

What have we learned in the last decade about health effects of air pollution?

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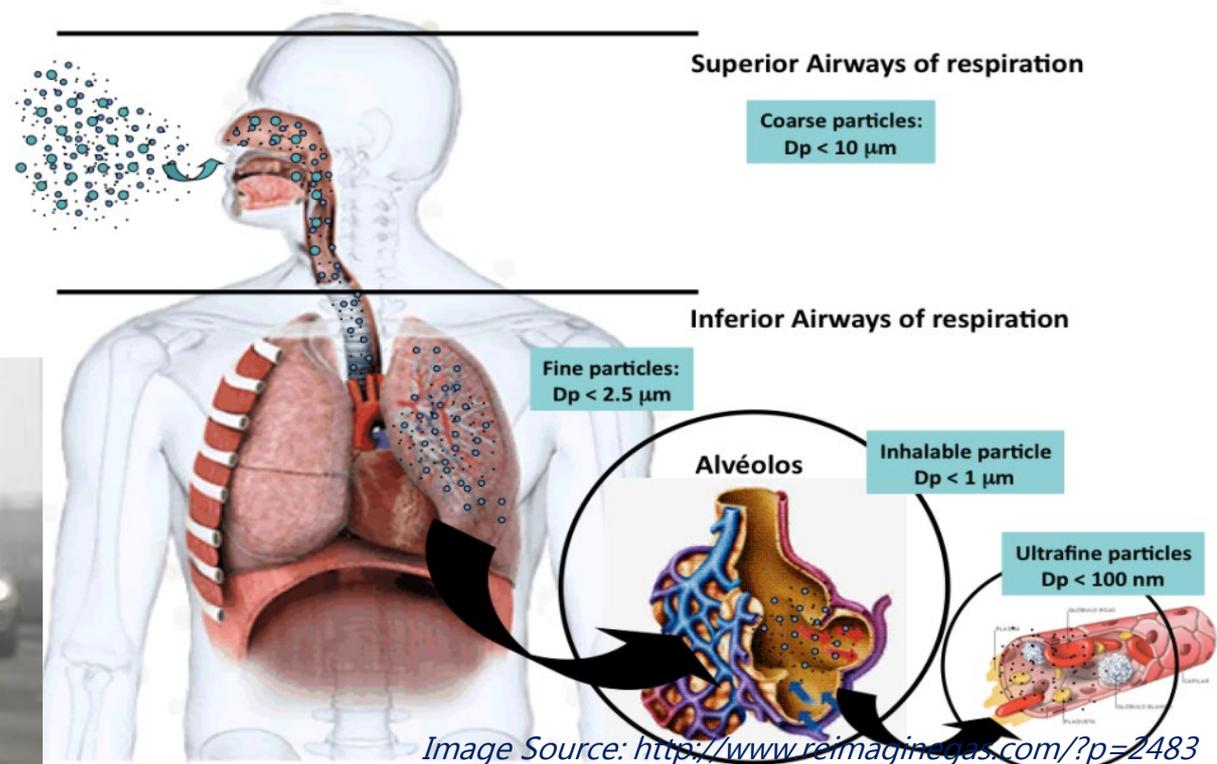
Outline - Health Effects of Air Pollution

- Biological Mechanisms & Epidemiological evidence
- Overall health burden of air pollution
- Are there any thresholds/safe levels?
- Air pollution/Environmental inequality
- Air pollution and COVID-19
- Air pollution and climate change
- Conclusions



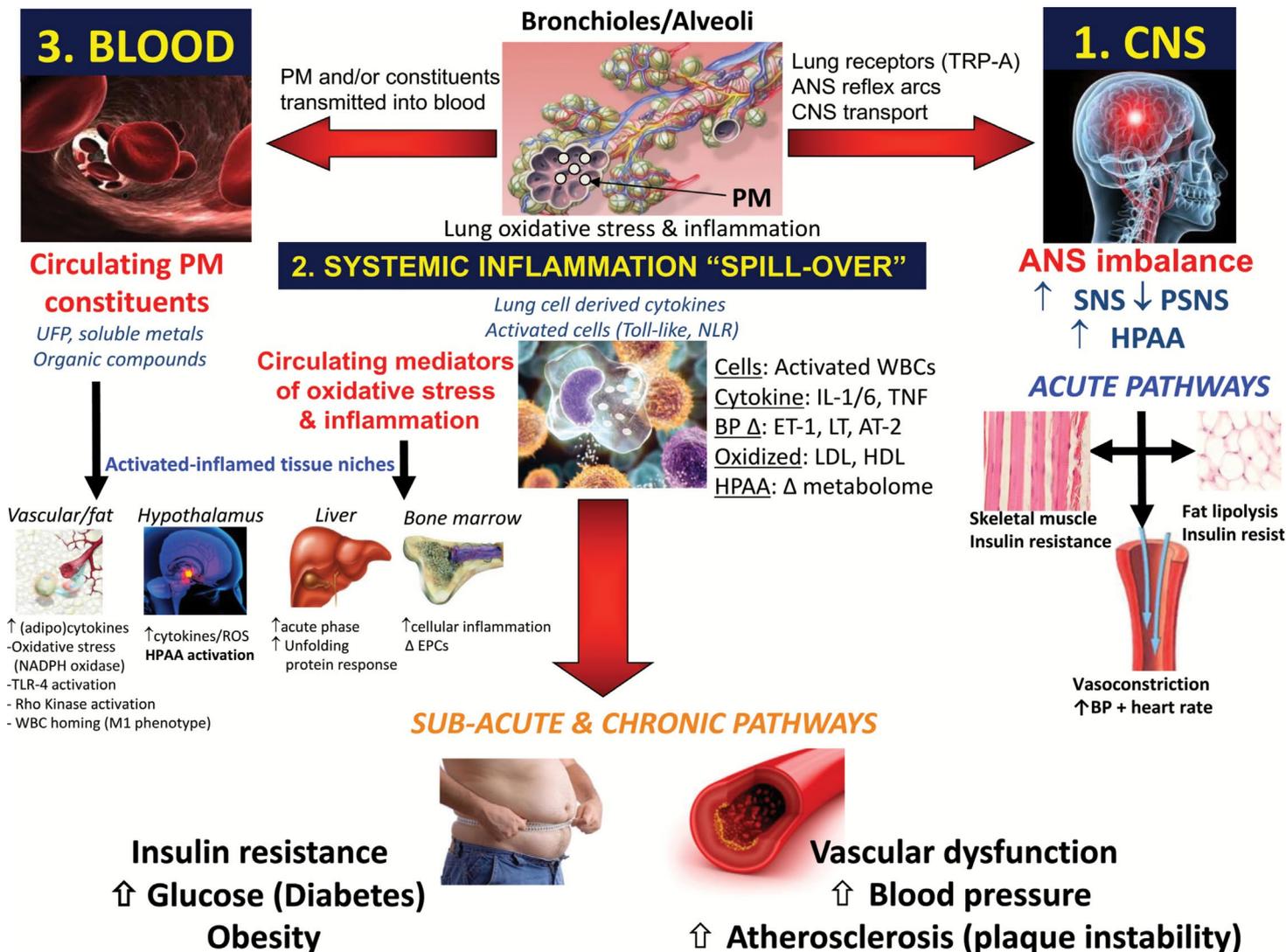
Biological Mechanisms behind Health Effects of Air Pollution

