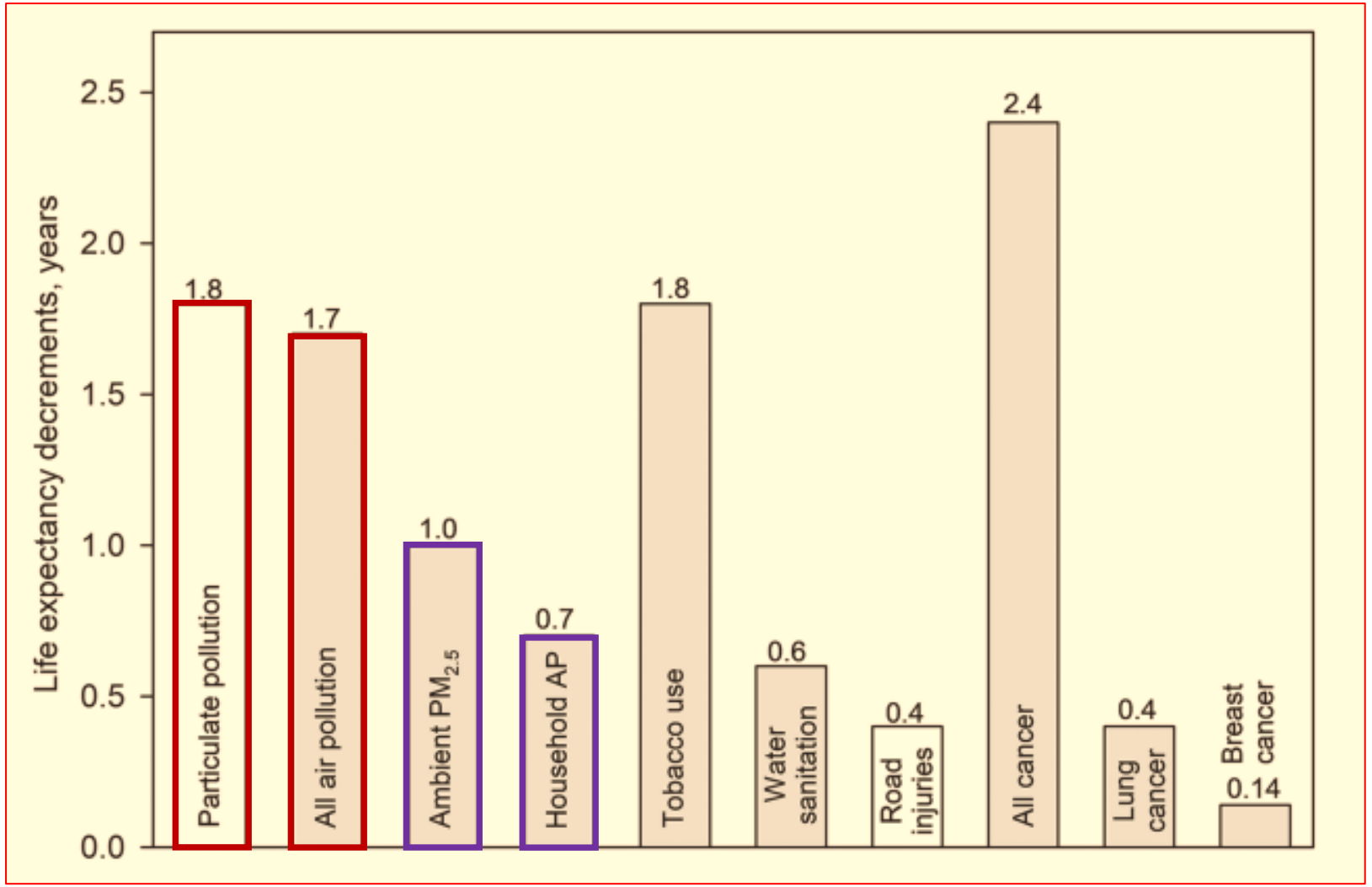
Breathing healthy air is everyone's business.

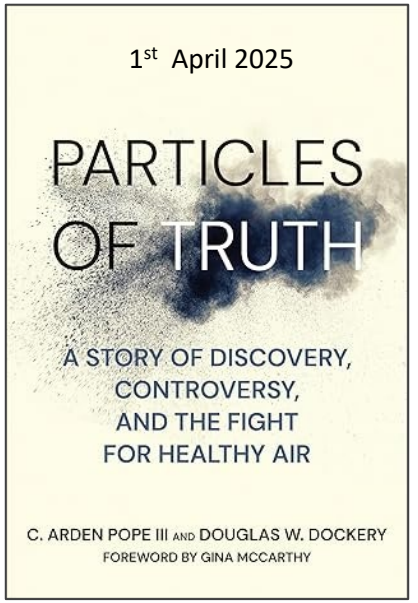
Stephen T Holgate,
Clinical Professor of Immunopharmacology,
University of Southampton

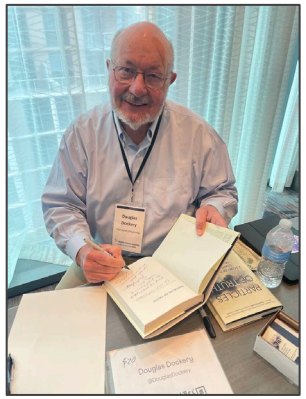
- UKRI Clean Air Champion
- Special Advisor to the RCP on Air Quality

Estimates of life expectancy decrements for air pollution and selected other risk factors and causes of death

Worldwide, accounts for 8.1 million premature deaths/yr
UK: 27-43,000 deaths/yr







Air pollution has officially overtaken high blood pressure and smoking as the leading contributor to global disease.
RCPCH Sept 19th, 2024

According to the World Health Organization (WHO), air pollution is now the greatest environmental risk to human health.

The health harms of air pollution

- Globally, air pollution is the **largest environmental health risk** causing loss of healthy years of life and premature death
- In 2021, there were an estimated **8.1 million preventable deaths** linked to outdoor and indoor pollution worldwide
- Air pollution needs to be recognised as a **public health issue** and must be taken more seriously as an avoidable health risk

The equivalent of around **30,000 deaths a year** in the UK are estimated to be attributed to air pollution.

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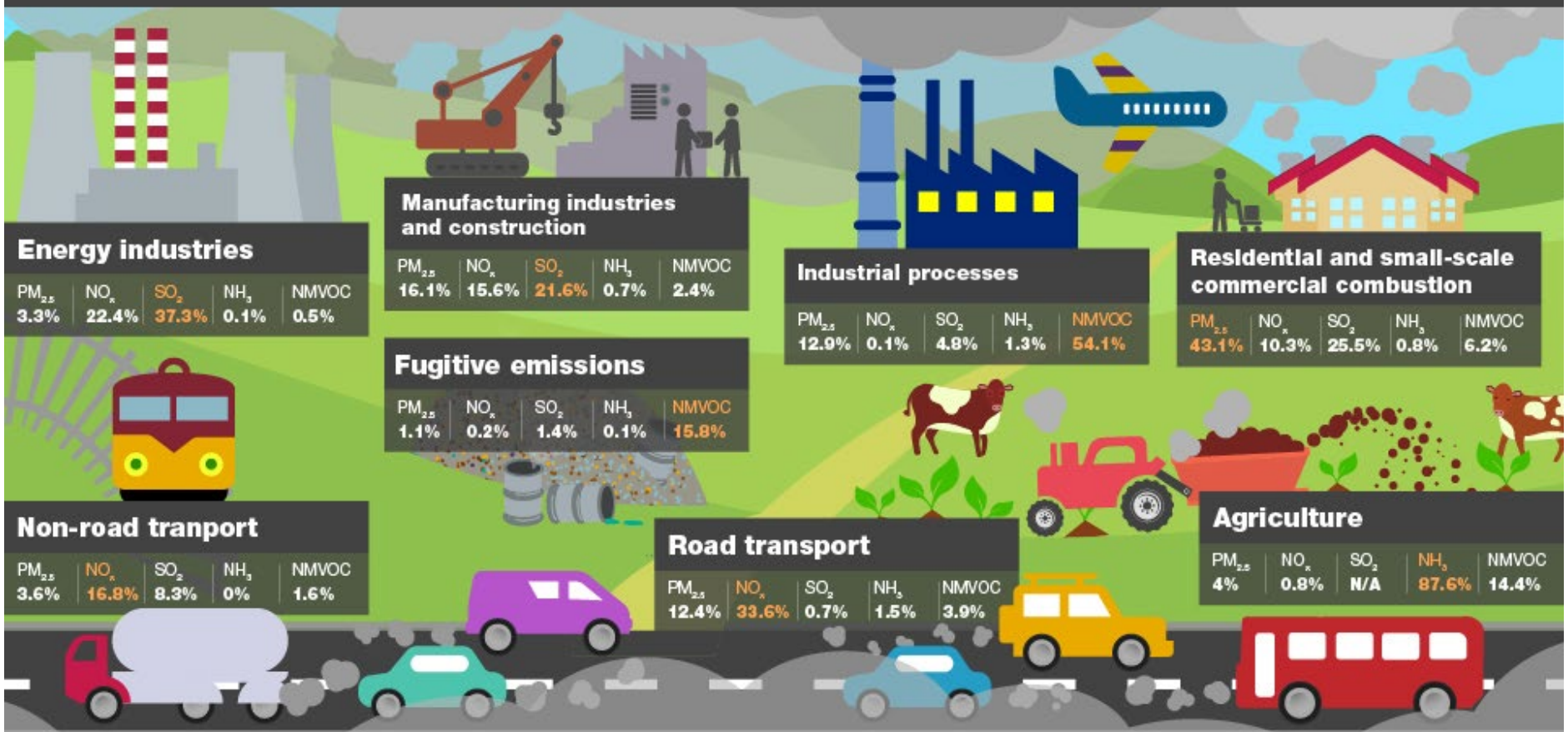
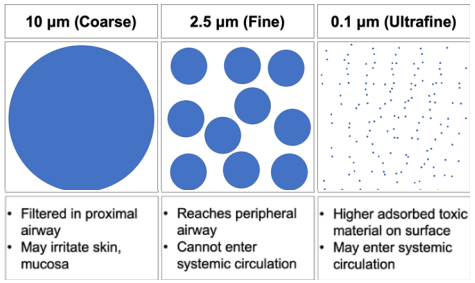
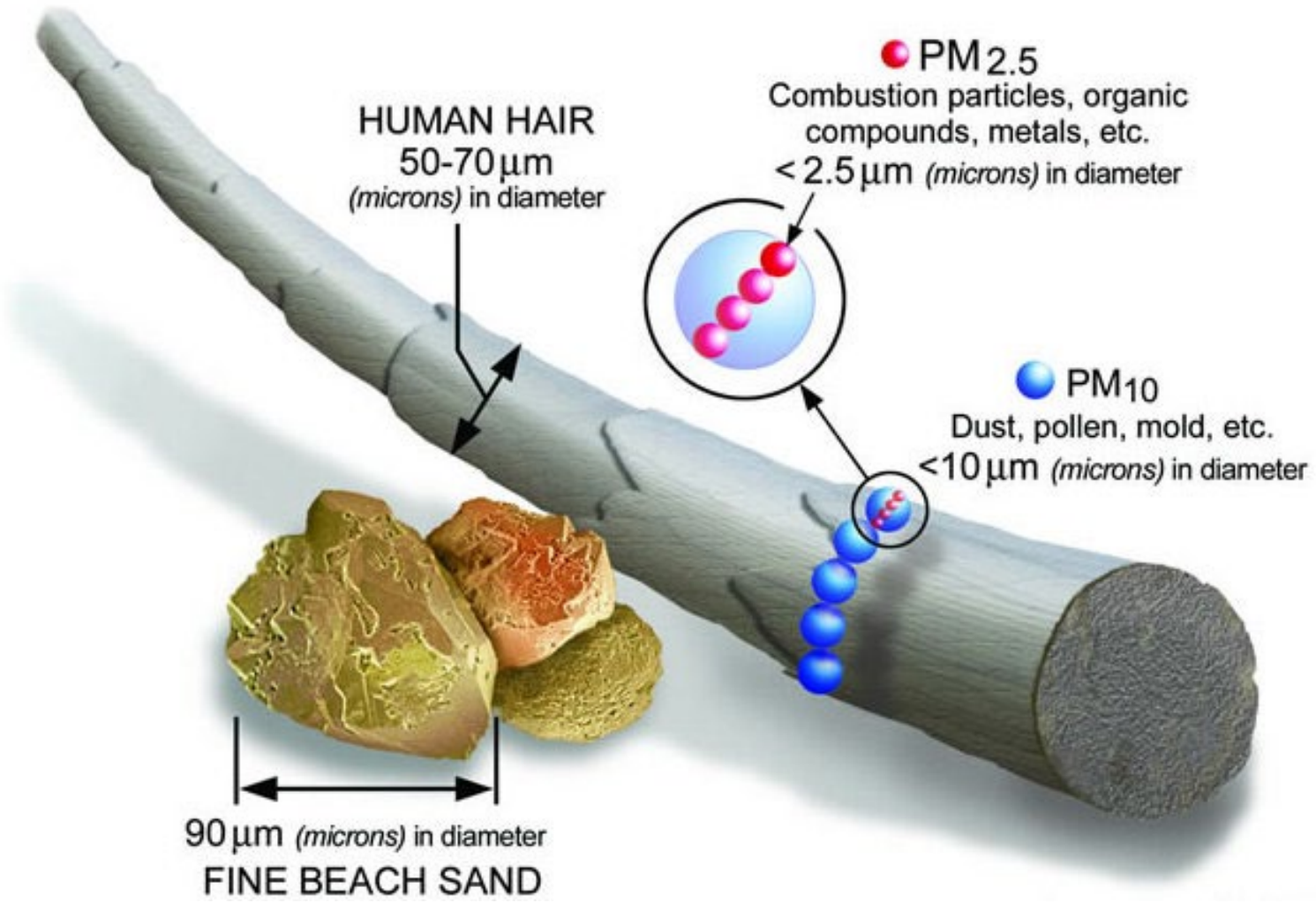
Sources of air pollution

