over time and based on proximity to source/s. They are influenced by weather, topography and emission rates. Local sources, such as outdoor burning, smokestacks, or traffic on major roads, can increase the exposure levels of individuals.
- 3 Air pollution monitors routinely measure a limited number of "indicator" gases and particles. They are typically sited to identify regional pollutant concentrations and/or to reflect the impact of specific sources.

What are the health effects of air pollution?

- 4 Long-term exposure to air pollutants can lead to cardiovascular and respiratory effects. In addition, exposures as brief as hours or days can precipitate sudden respiratory and cardiac illnesses or even death. Air pollutant exposure has also been linked to pre-term birth, low birth weight, acute respiratory infections and otitis media in children.

What is the health burden of air pollution for B.C. residents?

- 5 Studies have linked long-term exposure to current levels of air pollution in B.C. to various diseases and premature death. Additionally, higher daily pollution levels have been

associated with slightly higher death counts over the short term.

Recommendations

- 6 Health is protected over both the long and the short term by living in a community with low levels of air pollution, working and living away from local sources (including traffic), and having clean air indoors.
- 7 Air pollution triggers can be mitigated by avoiding local sources, choosing climate-controlled indoor spaces, and avoiding strenuous physical activity when broadcast pollutant levels are high or when near significant sources of pollution, such as major roads.
- 8 Controlling underlying cardiac and pulmonary diseases decreases the effects of air pollutants. As for supplements, small scale studies show that Omega-3 fatty acids and Vitamins C and E, limit the adverse cardiovascular and respiratory effects of exposure to higher levels of air pollution. *However, there are currently no established recommendations for the routine use of specific dietary supplements to prevent the effects of air pollution.*

Public air quality advice

- 9 The Air Quality Health Index is a tool that indicates the immediate risk to health of current and near-future levels of monitored air pollutants. The B.C. Ministry of Environment and Metro Vancouver issue advisories when individual air pollutants reach threshold levels of concern.

- **Air pollution** is the presence in the air of gases or particles, which are potentially harmful to human health or the environment. Levels of air pollutants vary by proximity to sources, and are influenced by topography, weather, as well as local, regional and even global factors. Some air pollutants like ozone are formed by the reaction of primary pollutants with sunlight, heat, water vapor, other atmospheric constituents and each other.
- **Common air pollution sources** are transportation (such as motor vehicles, marine vessels, rail, aircraft), outdoor burning, space heating (for instance, from wood stoves), industry and construction equipment.
- **Air quality monitors** are typically sited either to represent concentrations of air pollutants within a region or to measure the impact of a particular source, such as a large traffic corridor or major industry. Within a region, air pollution concentrations may vary substantially, influenced by source proximity and topography. Regular monitoring of air quality^{6,7} is conducted throughout B.C. by the B.C. Ministry of Environment and by Metro Vancouver within the Greater Vancouver area. For information on specific air pollutants and their concentrations, see: <http://www.bcairquality.ca> and <http://www.metrovancouver.org/services/air/monitoring/Pages/airqualityindex.aspx>. Environment Canada also produces air quality forecasts up to 2 days ahead; see: http://www.msc-smc.ec.gc.ca/aq_smog/aqcurrent_e.cfm



The **Air Quality Health Index⁸ (AQHI)** is a tool recently introduced to indicate the immediate risk to health of current and near-future levels of three monitored air pollutants. The B.C. Ministry of Environment issues Air Quality Advisories⁶ when specific air pollutants reach threshold levels of concern. Because the AQHI is an ongoing informational tool, and the AQ Advisories a means to encourage action in the face of higher levels of specific pollutants, the health messages they offer at any given time may not be entirely consistent.

- **Commonly monitored outdoor pollutants⁵ include particulate matter (PM), with aerodynamic diameter $\leq 10 \mu\text{m}$ (PM_{10}) and $\leq 2.5 \mu\text{m}$ ($\text{PM}_{2.5}$), or fine particulate matter, ozone, nitrogen oxides, sulphur dioxide, and carbon monoxide.** These pollutants are commonly monitored because they are associated with a range of respiratory, cardiac and other health effects, in addition to having an environmental impact.
- **Pollutant concentrations are important because they characterize air quality between locations and over time, determine the impact of specific sources, and indicate the success of measures to control emissions.** Concentrations are compared to provincial and national air quality objectives*.
- **"Air toxics,"** such as certain metal dusts and organic compounds, also pose a risk, especially around point sources, but they are not monitored routinely.

* For a list of current air quality objectives, see: <http://www.bcairquality.ca>



What are the health effects of air pollution? 4

Epidemiologic studies of long-term (months to years) exposure to air pollution show increases in relative risk of death from lung cancer and cardiopulmonary diseases.^{10,11,15,16} Depending on the study, exposure estimates were based on measured or modeled levels of traffic, ozone or PM. Here's a summary of the findings on long-term exposure.

Long-term exposure results in:

- Accelerated development of atherosclerosis^{17,18}
- Increase in systemic inflammatory markers^{19,20}
- Impaired lung development in children²¹⁻²⁴
- Increased incidence of asthma and asthma exacerbations²⁵⁻³¹
- More frequent pre-term births and low birth weight babies³²⁻³⁷
- Increased rates of otitis media^{38,39}

Over the short term (hours and days to weeks), air pollution has been associated with increased hospitalizations and/or deaths due to cardiovascular and respiratory causes.^{12,13,14} In general, respiratory effects and cardiovascular effects have been associated with exposure to ozone and PM respectively. Here's a summary of the findings on short-term exposure.