- Inflammation, oxidative stress
- Carcinogenicity
- Most evidence for PM (PM_{2.5})
- Air pollution enters the human body through inhalation (skin, digestion)



We inhale 10,000 liters of air/day

Air pollution, respiratory and cardio-metabolic system



From: Air Pollution and Cardiometabolic Disease: An Update and Call for Clinical Trials

Am J Hypertens. Published online June 24, 2017. doi:10.1093/ajh/hpx109

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Air pollution and the brain

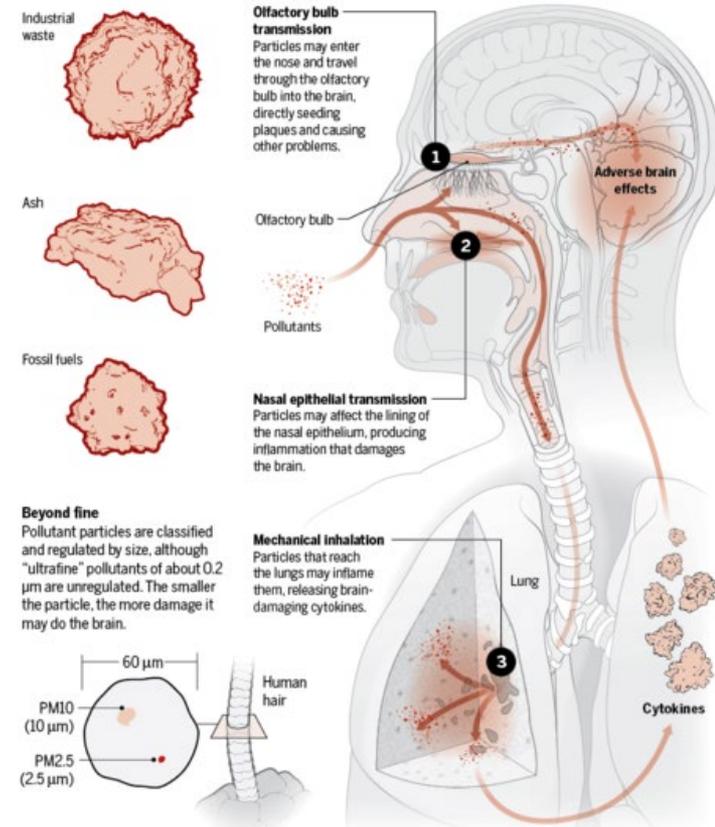
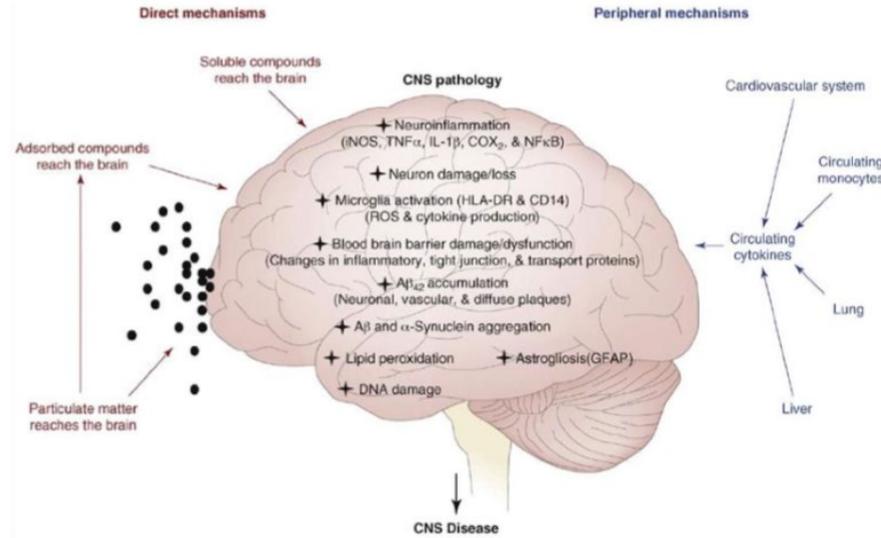
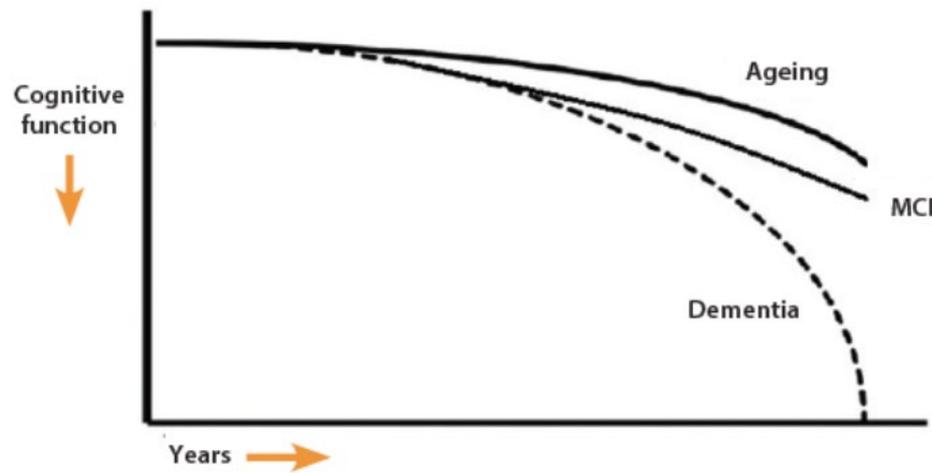


Figure 1. Air pollution impacts on the brain through multiple pathways (Block et al. 2009).