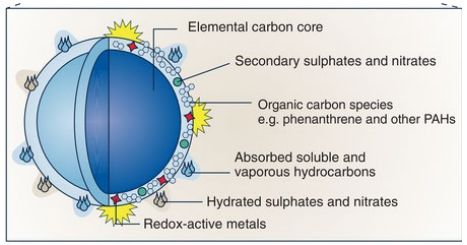


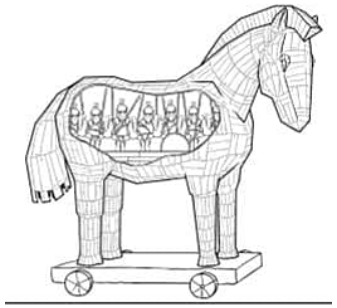
Small air pollutant particles ($PM_{2.5}$ and $PM_{0.1}$) behave like a gas

Ultrafine particles: unique physicochemical properties relevant to health and disease.
Kwon, HS, et al. Exp Mol Med. 2020; 52: 318-28)







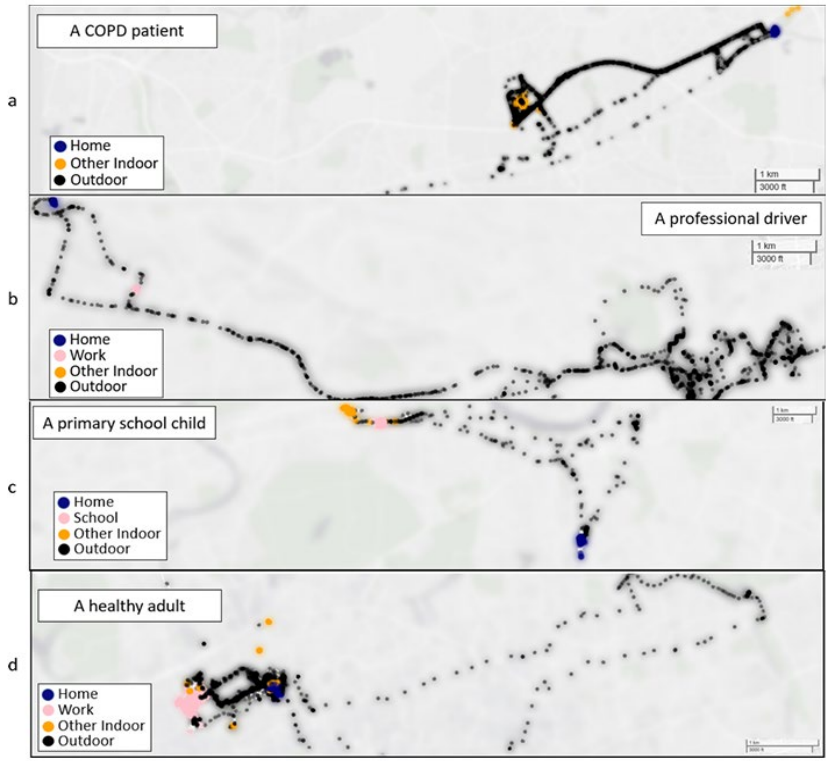


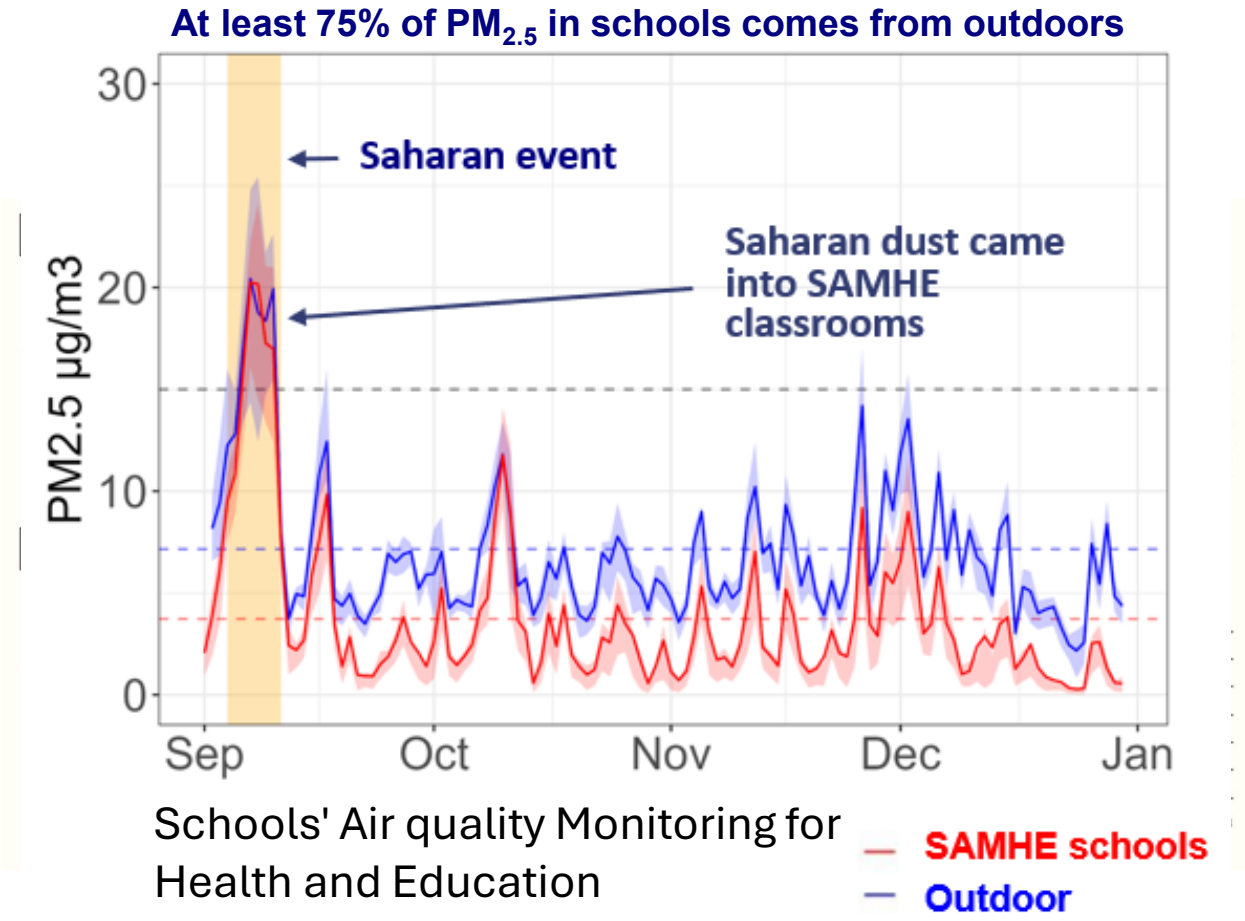
The Indoor-Outdoor Continuum

Estimating exposure to pollutants generated from indoor and outdoor sources within vulnerable populations using personal air quality monitors: A London case study.

Zhang H, et al. Environ Int. 2025; 198: 109431.

