Health Effects of Air Pollution

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Biological Mechanisms behind Health Effects of Air Pollution

- Air pollution enters the body through inhalation (skin, digestion)
- Inflammation, oxidative stress
- Outdoor air pollution, particulate matter, diesel exhaust all found carcinogenic to humans (Group 1) (2012/13). Outdoor air pollution causes lung cancer (Group 1).

We inhale 10,000 liters of air/day
Air pollution, respiratory and cardio-metabolic system
Figure 1. Hallmarks of environmental insults
The scheme enumerates the hallmarks of environmental insults described in this review: oxidative stress and inflammation, genomic alterations and mutations, epigenetic alterations, mitochondrial dysfunction, endocrine disruption, altered intercellular communication, altered microbiome communities, and impaired nervous system function.

- Systemic responses
  - Altered chemokine signaling, inflammation
  - Circulating extracellular vesicles
  - Circulating RNA species
  - Altered metabolites

- Circulating peripheral white blood cells
  - Altered composition and states
  - Epigenetic changes
  - Mitochondrial dysfunction
  - Telomere attrition

- Lung
  - Inflammation, cell death
  - Epigenetic changes
  - Immune cell interactions
  - Altered lung microbiome
  - Virus activation

- Reproductive organs
  - Inflammation
  - Epigenetic changes
  - Mitochondrial dysfunction
  - Telomere attrition
  - Endocrine disruption

- Brain
  - Neuroinflammation
  - Neurotoxicity
  - Stress hormone release
  - Endocrine disruption
  - Circadian rhythm disruption
  - Altered nervous system function

- Heart
  - Inflammation, cell death
  - Epigenetic changes
  - Mitochondrial dysfunction
  - Altered autonomous nervous system function

- Gut
  - Altered gut microbiome
  - Altered metabolites

- Skin
  - Inflammation
  - Epigenetic changes
  - Immune cell interactions
  - Altered skin microbiome

Figure 4. Illustration of organ-specific impacts based on the hallmarks of environmental insults
These pathophysiological changes summarize examples of how environmental exposures impact organs locally as well as exhibit their insults systemically.
Health Effects of Air Pollution

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
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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
Average Annual Population–Weighted PM2.5 Concentrations in 2019

New WHO recommendation = 5 µg/m³
## Table 0.1. Recommended AQG levels and interim targets

<table>
<thead>
<tr>
<th>Pollutant</th>
<th>Averaging time</th>
<th>Interim target</th>
<th>AQG level</th>
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</thead>
<tbody>
<tr>
<td>PM$_{2.5}$, $\mu$g/m$^3$</td>
<td>Annual</td>
<td>35</td>
<td>25</td>
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<tr>
<td></td>
<td>24-hour$^a$</td>
<td>75</td>
<td>50</td>
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<tr>
<td>PM$_{10}$, $\mu$g/m$^3$</td>
<td>Annual</td>
<td>70</td>
<td>50</td>
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<td></td>
<td>24-hour$^a$</td>
<td>150</td>
<td>100</td>
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<tr>
<td>O$_3$, $\mu$g/m$^3$</td>
<td>Peak season$^b$</td>
<td>100</td>
<td>70</td>
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<tr>
<td></td>
<td>8-hour$^a$</td>
<td>160</td>
<td>120</td>
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<tr>
<td>NO$_2$, $\mu$g/m$^3$</td>
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<td>30</td>
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<td>24-hour$^a$</td>
<td>120</td>
<td>50</td>
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<tr>
<td>SO$_2$, $\mu$g/m$^3$</td>
<td>24-hour$^a$</td>
<td>125</td>
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<tr>
<td>CO, mg/m$^3$</td>
<td>24-hour$^a$</td>
<td>7</td>
<td>–</td>
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</tbody>
</table>

$^a$ 99th percentile (i.e. 3-4 exceedance days per year).

$^b$ Average of daily maximum 8-hour mean O$_3$ concentration in the six consecutive months with the highest six-month running-average O$_3$ concentration.
Number of Deaths Attributable to PM2.5 in 2019

Global Burden of Disease (GBD) Air Pollution
- 4.2 million deaths in 2015*
- 6.7 million deaths in 2019**

Source:
** https://www.stateofglobalair.org/
Key health problems associated with air pollution 2020

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.

[https://www.stateofglobalair.org/](https://www.stateofglobalair.org/)
Air Pollution compared to other risk factors

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

- High systolic blood pressure
- Tobacco
- Dietary risks
- Air pollution
- High fasting plasma glucose
- High body-mass index
- High LDL
- Kidney dysfunction
- Malnutrition
- Alcohol use

Total number of deaths (millions) in 2019

*Figure: https://www.stateofglobalair.org/sites/default/files/figure-i.svg*
HEI’s Program to Assess Adverse Health Effects of Long Term Exposure to Low Levels of Ambient Air Pollution

Preface Figure 1. Shape of the concentration–response function for mortality associated with fine particulate matter in a Canadian Cohort. (Courtesy R. Burnett). NAAQS = National Ambient Air Quality Standard; WHO AQG = World Health Organization Air Quality Guidelines.
Conclusions

• Air pollution – major global health risk factor

• Health burden is found at all levels, 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

• 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

Sofia, Bulgaria

Hungary chokes on pollution

By Energy Reporters | 25.01.2019 | Environment

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