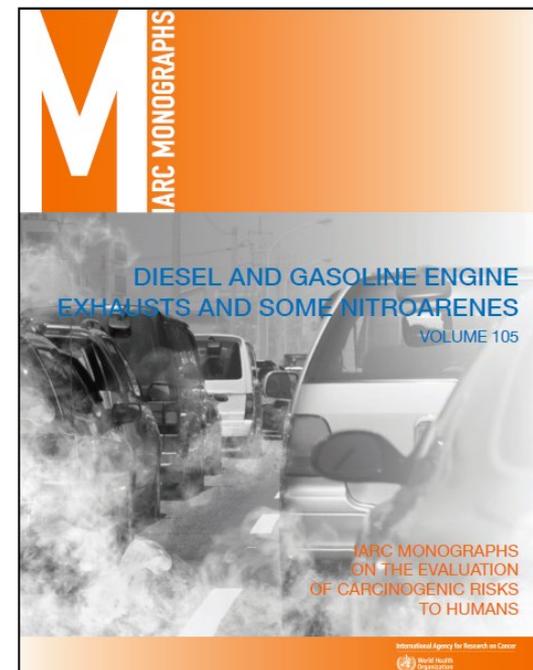
Air Pollution contains carcinogenic substances

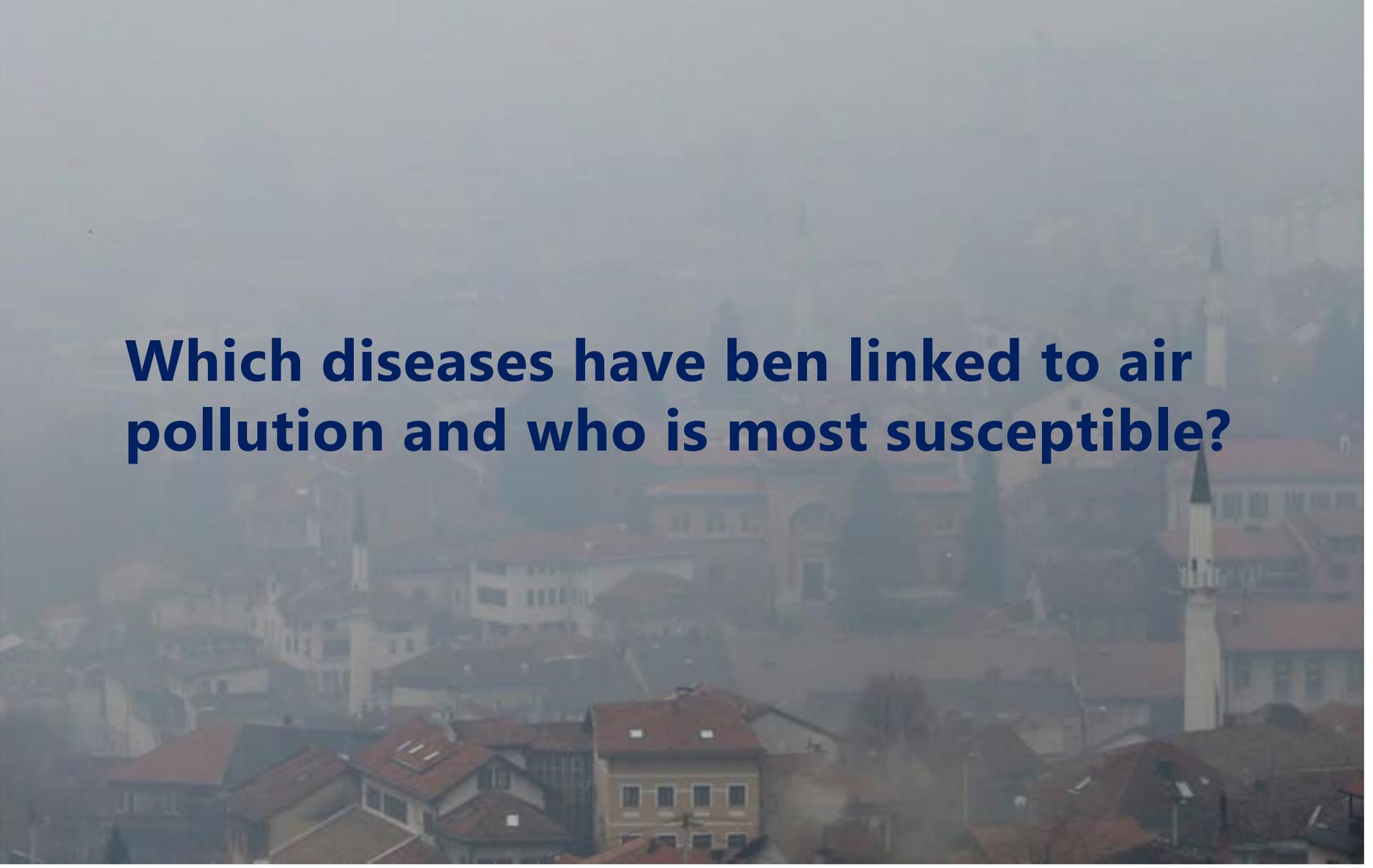
The International Agency for Research on Cancer (**IARC**) has classified:

- **Outdoor air pollution** as *carcinogenic to humans* (Group 1) in **2013**. *Sufficient evidence* that exposure to outdoor air pollution causes **lung cancer** (Group 1).
- **Particulate matter** was evaluated separately and was also classified as *carcinogenic to humans* (Group 1).
- **Diesel engine exhaust** (occupational and in ambient air) as *carcinogenic to humans* (Group 1) in **2012**. based on sufficient evidence that exposure is associated with an increased risk for **lung cancer** (2012).