Trajectories of panel participants based on one-minute resolution GPS

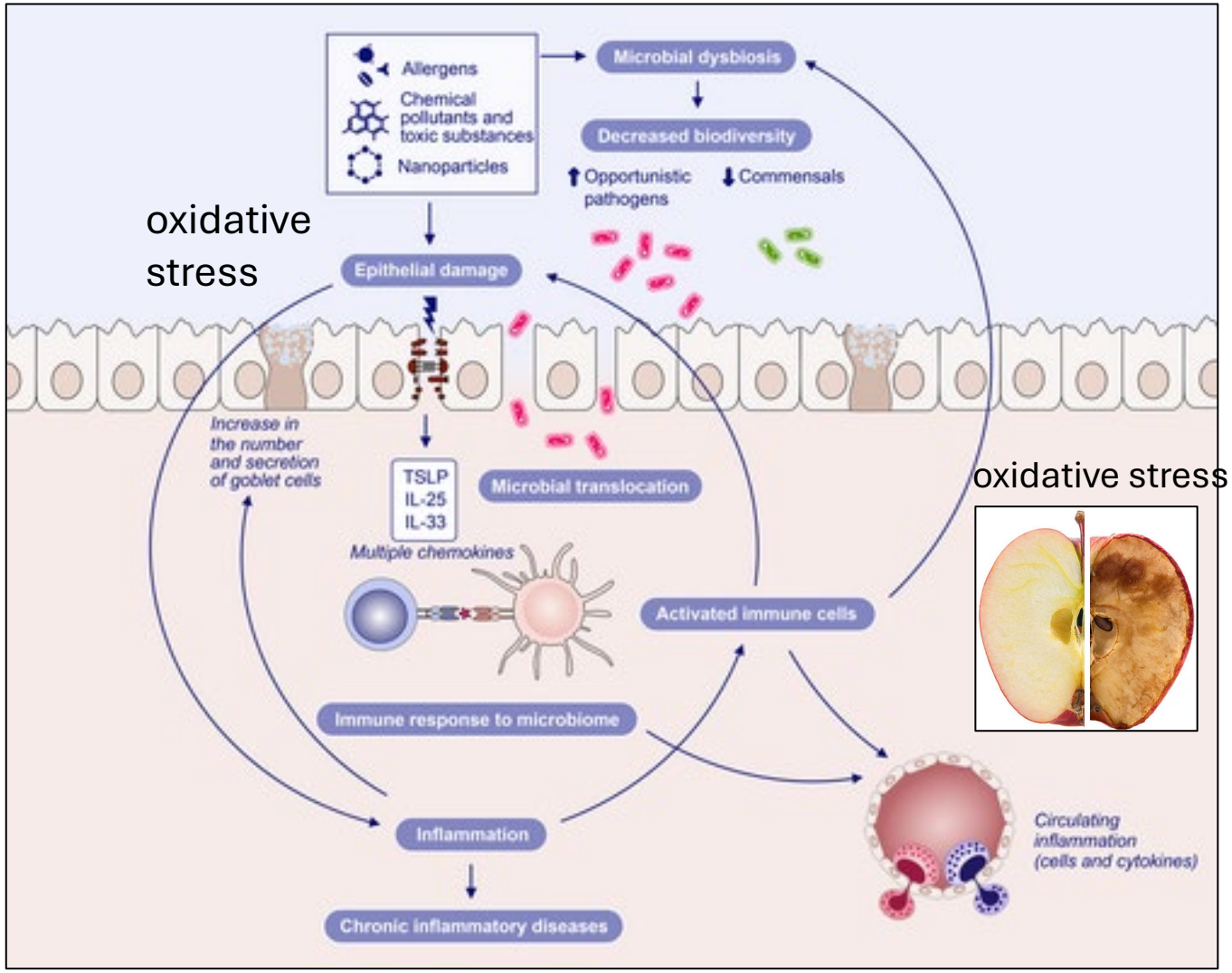




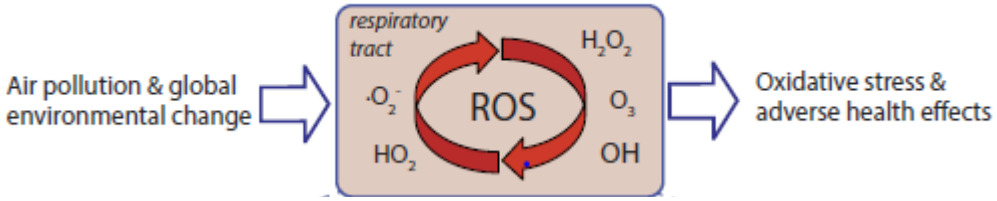
Participants spending most of their time indoors at home (COPE participants), **>40 % of total personal exposure to NO_2 and $PM_{2.5}$ were from outdoor sources** and **>60% for participants spending more time outdoors** including healthy adults (PASTA), school children (BLW), and professional drivers (DEMiST),

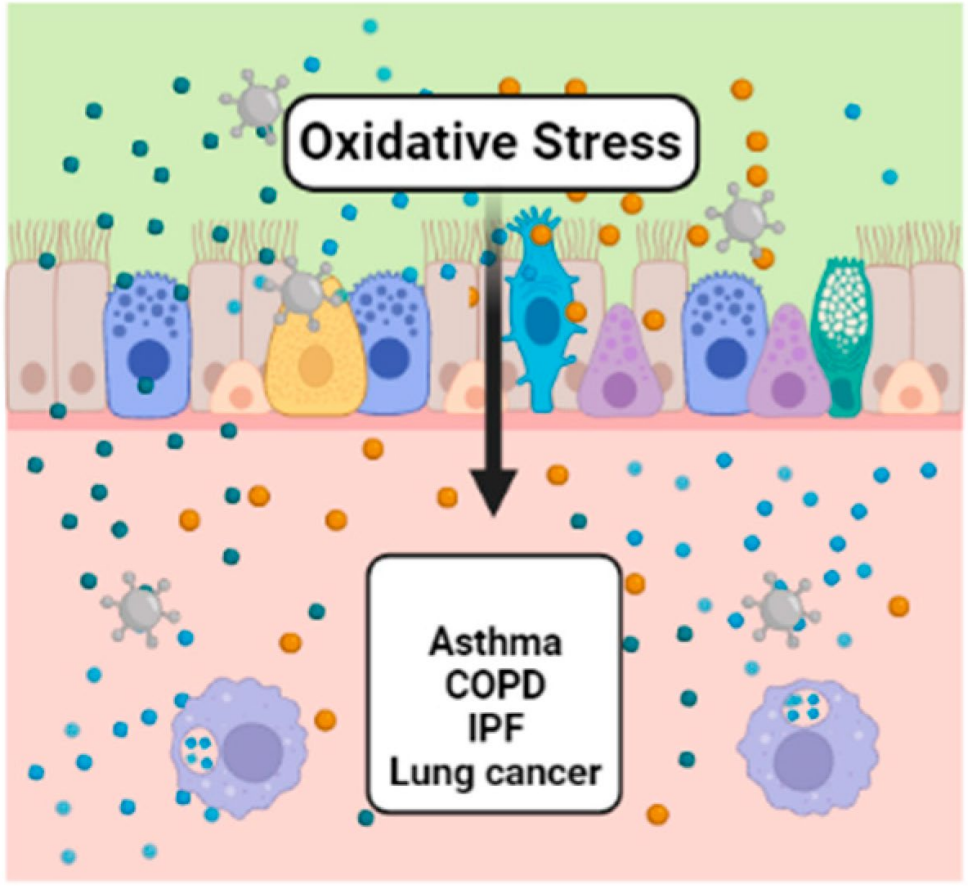
The epithelial barrier theory and its associated diseases.