Short-term exposure results in:

- Increased rates of myocardial infarction in those with risk factors for cardiovascular disease⁴⁰⁻⁴²
- Increased incidence of cardiac arrhythmia^{43,44}
- Exacerbation of obstructive respiratory illness (e.g. asthma⁴⁵⁻⁴⁸ and COPD⁴⁹⁻⁵¹)
- Respiratory inflammation and irritation⁵²⁻⁵⁴
- Reduced lung function⁵⁵⁻⁵⁷

Individuals react to air pollution differently. At the population level, it does not look like there is a no-effect threshold level for air pollution.^{58,59} Although for most people, air pollution may be a relatively minor risk, especially over the short term, studies of large populations indicate measurable health effects on susceptible individuals and substantial public health impacts. Increased exposure has been linked to increased risk. Controlling underlying cardiac and pulmonary diseases decreases the effects of air pollutants.



FACTS

Pollutants and staying indoors

- Indoor air concentrations of some pollutants like ozone are lower.⁷¹
- Some outdoor pollutants efficiently penetrate indoors. For PM, this is a function of the tightness of the building.⁷²
- Indoor pollutant sources can be significant (e.g., tobacco smoke, PM from improperly ventilated cooking space, volatile organic compounds from furniture or cleaning materials, and mould).⁷¹
- Indoor air quality needs to be protected through proper ventilation and limiting the sources of indoor pollutants.
- Staying indoors in hot weather, while a good way to avoid pollutants, may also produce adverse effects from heat.

What is the health burden of air pollution for B.C. residents? 5

The burden of air pollution is computed based on both measurements and estimates of exposure as well as on equations which relate exposure levels to health effects. The 2003 B.C. Annual Report of the Provincial Health Officer offered a series of estimates of annual mortality ranging from 25 to 644 air pollution-related deaths⁷⁶. "Mid-point" estimates included 712 hospital admissions and 994 emergency department visits per year for B.C. as a whole. A 2008 Canadian Medical Association estimate for B.C. projected 306 premature deaths (of which 85% relate to long-term and 15% to short-term exposure), 1,158 hospital admissions, 8,763 emergency department visits and 2,526,900 minor illnesses related to air pollution during 2008⁷⁷.

Recommendations 6 7 8

While over the short term some individuals (especially young children, pregnant women and those with cardiac and respiratory disease or diabetes) are more susceptible to the effects of air pollutants, the general population will also benefit from the recommendations below.

WAYS TO LOWER EXPOSURE OUTDOORS

- Commuting is a significant means of air pollution exposure. The highest pollutant concentrations are along major roads. When possible, individuals should limit the time they spend commuting to reduce exposure⁶⁰ and/or to lessen the amount of pollution they generate, if they drive a vehicle.
- When considering where to live and work, people should choose a location which is more than 150 meters away from major roads.⁶¹ High pollutant concentrations can be found up to 750 meters from truck routes.
- Patients should be assisted in finding a “clean air shelter” in their community during wintertime inversions, forest fires and similar circumstances. Examples of these shelters are air conditioned spaces (like shopping malls) with medium- or high-efficiency air filtration or a room with a HEPA filter air cleaner.



THINGS TO KNOW ABOUT MEDICATION AND DIET

- Optimal use of cardiac and respiratory medications based on individual clinical parameters offers protection, given acute exposure to particulates and ozone.^{64,65}
- Small scale studies show that Omega-3 fatty acids and Vitamins C and E, taken as supplements, limit the cardiovascular and respiratory effects of exposure to higher levels of air pollution.⁶⁶⁻⁷⁰ *However, there are currently no established recommendations for the routine use of specific dietary supplements to prevent the effects of air pollution.*

FACTS

Pollutants and times of day

THINGS TO KNOW ABOUT INDOOR SPACE

- Indoor spaces with central air conditioning limit exposure to outdoor pollutants.
- Installing HEPA filters in forced air furnaces will reduce indoor exposure to particles.
- Stand-alone air cleaners can improve air quality,^{62,63} but it is important to select non-ozone generating models. For a list of air cleaners which should be avoided, see <http://www.arb.ca.gov/research/indoor/o3g-list.htm>.
- Indoor air quality should be protected by properly ventilating cooking spaces, reducing emissions from heating, eliminating tobacco smoke and mould remediation.



- Concentrations of many pollutants fluctuate throughout the day.
- Patterns are different for different pollutants.
- Ozone is generated by the action of sunlight on air pollutants and generally peaks in the late afternoon.
- PM, NO₂ and other traffic-related emissions are higher during rush hours, especially in the morning.^{73,74}
- Wood smoke level is at its highest in the evening and at night.⁷⁵
- Different times of day will have different pollutant mixtures that individuals may wish to avoid.

LIMITING OUTDOOR EXERCISE

- During active exercise, both the rate and depth of respiration increase. Respiratory impacts can be avoided or limited by exercising earlier during the day, when ozone concentrations tend to be lower, and as far away as possible from roads, factories and smoke. The potential benefits of restricting exercise to certain times and places need to be weighed against the health benefits that exercise offers.

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