Source: <https://monographs.iarc.fr/ENG/Monographs/vol105/mono105.pdf>

Source: <http://www.iarc.fr/en/publications/books/sp161/AirPollutionandCancer161.pdf>



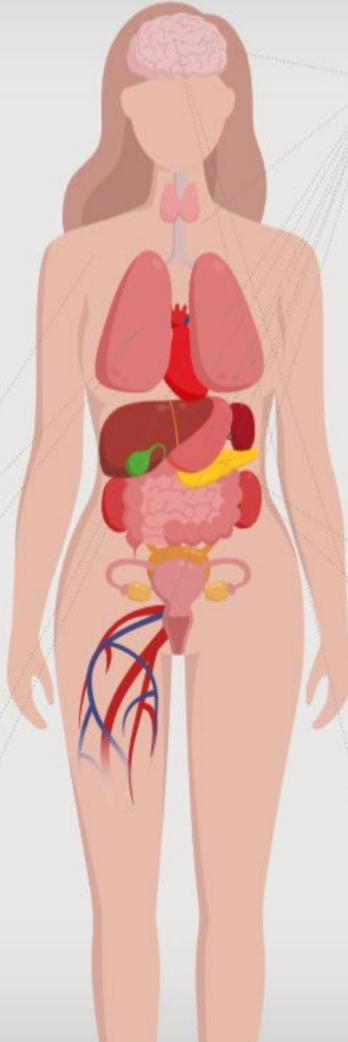


Which diseases have been linked to air pollution and who is most susceptible?

Health Effects of Air Pollution

FIGURE 1

Adults

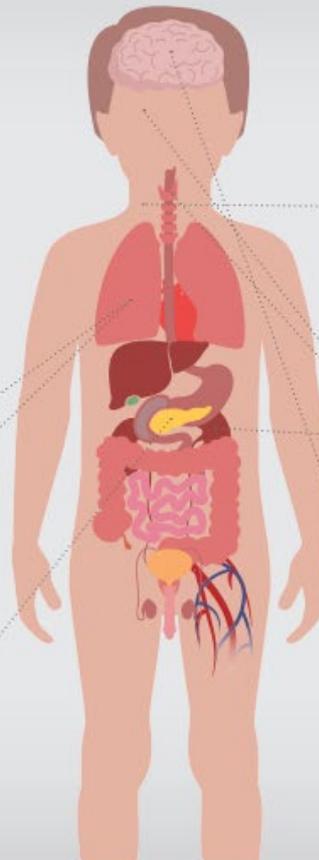
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- The diagram shows a human figure with internal organs highlighted. Callout lines connect specific health effects to the corresponding organ systems: brain (cancer, neurodegenerative, psychiatric), lungs (respiratory, cancer), heart and blood vessels (cardiovascular), and various internal organs (cancer, diabetes).
- All-cause mortality
 - Respiratory disease mortality
 - Respiratory disease morbidity
 - Asthma
 - COPD
 - Pneumonia
 - Cardiovascular disease mortality
 - Cardiovascular disease morbidity
 - Myocardial infarction
 - Stroke
 - Atrial fibrillation
 - Heart failure
 - Cancer morbidity and mortality
 - Lung cancer
 - Breast cancer
 - Kidney cancer
 - Bladder cancer
 - Liver cancer
 - Stomach cancer
 - Brain tumors
 - Leukemia
 - Lymphomas
 - Type 2 diabetes mortality
 - Type 2 diabetes morbidity
 - Neurodegenerative disease morbidity
 - Dementia and Alzheimer's Disease
 - Parkinson's disease
 - Multiple sclerosis
 - Psychiatric diseases morbidity
 - Depression
 - Suicide

Elderly most susceptible!

Health Effects of Air Pollution

Children outcomes

- **Respiratory disease mortality**
- **Respiratory disease morbidity**
 - Asthma and asthma related outcomes
 - Lower respiratory infections
- **Metabolic disease**
 - Type 1 diabetes



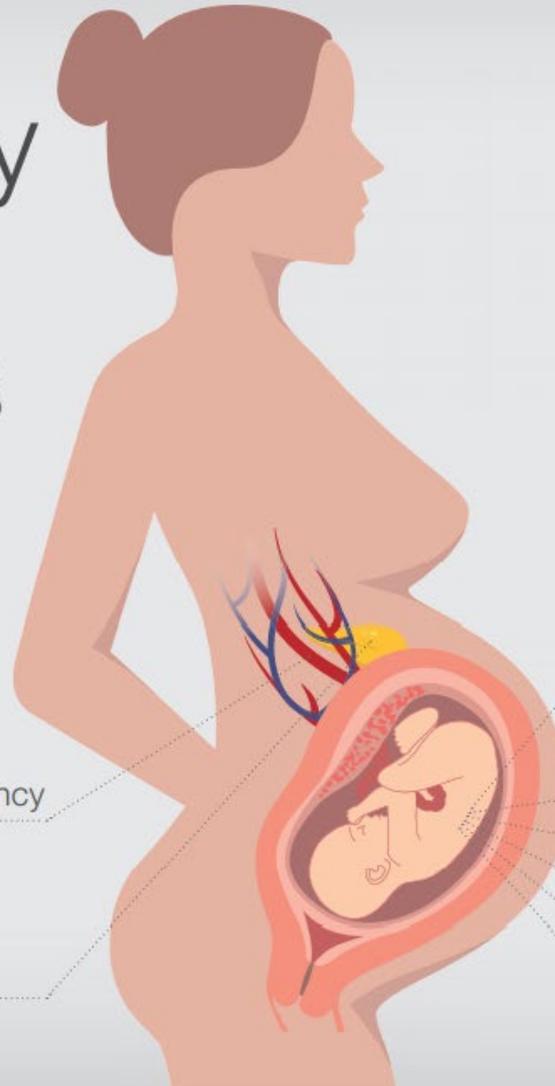
- **Childhood Cancers**
 - Leukemia
 - Lymphomas
 - Central nervous system cancers
- **Tumors originating in embryonic tissue**
 - Neuroblastoma
 - Retinoblastoma
 - Nephroblastoma
- **Neurodevelopment**
 - Autism
 - ADHD

Health Effects of Air Pollution

Pregnancy and birth outcomes

Mother

- Hypertensive disorders in pregnancy
 - Preeclampsia
 - Gestational hypertension
- Gestational diabetes