Sun N, et al. Allergy. 2024; 79: 3192-237



oxidative stress



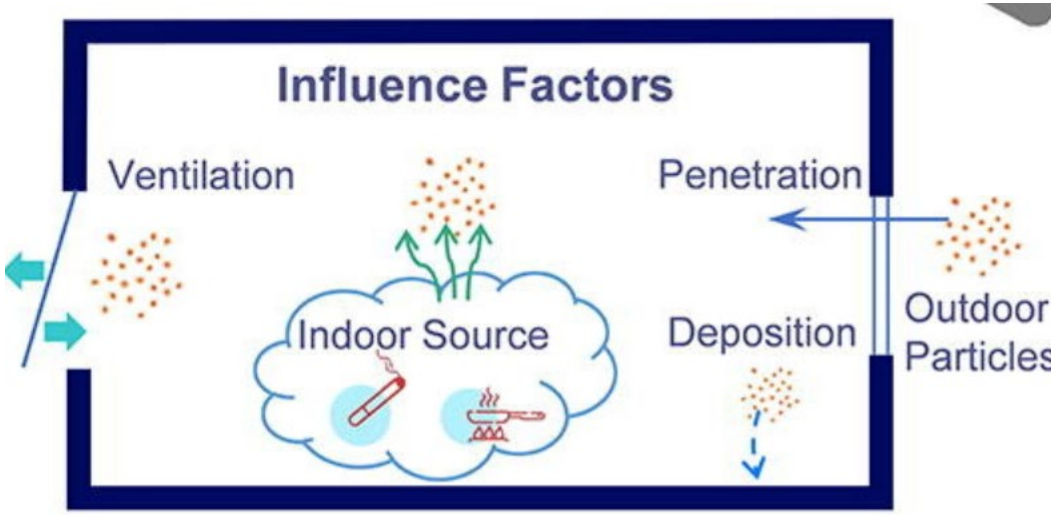


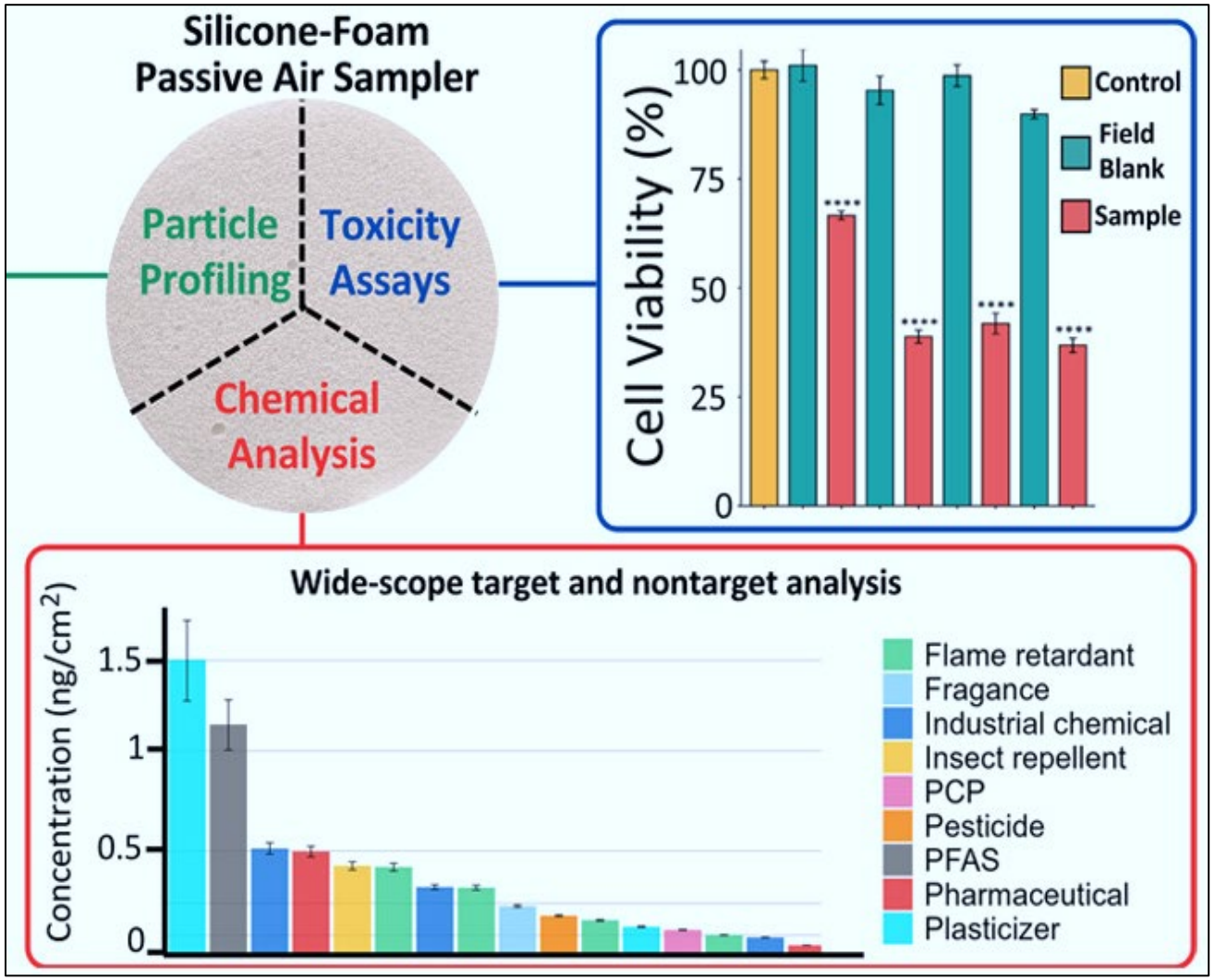
Human airways

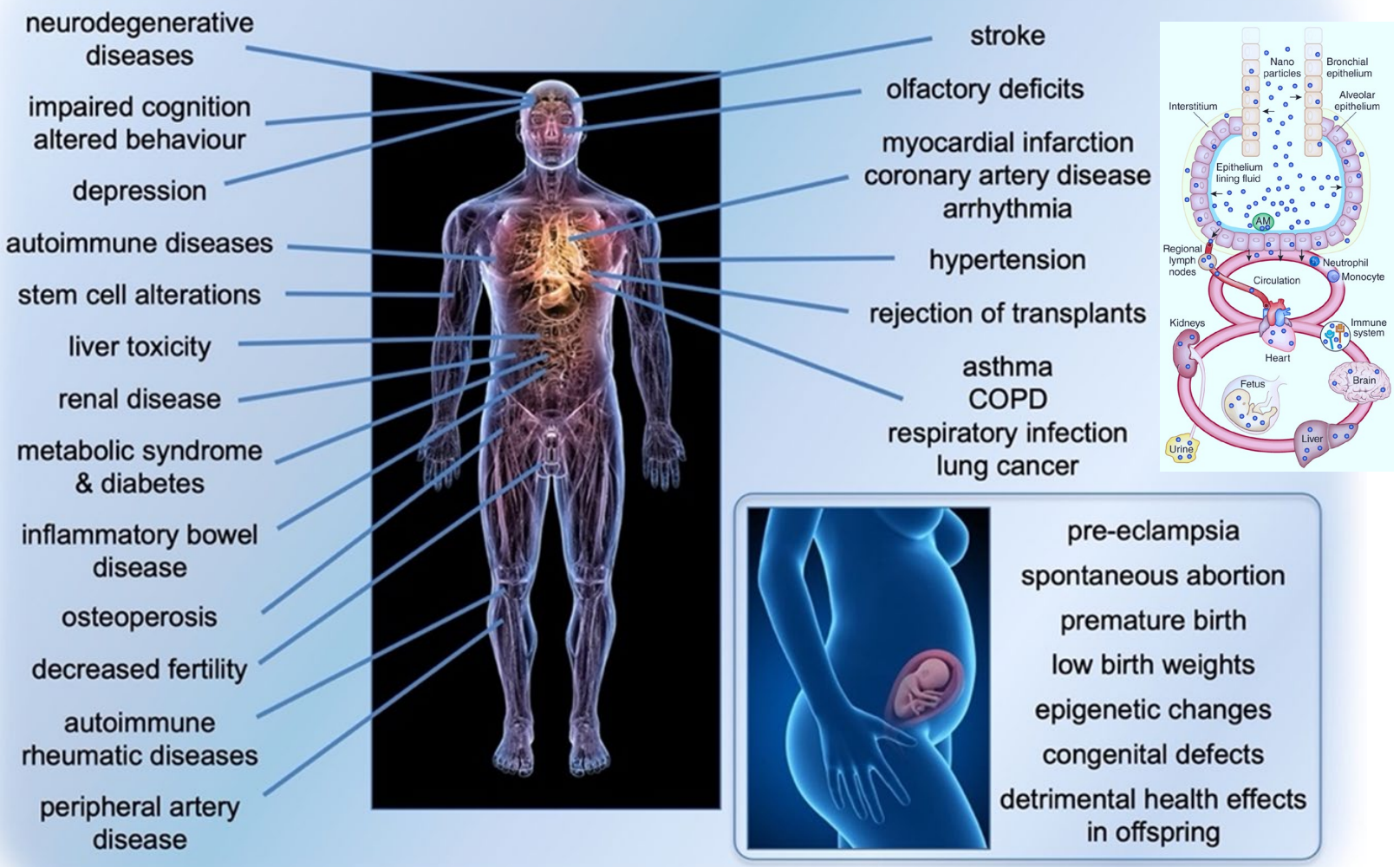
Silicone-Foam **passive air samplers** for combined target and nontarget chemical pofiling and toxicity assessment of **airborne exposomes**.

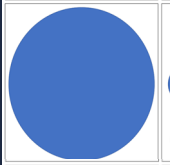
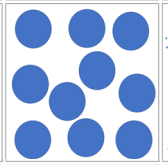
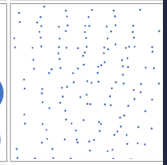
Sunyer-Caldú A. et al. Environ Sci Technol. 2026 Feb 10. doi: 10.1021/acs.est.5c16613.

The indoor/outdoor ratio of PM concentration is primarily affected by **human activity** and **ventilation**

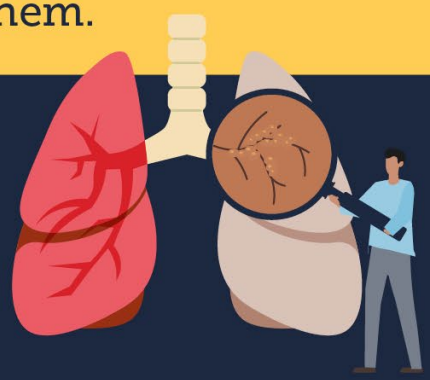






10 µm (Coarse)	2.5 µm (Fine)	0.1 µm (Ultrafine)
		
• Filtered in proximal airway • May irritate skin, mucosa	• Reaches peripheral airway • Cannot enter systemic circulation	• Higher adsorbed toxic material on surface • May enter systemic circulation

Air pollution affects almost every organ in the body, including the brain, lungs, heart, liver and kidneys and the diseases linked to them.



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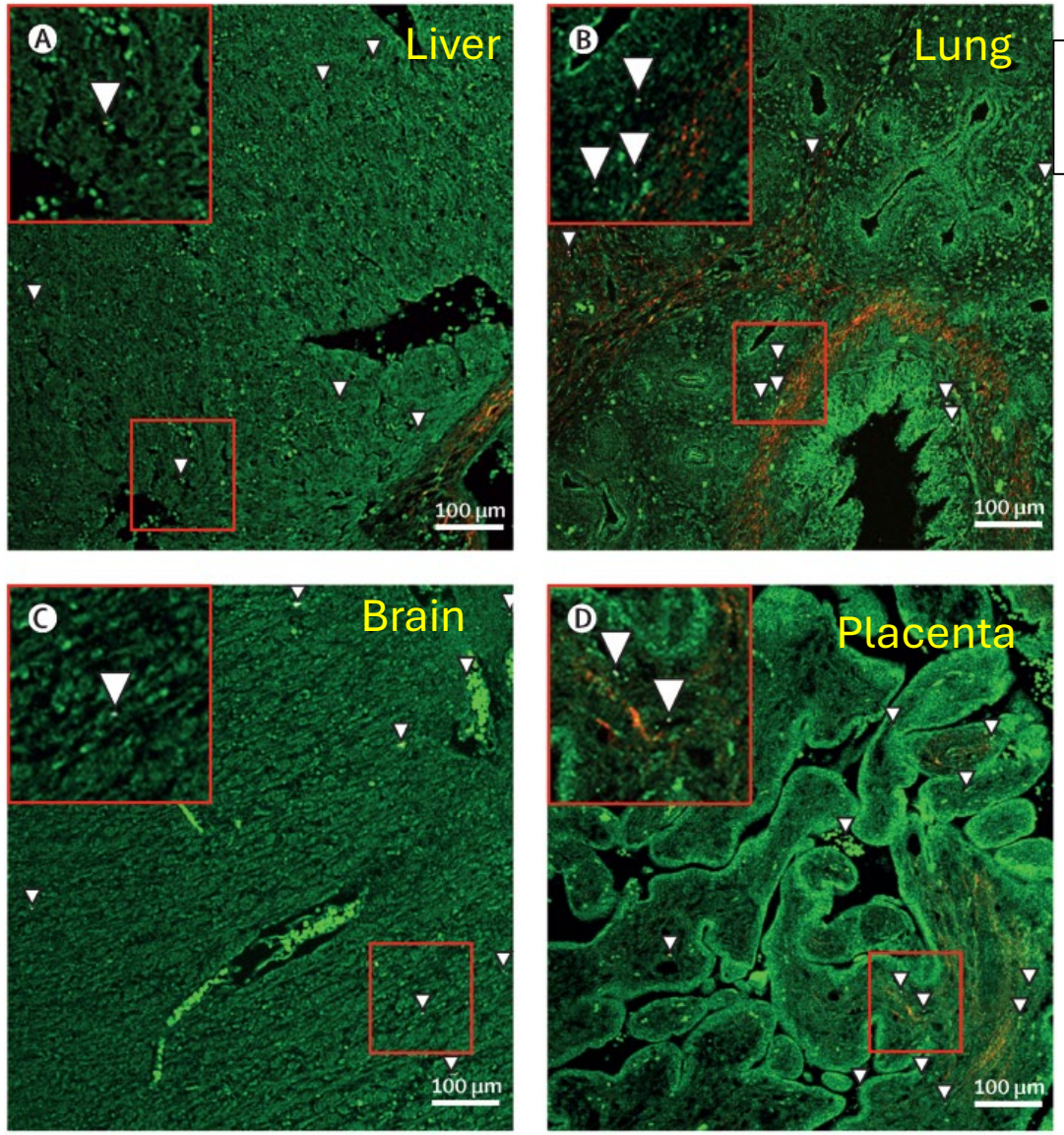
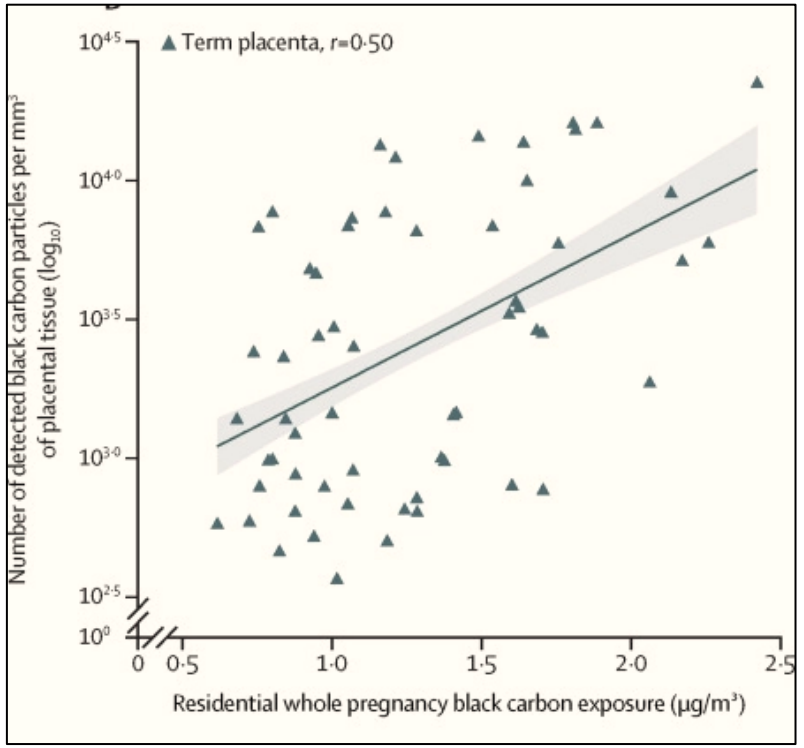
Maternal exposure to ambient black carbon particles and their presence in maternal and foetal circulation and organs

