Health impacts of air pollution: is there anything more to add?

The Science and Technology Facilities Council (STFC) Air Quality Network+

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MRC Centre for Environment and Health
NIHR-HPRU - Health impact of environmental hazards
Asthma UK Centre in Allergic Mechanisms of Asthma
Adverse effects of poor air quality on health across the life course

• Low birth weight (Smith 2017; ESCAPE, Pederson 2013)
• Incident asthma (Bharadwaj 2016)
• Pneumonia, asthma attacks, URTI (Peel 2005)
• Cardio-respiratory mortality (Hoek 2014)
• Type II diabetes (Yang 2019)
• Lung cancer incidence and survival (Eckel 2016)
• Dementia (Chen 2017)
• Impacts of mental health (Braithwaite 2019)
• Developmental deficits (Mudway 2019)
Annual average PM$_{2.5}$ concentrations in 2017 relative to the WHO Air Quality Guideline.
Global ranking of risk factors by total number of deaths from all causes for all ages and both sexes in 2017.

State of Global Air – HEI/IHME, 2019
How much more evidence do we need?

- 1000's of research studies, reviews (2006-2019)
- NPACT study (2013); ESCAPE (2013)
- REVIHAAP (July 2013); HRAPIE (Dec 2013)
- HEI Ultrafines report (2013)
- WHO Black Carbon report (2012)
- IARC Diesel exhaust reports (2013/2014)
- WHO Burden of disease report (March 2014)
- Every Breathe we take (RCP – 2016)
If there’s nothing more to add then there seems to be an awful lot of people publishing on it............

**KEY Themes**

- Multi-cohort analysis - ESCAPE
- Contribution of PM2.5 to the global burden of disease
- Primary combustion derived pollutants - diesel
- Multi-pollutant models
- Effects bellow the WHO guideline value
- Impacts of PM2.5 exposures on the brain – from early life cognition to dementia
- Indoor pollution – biomass
- Alternative metrics – black carbon / PNC/ oxidative potential
- Improved models / exposure estimates
- Prenatal impacts
How do pollutants interact with the airway?

- Oxidative stress
- Inflammation
- Injury/remodelling
- Chronic responses

Genetics
Pre-existing disease
Diet / lifestyle
Actual biological dose

Chronic responses
How to experimentally model the adverse effects of air pollutants?

- Immortalised cell lines
- Primary cells
- Commercial cell lines
- Differentiated primary cells
- Explants

**In vitro - In vivo correlation**

- Co-culture
- Air-Liquid interface
- Submerged culture
- Respiratory tract lining fluid
- Interstitium
- Oxygen (13 vs. 21%)
- Tissue culture artefacts
Challenges:

• Identifying the toxic components/characteristics of PM.
• Identifying source-specific toxicity.
• Disentangling the contribution of highly correlated pollutants to adverse cellular responses: PM$_{2.5}$ and NO$_2$.
• Understanding the mechanisms leading to the systemic effects of air pollutants.
• Biomarkers of exposure
• Identifying/validating source specific epigenetic and metabolomics signatures in urban populations.
• Linking acute effects in vitro with long-term effects in vivo.
Emerging themes:

• ‘Omics to disaggregate the biological effects of different components of the ambient aerosol
Emerging themes:

- Accelerated ageing hypothesis