Offspring

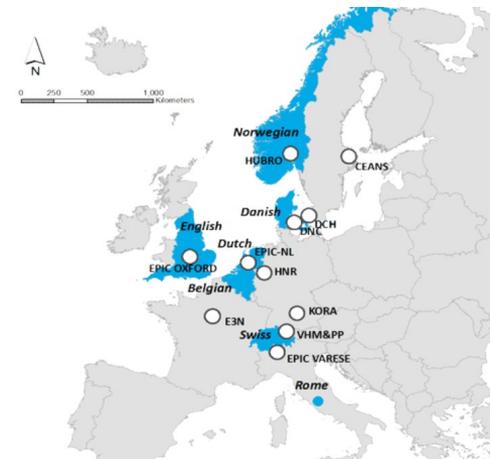
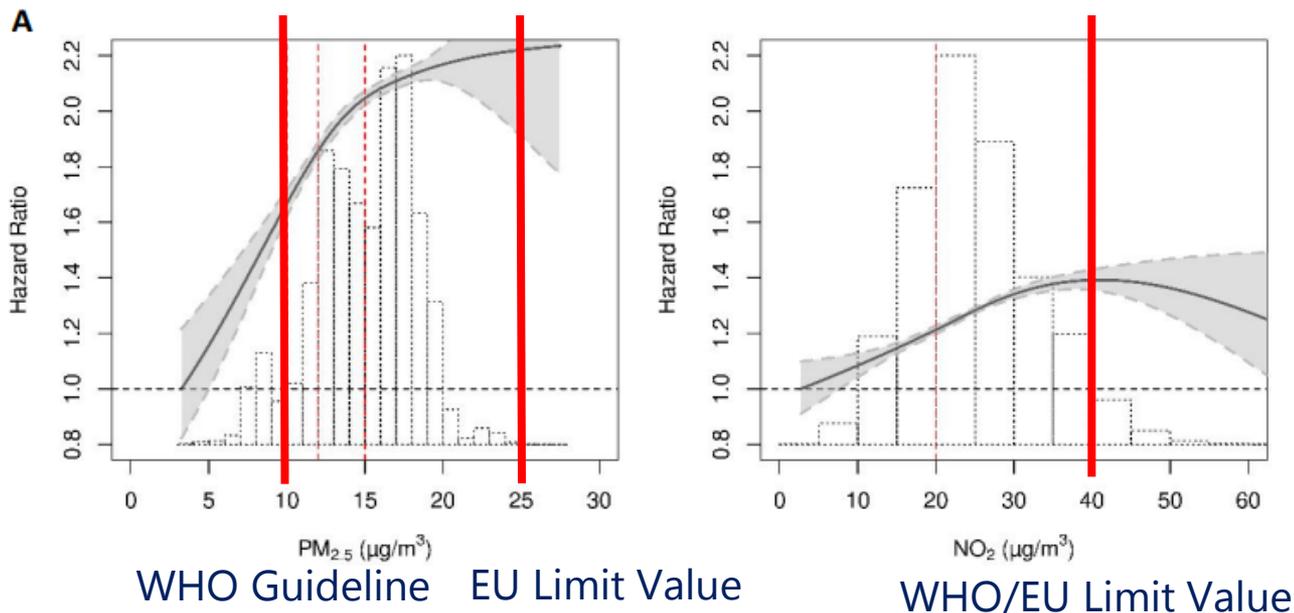
- **Intrauterine growth restriction**
 - Decreased birthweight
 - Reduced fetal growth
- Preterm birth
- Congenital anomalies
- Spontaneous abortion
- Stillbirth
- Infant death

Dose-response curves: mortality and PM_{2.5} / NO₂

- Linear association
- No safe exposure threshold below which air pollution is not harmful to human health

Long-term exposure to low-level air pollution and non-accidental mortality – a pooled analysis of eight European cohorts within the ELAPSE project

ELAPSE



(Strak et al. 2021)



Environmental Inequality or Injustice 'Double-burden'

- Air pollution levels are higher in countries and neighbourhoods with lower-socioeconomic status (SES)
- The poorest live closest to the pollution sources and are **most exposed**
- People with lower SES are **more susceptible** to adverse effects of air pollution:
 - more comorbidities
 - poorer lifestyle
 - poorer access to health care and information
 - less empowered to demand change