Bongaerts E, et al. Lancet Planet Health. 2022; 6: e804-e811



Presence of intra-tissue black carbon particles foetal tissues, gestational age 7-20 weeks

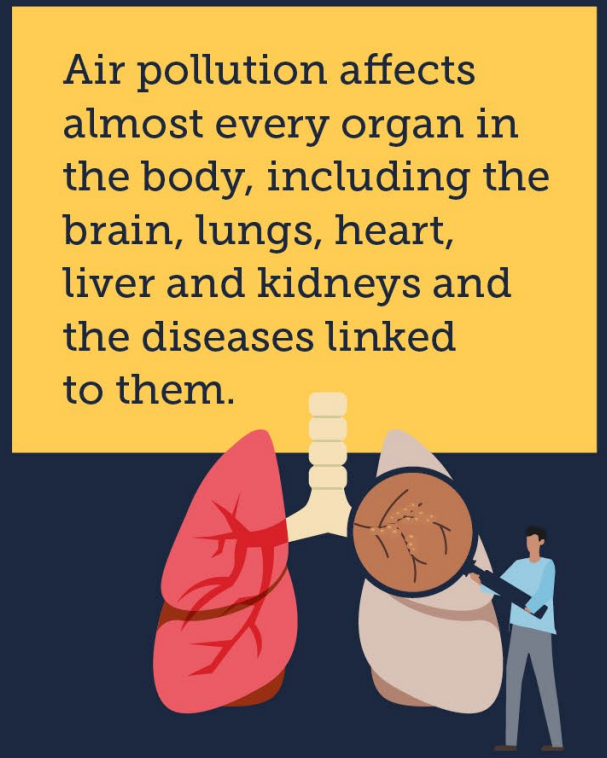


Maternal-perinatal black carbon load and residential black carbon exposure during pregnancy

- Air pollution is bad for our health
- Dirty air is detrimental to childhoods
- The most marginalised are hit the hardest
- Air pollution is bad for business
- Reducing air pollution would limit global warming
- Our cities should be liveable and sustainable

Impacts across the lifecourse

- Air pollution negatively affects health at **all stages of life**, beginning before conception and continuing throughout pregnancy
- **Children are especially vulnerable** as they are developing key protective systems. Effects include reduced lung growth, weakened immune systems and reduced brain development
- Exposure throughout life can substantially increase the risk of **dementia**



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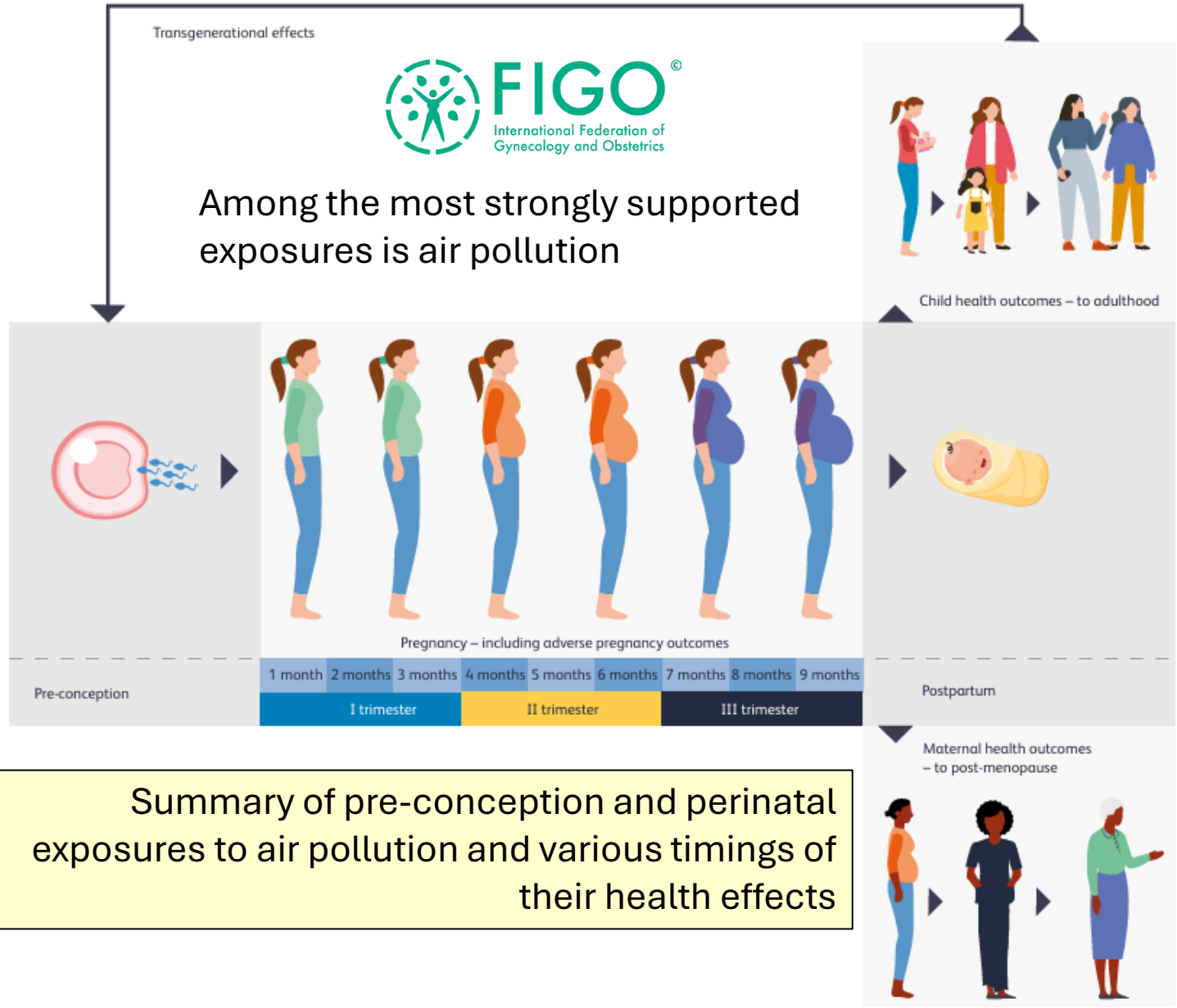


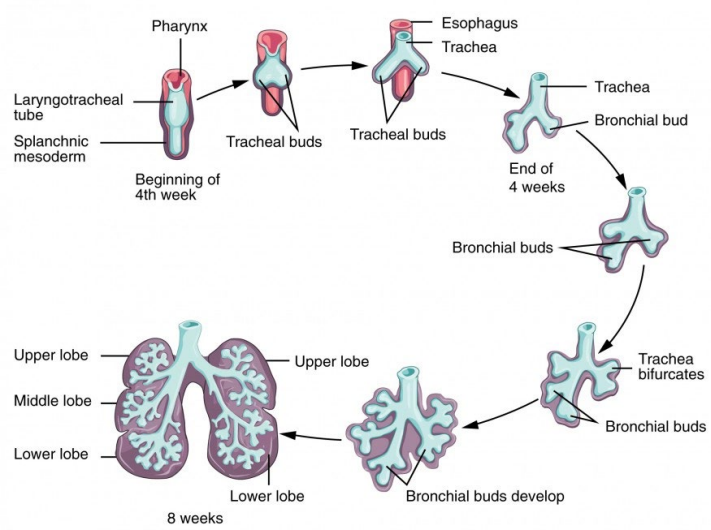
Summary of pre-conception and perinatal exposures to air pollution and various timings of their health effects

Impacts begin before conception and continue throughout pregnancy. Globally around 2.7 million low-birth-weight babies and 5.8 million pre-term babies each year are linked to $PM_{2.5}$ exposure.

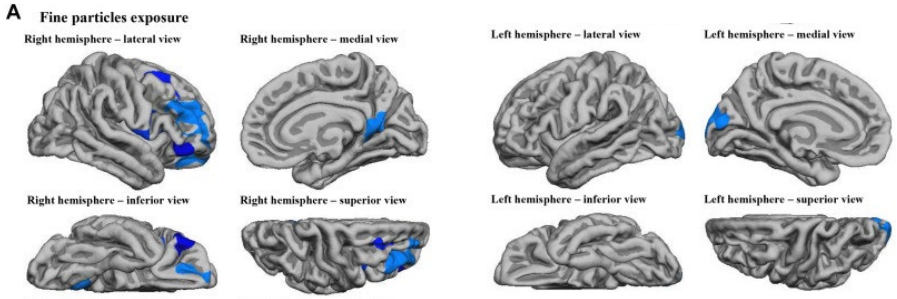
Royal College of Physicians

FIGO committee opinion: Environmental drivers of obstetric health and early childhood development. Int. J Gynaecol Obstet. 2025 Oct 1. doi: 10.1002/ijgo.70549

Foetal exposure affects the placenta, brain, lungs, liver, heart, and kidneys.



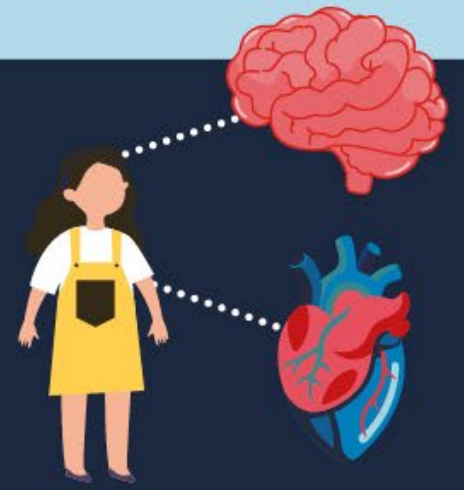
Differences in cortical thickness at 6–10 years of age associated with air pollution exposure during foetal life.



