Air pollution and health risks: bridging public health and patient health

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Air pollution: a complex mixture

Los Angeles – 1988



Particles and gases

Major pollutants with air quality standards in the U.S.

- Numerous, diverse, widespread sources
- Particulate matter, ozone, nitrogen dioxide, sulfur dioxide, carbon monoxide, lead

Hazardous pollutants

- Can cause cancer, other serious health effects
- Benzene, metals, formaldehyde

Diverse sources of air pollution



Wintertime inversions increase air pollution levels





Sarajevo from Trebevic Mountain, 7 December 2017 Courtesy of U.S. Embassy Sarajevo Science Fellow

Fine particles (PM_{2.5}): indicator of general air quality



https://www.epa.gov/pm-pollution/particulate-matter-pmbasics



Diverse chemical species



https://www.londonair.org.uk/london/asp/news.asp?NewsId=C amden1&StartIndex=430

Inhaled PM_{2.5} can reach deep lungs and affect other organs



Air pollutants and associated health risks

	PM _{2.5}	Ozone	Nitrogen Dioxide	Sulfur Dioxide	Carbon Monoxide			
Short-term exposure: minutes to 1 month								
Respiratory	+	++	++	++	+/			
Cardiovascular	++	+	+/	?	+			
Mortality	++	+	+/	+/	+/			
Long-term exposure: months to years								
Respiratory	+	+	+	+/	?			
Cardiovascular	++	+/	+/	?	?			
Reproductive/ Developmental	+/	+/	+/	?	+/			
Mortality	++	+/	+/	?	+/			
Cancer	++	?	+/	?	Not evaluated			

++ Evidence of causal relationship, + Evidence of likely causal relationship,

+/- Suggestive evidence of a relationship, ? Uncertain relationship

Derived from U.S. Environmental Protection Agency's Integrated Science Assessments (https://www.epa.gov/isa) and International Agency for Research on Cancer (http://www.iarc.fr/en/publications/books/sp161/index.php)

Groups at increased risk for air pollution-related health effects

Children



People with heart or vascular disease



People with obesity

People with asthma



People of low socioeconomic status





Evidence is less clear for sex, genetic factors, race/ethnicity, smoking, diet

U.S. EPA's Integrated Science Assessments, https://www.epa.gov/isa

Scientific uncertainties remain

- Is there a zero-risk level of air pollution below which health risks are not increased?
- How do risks compare for a single air pollutant versus a pollutant mixture?
- What time windows, durations, patterns of air pollution exposure are associated with the highest risk of health effects?
- What is the persistence of air pollution-related health effects in childhood to adulthood?

U.S. National Ambient Air Quality Standards*: informed by the science

Pollutant		Primary/ Secondary	Averaging Time	Level	Form	
Carbon Monoxide (CO)		primary	8-hour	9 ppm	Not to be exceeded more than once per year	
			1-hour	35 ppm	Not to be exceeded more than once per yea	
Lead (Pb)		primary and secondary	Rolling 3-month average	0.15 µg/m³	Not to be exceeded	
Nitrogen Dioxide (NO ₂)		primary	1-hour	100 ppb	98 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
		primary and secondary	Annual	53 ppb	Annual Mean	
Ozone (O ₃)		primary and secondary	8-hour	0.070 ppm	Annual fourth-highest daily maximum 8-hr concentration, averaged over 3 years	
Particulate Matter (PM)	PM _{2.5}	primary	Annual	12 µg/m³	Annual mean, averaged over 3 years	
		secondary	Annual	15 µg/m³	Annual mean, averaged over 3 years	
		primary and secondary	24-hour	35 µg/m³	98th percentile, averaged over 3 years	
	PM ₁₀	primary and secondary	24-hour	150 µg/m³	Not to be exceeded more than once per year on average over 3 years	
Sulfur Dioxide (SO ₂)		primary	1-hour	75 ppb	99 th percentile of 1-hour daily maximum concentrations, averaged over 3 years	
		secondary	3-hour	0.5 ppm	Not to be exceeded more than once per year	