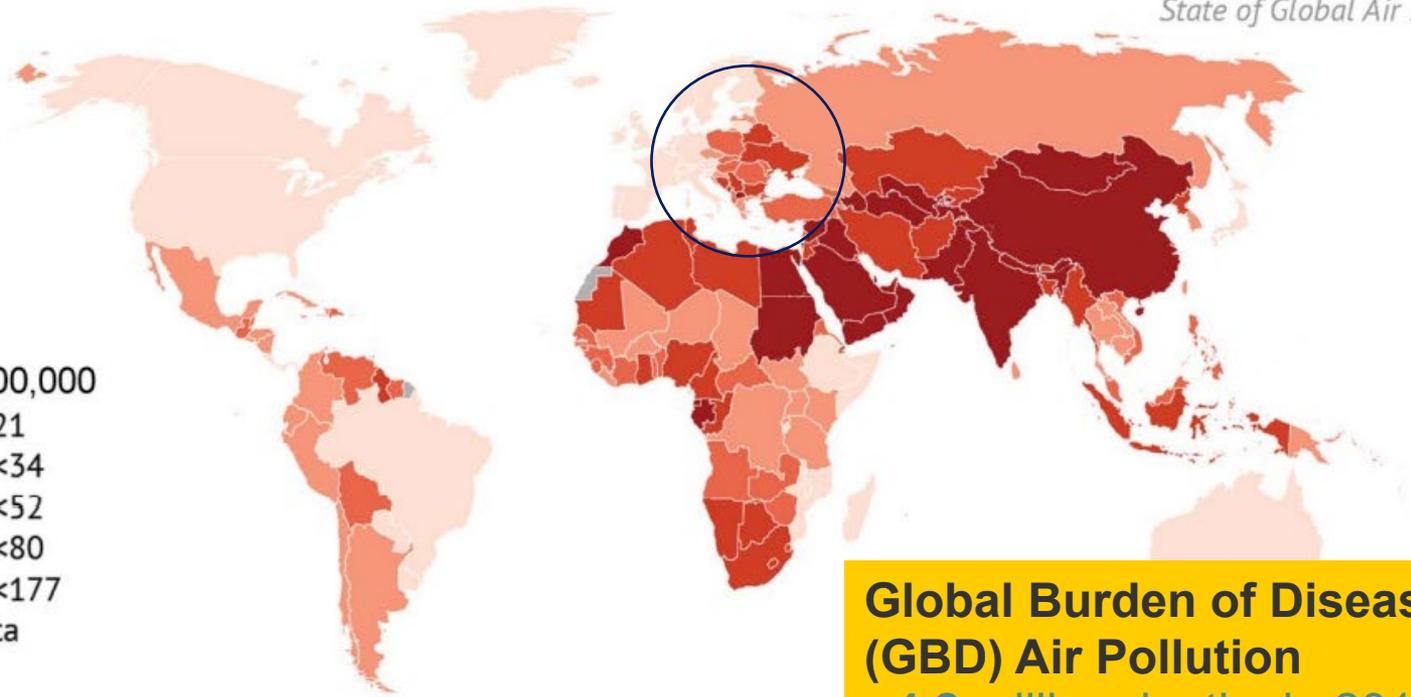


FIGURE 15 Global map of age-standardized rates of death attributable to PM_{2.5} in 2019.

State of Global Air 2020

Deaths/100,000

- 2 to <21
- 21 to <34
- 34 to <52
- 52 to <80
- 80 to <177
- No data



Global Burden of Disease (GBD) Air Pollution

- 4.2 million deaths in 2015*
- 6.7 million deaths in 2019**

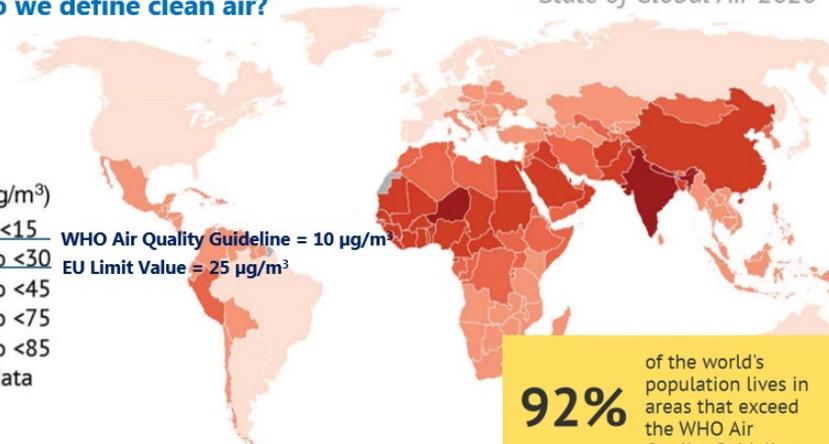
FIGURE 2 Global map of population-weighted annual average PM_{2.5} concentrations in 2019.

State of Global Air 2020

How do we define clean air?

PM_{2.5} (µg/m³)

- 0 to <15 WHO Air Quality Guideline = 10 µg/m³
- 15 to <30 EU Limit Value = 25 µg/m³
- 30 to <45
- 45 to <75
- 75 to <85
- No data



92%

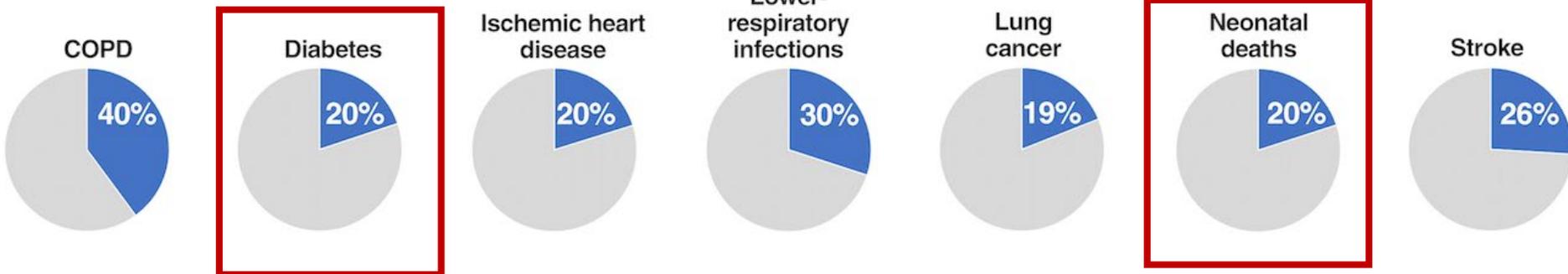
of the world's population lives in areas that exceed the WHO Air Quality Guideline

Source:

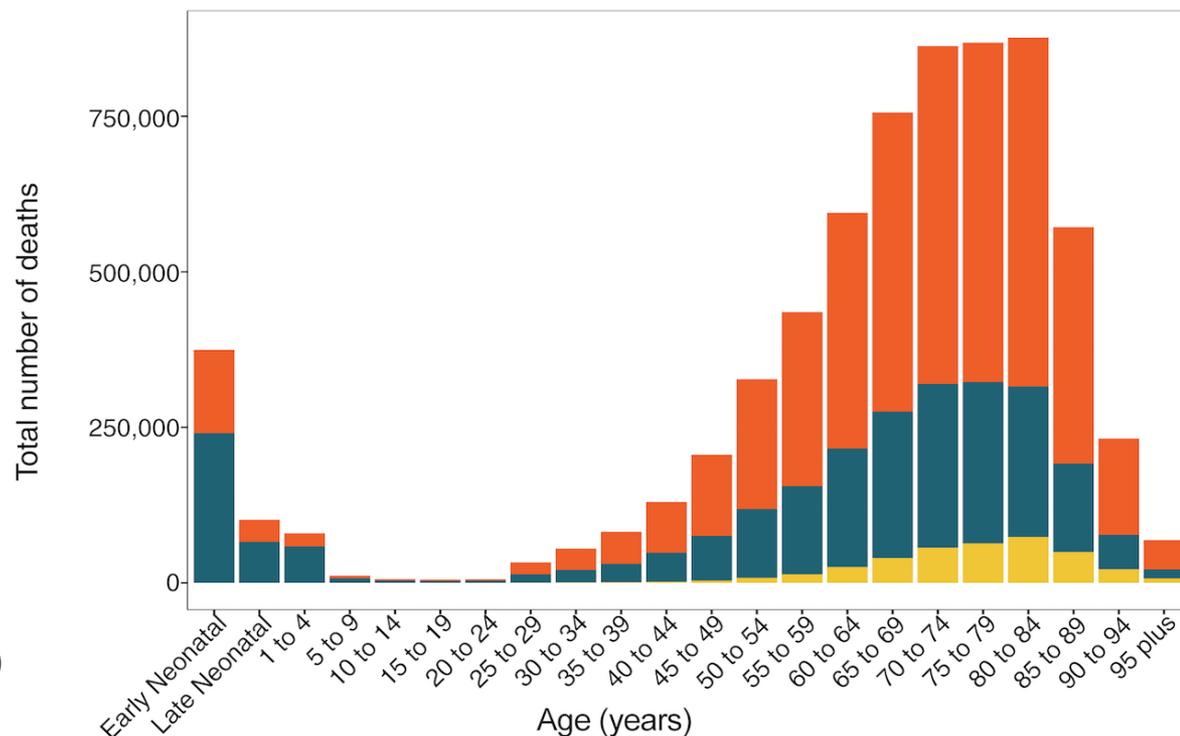
*Cohen AJ, Brauer M, Burnett R, et al. Estimates and 25-year trends of the global burden of disease attributable to ambient air pollution: an analysis of data from the Global Burden of Diseases Study 2015. *Lancet* 2017;389:1907-1918.

** <https://www.stateofglobalair.org/>

Key health problems associated with air pollution 2020



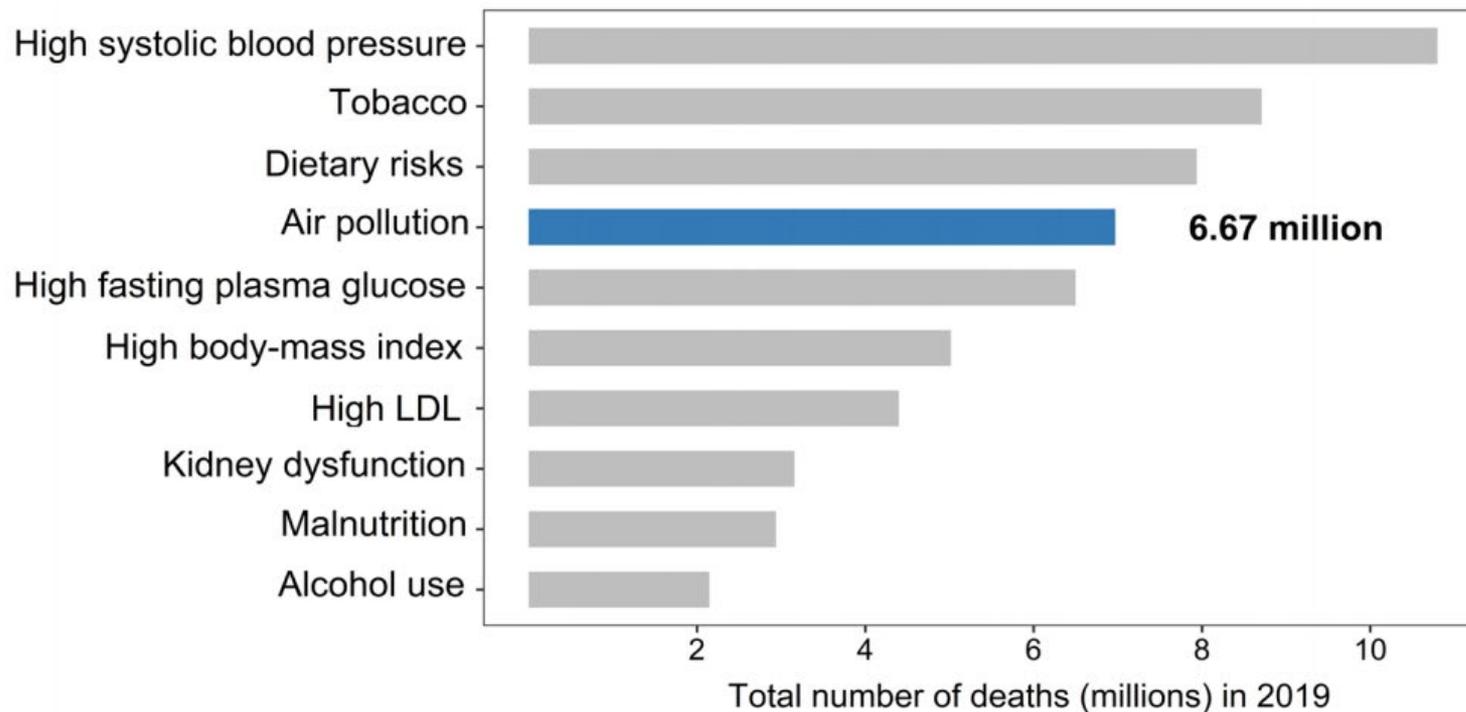
Pollutant: ■ Ambient PM_{2.5} ■ Household air pollution ■ Ambient ozone



Ongoing studies continue to explore air pollution's role in the development of additional conditions including **asthma**, **cognitive disorders**, which are not currently included in the GBD estimates.

Air Pollution compared to other risk factors

FIGURE 1 Global ranking of risk factors by total number of deaths from all causes in 2019.