- **Impaired Lung development**: Multiple large-scale studies have shown that long-term exposure to air pollution in early life **adversely affects lung growth, even at relatively low concentrations**.

- Improvements in air quality linked to improved lung function development.

Children are vulnerable as they are developing their key protective systems. Effects include reduced lung growth, weakened immune systems, and reduced brain development.



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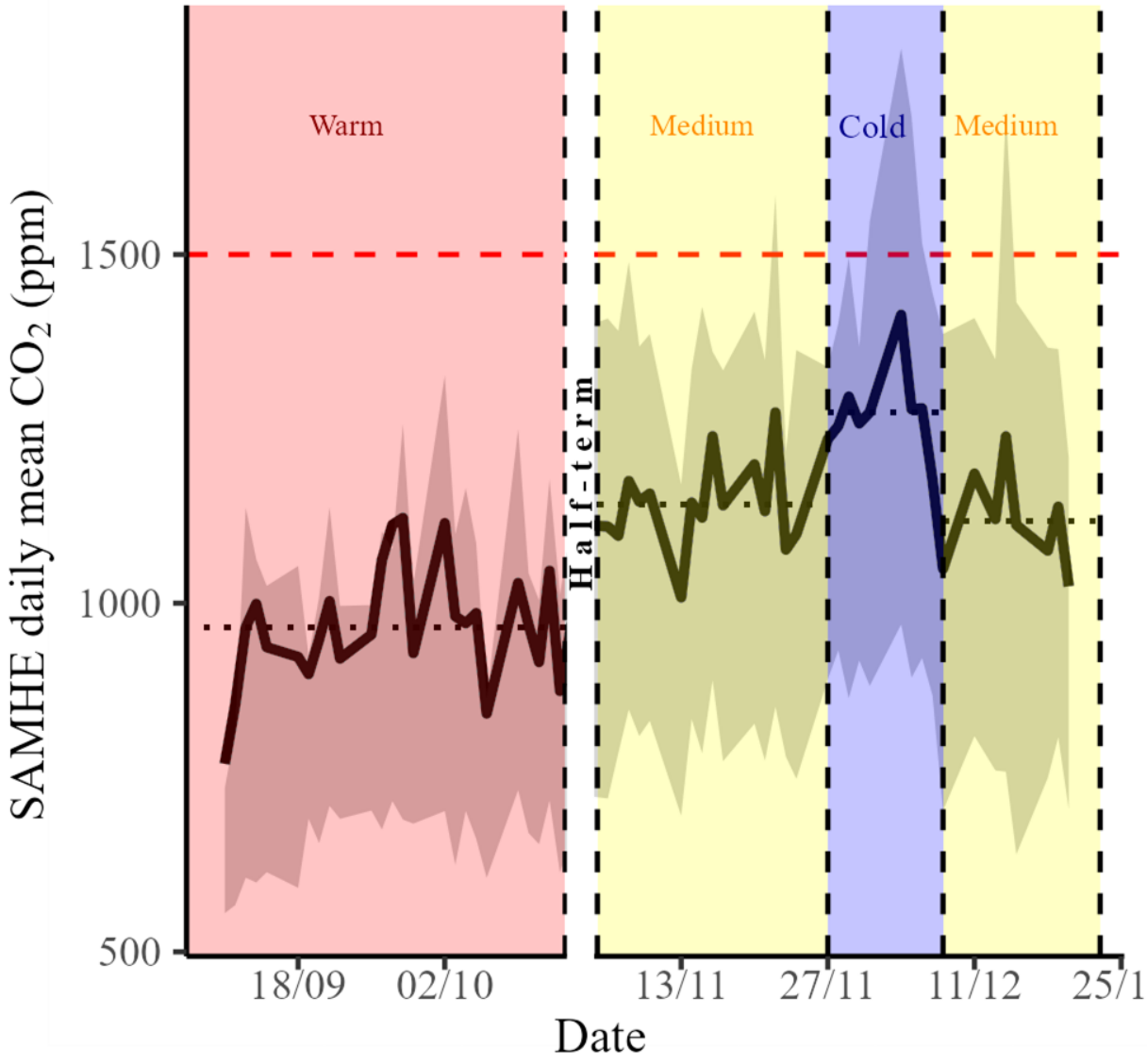
Ventilation and the weather

Elevated CO_2 in the classroom

causes fatigue, drowsiness, and reduced attention spans, which hinder learning and decrease standardized test scores in reading, writing, and mathematics.

(The relationships between classroom air quality and children's performance in school. Wargocki P et al. Build Environ. 2020; 173: 106749)

Recommendation: establish training classroom staff on air quality; provide monitors and encourage staff to use them

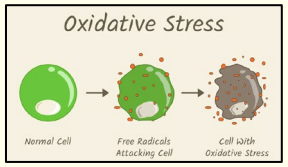


SAMHE
SCHOOLS' AIR QUALITY MONITORING FOR HEALTH AND EDUCATION

Henry Burridge, ICL

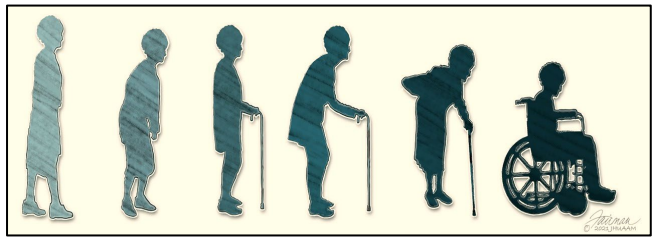
Air pollution worsens existing comorbidities and increases the risk of developing new ones

- Systemic inflammation and oxidative stress, making pre-existing conditions more vulnerable to acute events and progression.



- Directly contribute to development of various chronic conditions, including cardiovascular, respiratory diseases, diabetes, and neurological disorders.

- Air Pollution increases the risk of frailty (Jafari Z et al. Age and Ageing. 2025; 54: afaf129).



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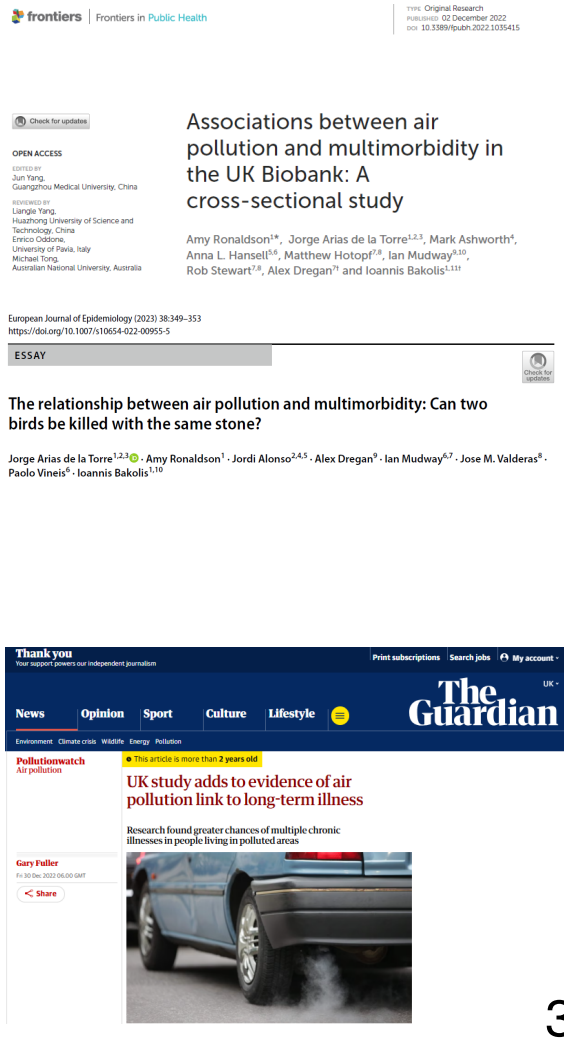
Is air pollution hiding in plain sight in the burden of chronic diseases that affect so many?


frontiers | Frontiers in Public Health

TYPE Original Research
PUBLISHED 02 December 2022
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Associations between air pollution and multimorbidity in the UK Biobank: A cross-sectional study

Amy Ronaldson[1*], Jorge Arias de la Torre[1,2,3], Mark Ashworth[4], Anna L. Hansell[5,6], Matthew Hotopf[7,8], Ian Mudway[9,10], Rob Stewart[7,8], Alex Dregan[7†] and Ioannis Bakolis[1,11†]

European Journal of Epidemiology (2023) 38:349–353
https://doi.org/10.1007/s10654-022-00955-5

ESSAY

Check for updates

The relationship between air pollution and multimorbidity: Can two birds be killed with the same stone?

Jorge Arias de la Torre[1,2,3] · Amy Ronaldson[1] · Jordi Alonso[2,4,5] · Alex Dregan[9] · Ian Mudway[6,7] · Jose M. Valderas[8] · Paolo Vineis[6] · Ioannis Bakolis[1,10]

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Pollutionwatch
Air pollution

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UK study adds to evidence of air pollution link to long-term illness

Research found greater chances of multiple chronic illnesses in people living in polluted areas