*As of October 2017, https://www.epa.gov/criteria-air-pollutants/naaqs-table

U.S. air standards and science inform public health messaging

Air Quality Index	Who Needs to be Concerned?	What Should I Do?	
Good (0-50)	It's a great day to be active outside.		
Moderate (51-100)	Some people who may be unusually sensitive to particle pollution.	Unusually sensitive people: Consider reducing prolonged or heavy exertion. Watch for symptoms such as coughing or shortness of breath. These are signs to take it easier. Everyone else: It's a good day to be active outside.	
Unhealthy for Sensitive Groups (101-150)	Sensitive groups include people with heart or lung disease, older adults, children and teenagers.	Sensitive groups: Reduce prolonged or heavy exertion. It's OK to be active outside, but take more breaks and do less intense activities. Watch for symptoms such as coughing or shortness of breath.	
		People with asthma should follow their asthma action plans and keep quick relief medicine handy.	
		If you have heart disease: Symptoms such as palpitations, shortness of breath, or unusual fatigue may indicate a serious problem. If you have any of these, contact your heath care provider.	
Unhealthy (151-200)	Everyone	Sensitive groups: Avoid prolonged or heavy exertion. Consider moving activities indoors or rescheduling.	
(15) 2007		Everyone else: Reduce prolonged or heavy exertion. Take more breaks during outdoor activities.	
Very Unhealthy (201-300)	Everyone	Sensitive groups: Avoid all physical activity outdoors. Move activities indoors or reschedule to a time when air quality is better.	
		Everyone else: Avoid prolonged or heavy exertion. Consider moving activities indoors or rescheduling to a time when air quality is better.	
Hazardous	Everyone	Everyone: Avoid all physical activity outdoors.	
(301-500)		Sensitive groups: Remain indoors and keep activity levels low. Follow tips for keeping particle levels low indoors.	

- U.S. Environmental Protection Agency's Air Quality Index (AQI)
- Color-coded tool for telling the public how clean or polluted the air is
- Calculated for each of 5 criteria
 pollutants (PM, O₃, NO₂, SO₂, CO)
- Pollutant concentrations converted to a number 0 to 500
- One value reported: pollutant with highest index
- Recommends steps people can take to reduce their daily exposure to air pollution
- Forecasts can be used to plan outdoor activities

https://airnow.gov/index.cfm?action=pubs.aqguidepart

Educating patients on using the AQI: awareness of air quality information

- Hydro-metrological Institute of FBIH (http://www.fhmzbih.gov.ba/latinica/ZRAK/index.php)
 - Federation of BiH measurement data
 - Current pollutant concentrations and air quality index (different than U.S.)
 - Annual reports with statistics, days or hours above allowable level
- BiH air quality data (http://zrak.ekoakcija.org/)
 - Compiled by Eko Akcija
 - Current pollutant concentrations and air quality index (different than U.S.)
 - Trends for the year
- CityOS (http://cityos.io/air)
 - Open-source platform with data from personal low-cost air sensors
- aqicn.org (www.aqicn.org)
 - Organization based in Beijing, China
 - Pulls data from local government sources (does not validate quality of data)
 - Current air quality index (local method)
 - Forecasts for air quality

Real-time air quality information from aqicn.org



www.aqicn.org: April 3, 2018, 15:45

- Current air quality and forecasts for next four days
- Also available for Goradze, Zenica, Jajce

Resources for health care providers

Handouts for patients

What are the health effects? Who is at risk? What steps can one take to reduce risk?



https://www3.epa.gov/airnow/healthprof/common-air-pollutants-2011-high.pdf



O Air pollution can make asthma symptoms worse and trigger attacks.

If you or your child has asthma, have you ever noticed symptoms get worse when the air is polluted? Air pollution can make it harder to breathe. It can also cause other symptoms, like coughing, wheezing, chest discomfort, and a burning feeling in the hungs.

Two key air pollutants can affect asthma. One is some (found in smog). The other is particle pollution (found in haze, smoke, and dust). When ozone and particle pollution are in the air, adults and children with asthma are more likely to have symptoms.

O You can take steps to help protect your health from air pollution. ► Get to know how sensitive you are to air

- pollution. · Notice your arthma symptoms when you
- are physically active. Do they happen more often when the air is more polluted? If so, you may be sensitive to air pollution.

https://www3.epa.gov/airnow/asthmaflyer.pdf

· Also notice any asthma symptoms that begin up to a day after you have been outdoors in polluted air. Air pollution can make you more sensitive to asthma triggers, like mold and dust mites. If you are more sensitive than usual to indoor asthma triggers, it could be due to air pollution outdoors.

Know when and where air poliution may be bad.