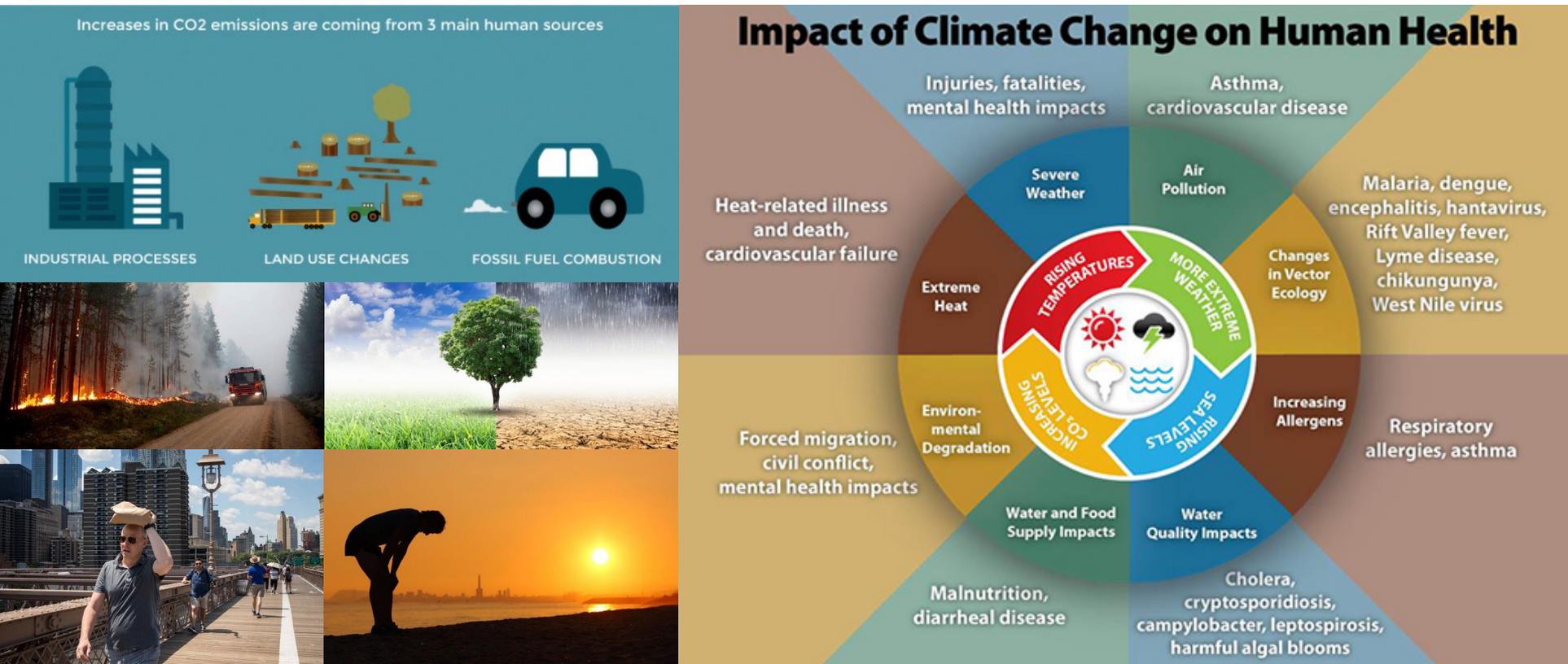
Climate Change, Air Pollution and Health

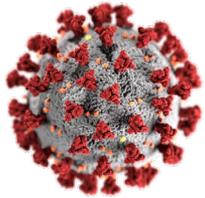
Climate change impacts on air pollution:

- Heat → higher ground-level ozone
- Heat/droughts → dust resuspension, more frequent/intense sandstorms
- Warm weather/heat → more frequent wildfires
- Shared major sources of air pollution and green house gases

Why climate change is also a public health problem

It's not only the environment that's at risk.





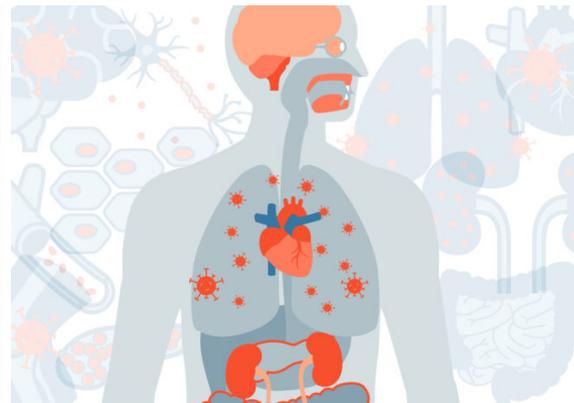
Air Pollution and COVID-19

- Exposure to air pollution can increase the risk of COVID-19 infection/death:
 - by compromising the individual's immune system's ability to fight infections (air pollution and pneumonia/influenza)
 - by increasing the risk of predisposing chronic diseases
- COVID-19 lockdown measures have resulted in unprecedented short-term reductions in air pollution, showing a glimpse of what can be achieved, bringing about renewed interest and demand for clean air

New Research Links Air Pollution to Higher Coronavirus Death Rates

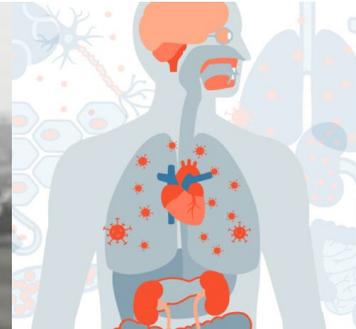
Air pollution in eastern Europe adds to pandemic health woes

With the arrival of cold and foggy winter weather amid the pandemic, eastern Europe is facing an extra respiratory health hazard — air pollution



Conclusions

- Air pollution – major global health risk factor
- Health burden is huge and likely to increase, as new diseases are linked to air pollution and populations aging
- Call for action is justified & urgent: current legislation does not protect human health adequately, any reductions in air pollution would bring substantial health benefits
- Climate change agenda, COVID-19, present opportunities for co-benefits of air pollution control and call for joint action
- More research needed in South Eastern Europe: locations with different PM constituents/sources, exposure levels, and population composition
- Medical societies, clinicians, patient organizations to play a role in spreading information and protecting citizens from adverse effects of air pollution



Coming up for clean air in Bosnia and Herzegovina



ENVIRONMENT

Bucharest, Sofia, Zagreb among 24 cities with EU's highest air pollution costs

Bulgaria citizens concerned about rising air pollution amid coronavirus crisis

 COMMENTS

Is Belgrade really the most polluted city in the world? Data is alarming, health warning issued

Hungary chokes on pollution

By Energy Reporters | 25.01.2019 | Environment



Sofia, Bulgaria



Illustration: Nikola Jovanovic Photo: Shutterstock

THANK YOU

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every breath counts