Gary Fuller

Fri 30 Dec 2022 06.00 GMT

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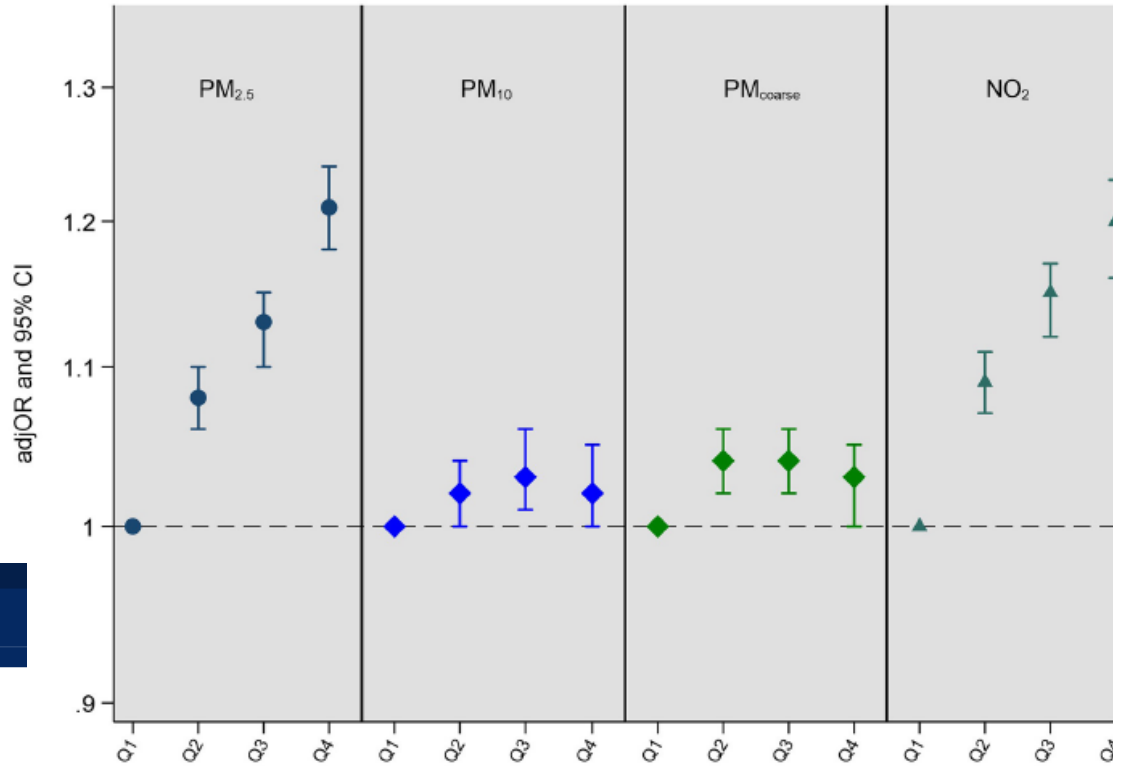
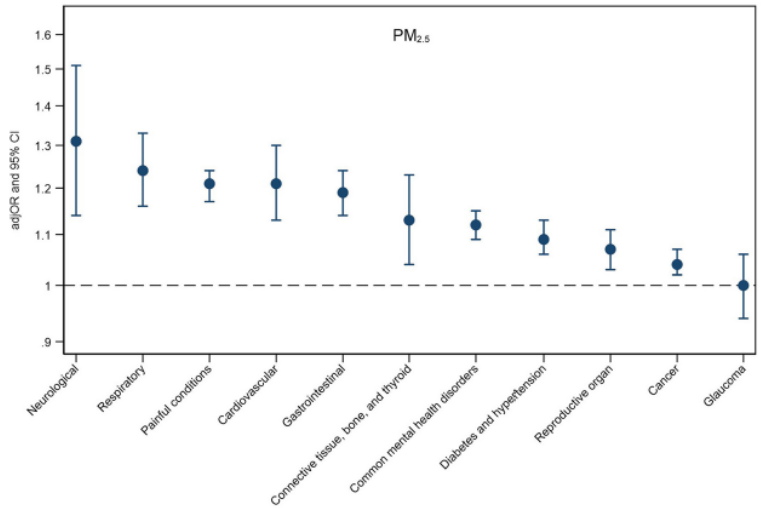
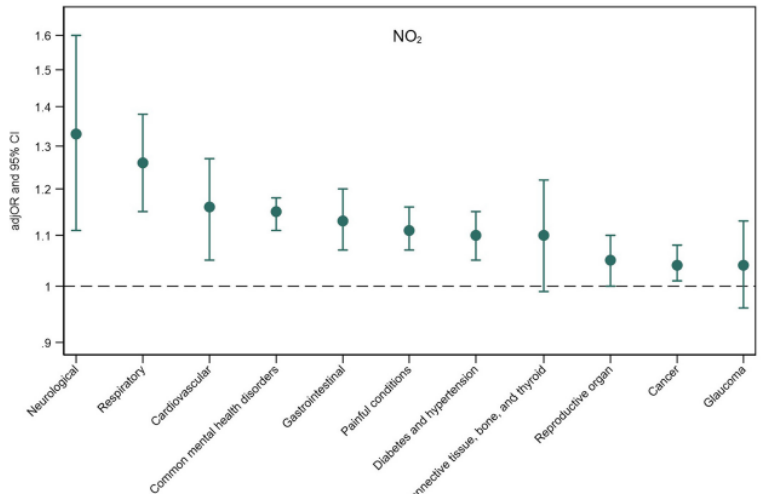






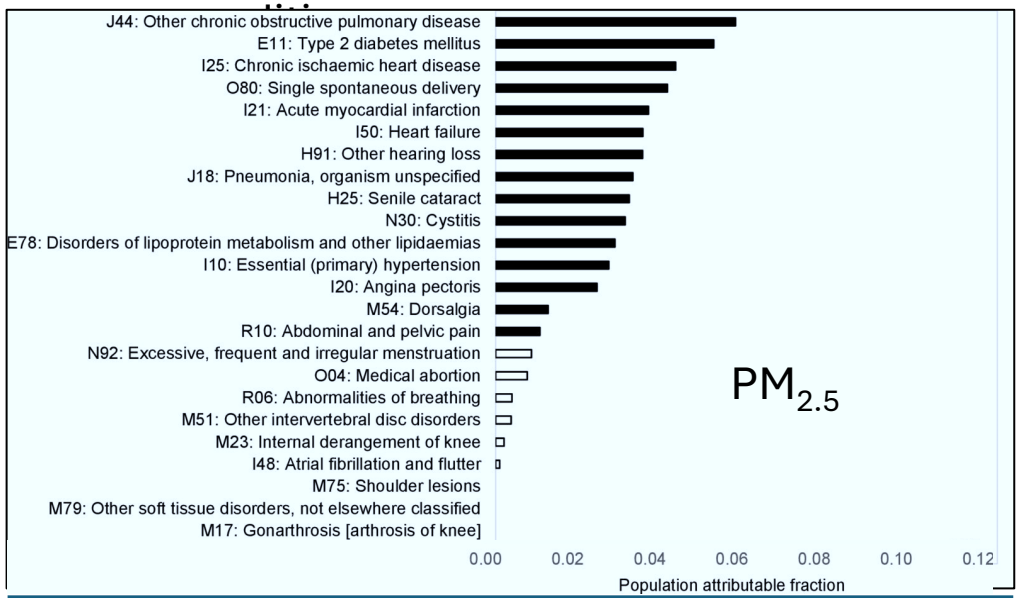
360,000 people aged 40-69, 43% had 2 or more chronic illnesses

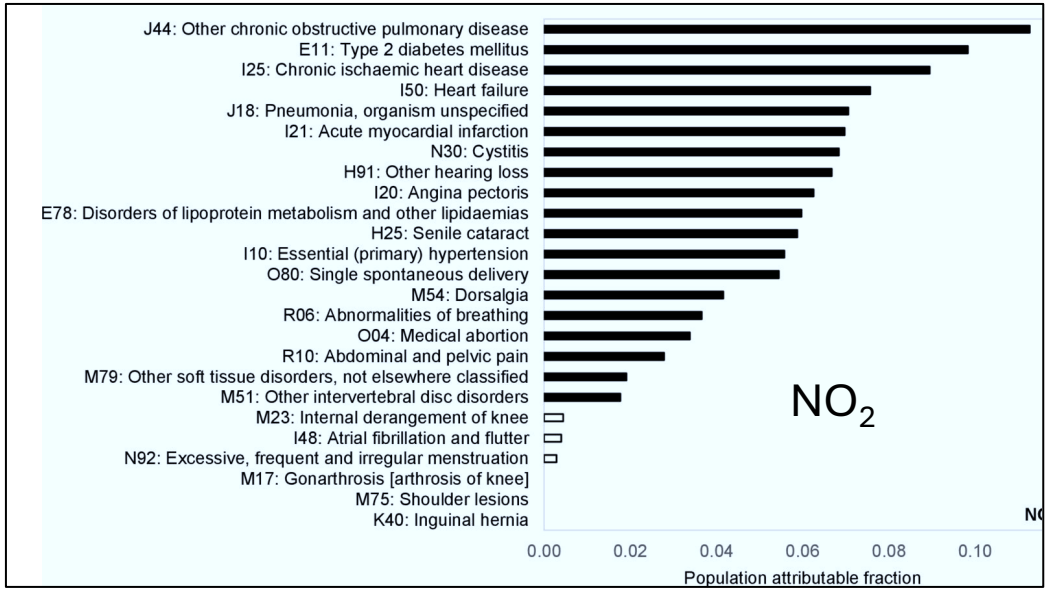
Air pollution and human health: a phenome-wide association study.

Hegelund ER et al. BMJ Open 2024; 14: e081351.

- 3,111,988 individuals aged ≥30 years who lived in Denmark on 1st Jan 2000.
- Residential addresses geocoded to link place of residence to air pollution level.
- Long-term exposure $PM_{2.5}$ and NO_2 positively associated with the onset >700 health conditions (i.e., >80% of registered health conditions) after correction for multiple testing.

Associations of long-term exposure to $PM_{2.5}$ and NO_2 with the top 25 prevalent

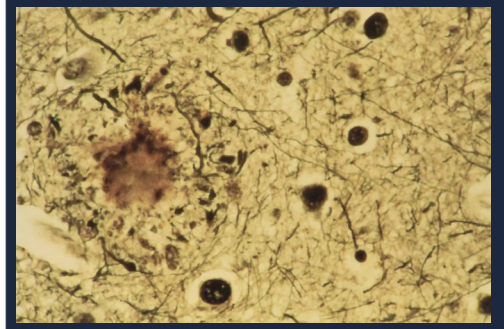




Ambient Air Pollution and the Severity of Alzheimer Disease Neuropathology.

Kim B, et al. JAMA Neurol. 2025 Sep 8:e253316.

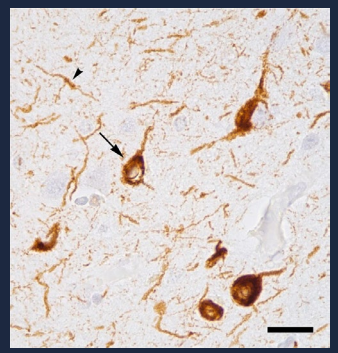
- Each 1μg/m^3 annual increase in $PM_{2.5}$ is linked to 19% higher odds of having more severe Alzheimer's.
- About 63% of the link between air pollution and dementia severity is explained by Alzheimer's-related brain changes, according to the researchers.
- This study shows that air pollution doesn't just increase the risk of dementia — it makes Alzheimer's disease worse.



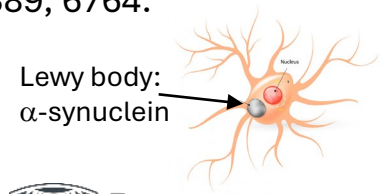
Amyloid plaque in Alzheimer's

Policy development must respond to new evidence on its health harms and impacts, including on brain health and dementia.

Neurofibrillary tangles of Tau in Alzheimer's



Zhang, X. et al. (2025). Lewy body dementia promotion by air pollutants. Science, 389, 6764.