- · Ozone is often worst on hot summer days, especially in the afternoons and early evenings. · Particle pollution can be bad any time of year, even in winter. It can be
 - especially bad when the weather is calm. allowing air pollution to build up. Particle levels can also be high:
 - Near busy roads, during rush hour, and around factories.
 - When there is smoke in the air from wood stoves, fireplaces, or burning vegetation.
- 55 swams or older · You have a family history of stroke or early heart disease (infer or brother diagnoses below age 55 mother or sister disgnosed betters age 57)

trigger heart attacks, stroke, and other health effects?

with a medical condition called bears lab

Very small particles are the pollutants of

This fact sheet tells you how you can

local an quality

is at universitive levels

You are at goester this it row.

Are you at higher risk!

· Get up-to-date intermation about your

· Protect your health others particle pollution.

Older adults and people with mik factors for

heart disease or stroke may be of greater risk.

surgery, angioplasts with or settlesset a steel, a stooler, blockages in the neck or leg atterns.

heart failure, beart thythm problems, diabetes, or chrome obstractive large disease.

· Hove had a heart stuck, argins, bypain

You may be at greater with of locart disease

particle pollations if any of these apply

or strike land therefore at growter that from

· You are a man 45 years or older, or a writenan

SEPA

- · You have high blood permanent high blood tholesterol
- You are overweight or not physically active
 You stroke digaretter.



AMERICAN COLLEGE of CARDIOLOGY

B How can you protect your health?

Regular eventue is tesportant too staying the especially if you have heart disease By adjusting when and where you exercise you can lead a healthar theotyle and help edace your risk of heart problems or stocks triggered by air poliution. In addition:

- · D you have heart threase or have experienced a stroke, check with your health case provides about the heat warn to protect your health. when the air quality is indealthy.
- + If you're at mik of heart disease or strake and plan to eventive more dram targed, discan this with your health care provider
- Know when and where particle pollution fevels may be unhealthy Partially pollicition levels out by high any time

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- of year. Particle levels can also be high: · Near barr roads, in urban amar (especially during risk hour), and to industrial ureas · When there is musice in the air from wood stoves, dreplaces, burning vegetation, or
- https://www3.epa.gov/airnow/heartflye r.pdf

Pollutant-specific education





During the scenere muchs, million of people in the initial their an expression in the polyant large polyant spread at more than constitution in a second se polytoms based topology course to halp destings and allow health performing an address base health effects.

Ozone and Your Patients' Health Training Course

First management of the local diversion of the

- Purishgial recharges Bulgavin the long function manges
- web treatment from papers of the cancer · relationships also need for an an and other advance build

Older male with hypertension, has discomfort when walking

With careful questioning, it is established that his pattern of angina is unchanged, and his concern is based on the variability of angina when walking up the hill at the end of his exercise route. It is unlikely that the inhamiltent anginal pain is related to the progression of his coronary artery disease. or the development of unstable argins. The pattern of angina remains essentially the same but appears to have a slightly lower threshold when preceded by several days of air pollution.

Evidence is mounting that particle pollution, possibly in combination with oppne or other gavenus pollutants, can affect endothelial function and might explain an increase in ischemic symptoms in the preserve of high levels of particle pollution. Co-morbid conditions such as advanced age, hypertension, diabetes, and obesity appear to increase one's susceptibility to the effects of particle pollution. Particle pollution is greatest on and adjacent to the mads, and the concentration of ultraffine particles decreases rapidly as one increas away from the road. Among individuals with established ischemic heart disease, exposure to line particle pollution modilies the magnitude of exercise-induced ST depression, suggesting that exposure to particle pollution worsens inchemia.

Balanced response

Mr. Wichards was congratulated for his efforts to modify his risk factors and ensuraged to confirme lifestyle changes and adhere to the medications for hypertension, diatietes, and hyperlipidemia, tri particular, he was encouraged to continue walking six days each week, but was advised to change his route to exclude walking along a bury highway. He was advised to monitor the EPK's Airlien metride for information on particle pollution and cause and to do his walking induces if the air is hazy or if particles and/igtone are predicted to be in the orange range (anhealthy for sensitive penneci) or worse. He was also advised to exercise in the morning when temperatures and levels of opone are likely to be knew.

