Health Concerns

10:35

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Joining Forces to Improve Air Quality and Health

Basic Concepts

Air Quality Health Concerns

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1. Possible Guiding Questions

- What do we know about how poor air quality impacts on our health (mechanisms involved, evidence of causation etc)?
- What do we still need to know?
- What do we know about indoor vs outdoor environments and their impacts?
- Are some people more susceptible to the harmful impacts than others?
- What is currently being done to improve our understanding and are there any major new initiatives/innovations that might provide a step change in our understanding?
2. ‘Sales pitch’

- Air pollution damages everyone’s health
- Air pollution harms all organs of the body
- 90% of the world’s population live in air pollution above recommended levels
- Air pollution is on the rise in many developing countries
- No ‘safe’ level of air pollution
- Air pollution is responsible for 7 - 9 million early deaths worldwide every year
3. Categorising air pollution

- Key pollutants for health: \( PM_{10} \), \( PM_{2.5} \), \( NO_x \), \( O_3 \) (\( SO_2 \), \( NH_3 \), \( CO \), VOCs etc)
- All have the potential to cause harm
- Short vs long-term effects
- \( NO_2 \) & \( O_3 \) most commonly linked to respiratory conditions
- \( PM_{10} \) & \( PM_{2.5} \) linked to respiratory, cardiovascular and other conditions
- Strongest associations are for particulate matter
4. Particles

“Coarse” (PM\textsubscript{10}): <10.0
“Fine” (PM\textsubscript{2.5}): <2.5
“Ultrafine” (PM\textsubscript{0.1}): <0.1 (nanoparticles, <100 nm)

PM\textsubscript{2.5} is measured as the mass of particles with an aerodynamic diameter of 2.5 \(\mu\text{m}\) or less.
5. **PM\(_{2.5}\)** is not the whole story

- Not adequately measured by \(\text{PM}_{10}\) and \(\text{PM}_{2.5}\)
- High surface area for a given mass
- Greater surface area to carry chemicals into the body
- Combustion-derived nanoparticles contain many harmful constituents

If a \(\text{PM}_{10}\) particle weigh the same as 1,000,000 nanoparticles, the surface area of the nanoparticles would be 100x bigger.

- Penetrate deep into the lungs and further
- Less efficiently cleared from the lung
6. Susceptibility to air pollution

Substantial loss of blood vessel relaxation function
(similar to long-term smoking)

Long-lasting impairment: > 24-h
7. Safe levels of air pollution
8. Deaths from air pollution

**UK:**
- 29,000 – 52,000 deaths per year
- Associated with £54 billion cost to UK economy annually
- Reduces average life expectancy by 8 months

**Europe:**
- 400,000 premature deaths per year
- Exposure to airborne particles reduce life expectancy by 1 year

**World-wide:**
- 7-9 million deaths per year
- Responsible for 6% of all deaths globally
9. Causation: the disease process

Exposure → Short-term impairment → [Biological mechanisms]

Asthma attack? → Clinical event → (cardiovascular) disease → Hospital admissions → Mortality → Premature death

life-time
10. Biological mechanisms

Cellular mechanisms
- Particles
- Direct toxicity
- Membrane damage
- DNA mutation
- Inflammation pathways
- Oxidative stress

Mechanistic endpoints

**Blood**
- Blood is more likely to clot
- Decreased ability to remove blood clots

**Heart**
- Change in the rhythm of the heart
- Heart more susceptible to damage from lack of oxygen

**Blood vessels**
- Vasodilatation responses impaired
- Increased blood pressure
- Increased stiffness of arteries
11. Multi-organ effects of air pollution

- neurodegenerative diseases
- impaired cognition
- altered behaviour
- depression
- autoimmune diseases
- stem cell alterations
- liver toxicity
- renal disease
- metabolic syndrome & diabetes
- inflammatory bowel disease
- osteoporosis
- decreased fertility
- autoimmune rheumatic diseases
- peripheral artery disease
- stroke
- olfactory deficits
- myocardial infarction
- coronary artery disease
- arrhythmia
- hypertension
- rejection of transplants
- asthma
- COPD
- respiratory infection
- lung cancer
- pre-eclampsia
- spontaneous abortion
- premature birth
- low birth weights
- epigenetic changes
- congenital defects
- detrimental health effects in offspring
12. Linking mechanisms – translocation
13. Future research / talking points

1. **Under-explored air pollutants** – other transport sources, agriculture, wood burning, indoor

2. Under-explored organs

3. **Low and high** air pollution

4. Better **metrics** - PM size, PM composition, mixtures?

5. **Interactions** – smoking, noise, temp, exercise, infectious diseases

6. **Policies and interventions**
14. End

Thank you for listening

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