- Science education
- How to advise patients
 - Exposure, health impacts
 - Using the AQI

How to address patient questions about air pollution and health risks

Examples of patient encounters and provider response

Start the Course

Cardiovascular health resources

Healthy Heart Toolkit and Research



Heart Facts

- · Heart disease and stroke are the first and fourth leading causes of death in the U.S.
- Air pollution can affect heart health and can trigger heart attacks and strokes that cause disability and death.
- One in three American adults has heart or blood vessel disease and is at higher risk from pollution.

EPA is raising awareness of heart disease and its link to air pollution and other environmental factors as a partner in <u>Million Hearts</u>, a national initiative to prevent heart at rokes and strokes.

Protect Your Heart From Air Pollution

- Steps you can take
- Check pullation forecests
- Get free air pollution alerta by email
- Ease and your health
- Eublic education materials



- Resources for Health Professionals
- What is the link between air pollution and conditivational effects?
- Exclusion and Your Patients' Health Online Training
- Wildfire Strokes & Guide for Public Health Officials (https://www.struk.htm)
- Becaublications
- Eactabasta
 Other health care repsider information and online training

 Focus on people with cardiovascular disease

- Promote health protective behaviors
- Resources for health care providers
- Goal: reduce vascular and arrhythmic events, improve cardiovascular health, save health care resources

https://www.epa.gov/air-research/healthy-heart-toolkit-and-research

Asthma resources

NACOMMENTS NETWORK DR

to take with other practitioners.

access an extension resource bank and

match archived weltstary to help one

develop a comprehensive hume visit

program.

Joint Authors Community Nationals

Asthma

CONTACT US SHARE

Indoor Air Quality Home Page

Asthma Home

Take the Asthma Quiz

Learn About Asthma

Publications about Asthma

Resources about Asthona

Manage Environmental Authma Triggers

Authona Triggers

Asthma in Communities and Schoola

Take Action on Asthma

Arthma Awareness

National Asthma Awards

Federal and Partner Organizations

Public Service Announcements £ Multimedia

Resources about Asthma

Healthcare Professionals Parents, Caregivers and Kids

Asthma Actions for Healthcare Professionals

As a healthcare professional, you want to improve the quality of life for your patients with asthma. Understanding environmental asthma triggers is an important first step. EPA promotes environmental management as a standard of care and clinical practice and provides a variety of resources that healthcare professionals and people with asthma can use to take action.

- Resources for Your Patients and Caretivers
- Encourage the Use of Asthma Action Plans
- Develop a Comunificative Asthing Home Visit Program

Authma Action Plan

Learn More through Online Courses



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lations!

Education for families

Education for health care providers

- Developing asthma action plan
 - List of triggers
 - Instructions of taking medication
 - What to during asthma episode

https://www.epa.gov/asthma/ resources-aboutasthma#action

Resources for And Marine Distances During Well-As a healthcare profi When the address of the state o with our free publica And, if a parak flow reator in acad. Prot Box (Sec. For) **Breathing Free** Authors is Getting Worke The station were set of the set o · Lough almost deal formers in - Dation of right data is indicated. Device series, had not all cated principal. mp uppersonalized parts from it used, where it (FEEN 2008 after 1 have of phone backman 100 If your symptoms (and pash from if seeds its not return to GREEN 2016 after 1 from of above boutments Fact from an and the set pair for 1.040 route into the a fighter income wagters i walker manufacture provide the set of the set. NA DA CARACTER Madical Alarti e di sela, s and or industry of elimination that always had a worked Production in the second se The last of The output inche KIN. In this implies and a principal of + the set of the set are observables if () + the set of the set are the fittered at () Problem on for-Inskill make a Tours making and taking day to destinant of Lought a Take 1.4 or 1.0 paths of pour paints only continuous. AND

+ Lips or Regardulit are blue

Education has been effective

- U.S.-wide survey: people with lifetime asthma were almost twice as likely to report a change in activity based on an air quality alert if they had been advised by a healthcare professional (Wen XJ, BalluzL, MokdadA. 2009. J Community Health. 34(1):40-6.)
- In the U.S. state of Kansas, people were almost four times as likely to change outdoor activity levels if they were advised by a healthcare professional (Kansas Department of Health and Environment, 2006)
- BUT, only a small percentage of people in groups considered to be at increased risk from particle pollution reported that healthcare professionals had advised them to pay attention to the AQI (Kansas Department of Health and Environment, 2006)