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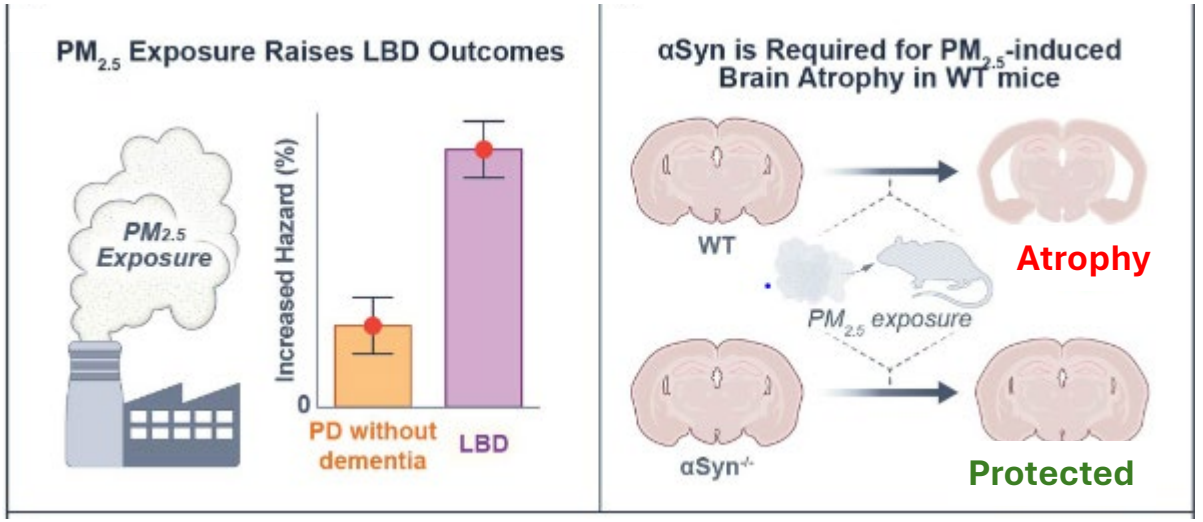

Health inequalities

- In 2023, individuals living in the **20% most deprived** areas in England experienced **8% higher average PM2.5** concentrations than those in the 20% least deprived
- **Vulnerable groups** or those living in more **deprived areas** are more likely to be **susceptible** to the harms of air pollution because they are more likely to have worse health generally
- They are **less likely to benefit from interventions** and **less likely to be main contributors** of air pollution
- Policy action should account for **health, risk and economic impact to deliver equitable health gains**

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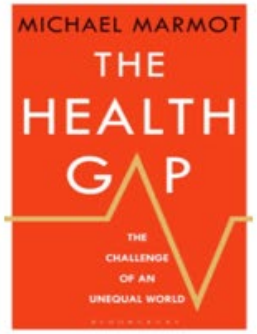
Sir Michael Marmot

INSTITUTE of HEALTH EQUITY



Why treat people and send them back to the conditions that made them sick?

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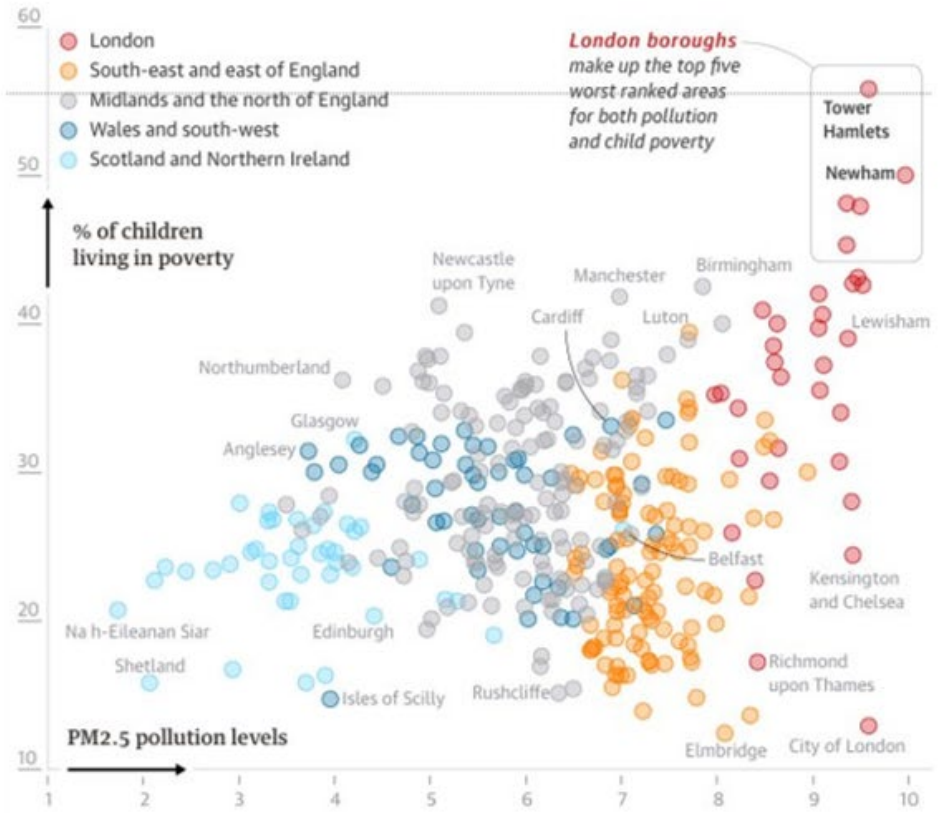
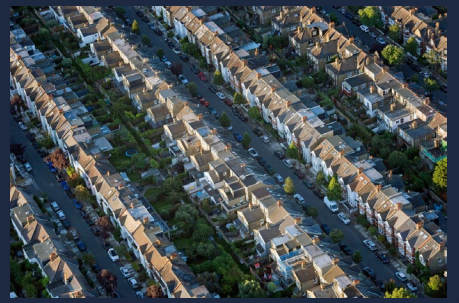
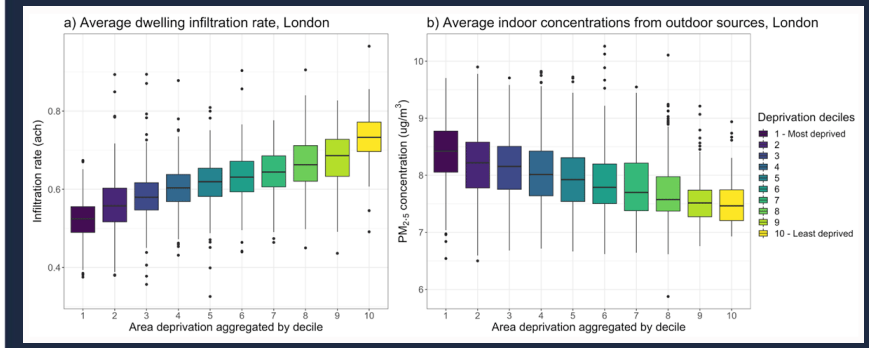


Guardian graphic. Source: Labour analysis of Defra, End Child Poverty coalition data. Note: child poverty data is after housing costs. Pollution is population-weighted annual mean PM2.5 concentration for 2020 (micrograms per cubic metre)



In 2023, people living in the 20% most deprived areas experienced 8% higher average $PM_{2.5}$ concentrations than those in the 20% least deprived.

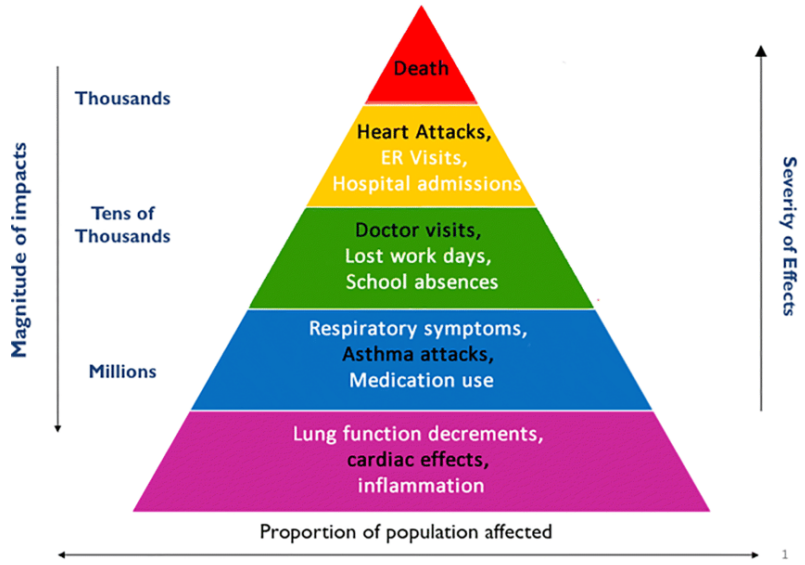
Systemic inequalities in indoor air pollution exposure in London, UK



The cost of air pollution

	2019	2040
Core effects		
Healthcare	2.6	1.6
Productivity	0.8	0.4
Utility	23.6	17.1
Core total	**27.0**	**19.1**

Utility - the advantages that come from being well and not experiencing ill health



In 2019, air pollution was estimated to have an economic cost of

£27 billion

per year in core healthcare costs and productivity losses, and may be as much as £50 billion when wider impacts, such as dementia, are accounted for.

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Policies fit for the future

- Governments must recognise air pollution as a key public health issue and take **increasingly ambitious action** to reduce people's exposure
- Identify robust pathways to **WHO's 2021 global air quality guideline** levels
- Air quality limits and **targets must be regularly reviewed** with more effective approaches considered
- All types of air pollution need to be **tackled at source**
- Government should deliver a UK-wide **public health campaign** on air pollution
- **Engage the public** in the development of air quality policies

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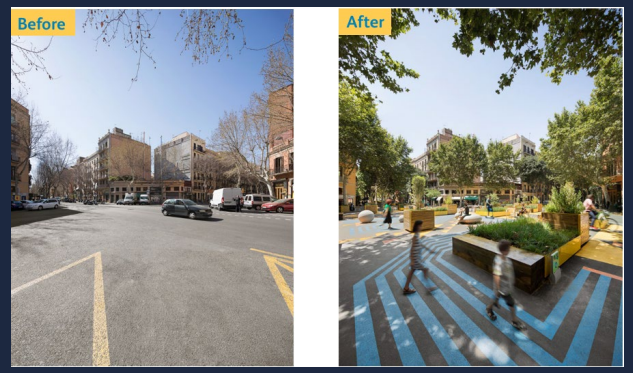
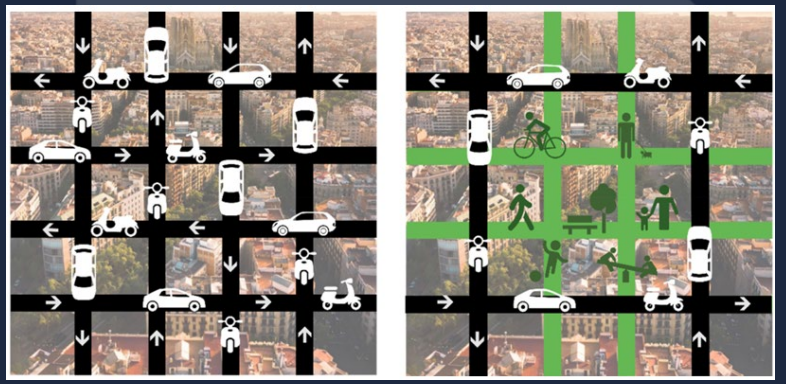
Policies fit for the future

- Take a **health in all policies approach** to the built environment and delivery of local services
- Improve the provision of **public transport** and infrastructure for **active travel**
- Develop an **indoor air quality strategy**
- Focus action on areas with high levels of air pollution and **greatest vulnerability** to the health harms
- **Coordinate action** from bodies with responsibility for air quality, public health, education, social and healthcare
- Air quality needs to be **integrated into Net Zero policy**



Effective urban planning and space design can reduce air pollution.



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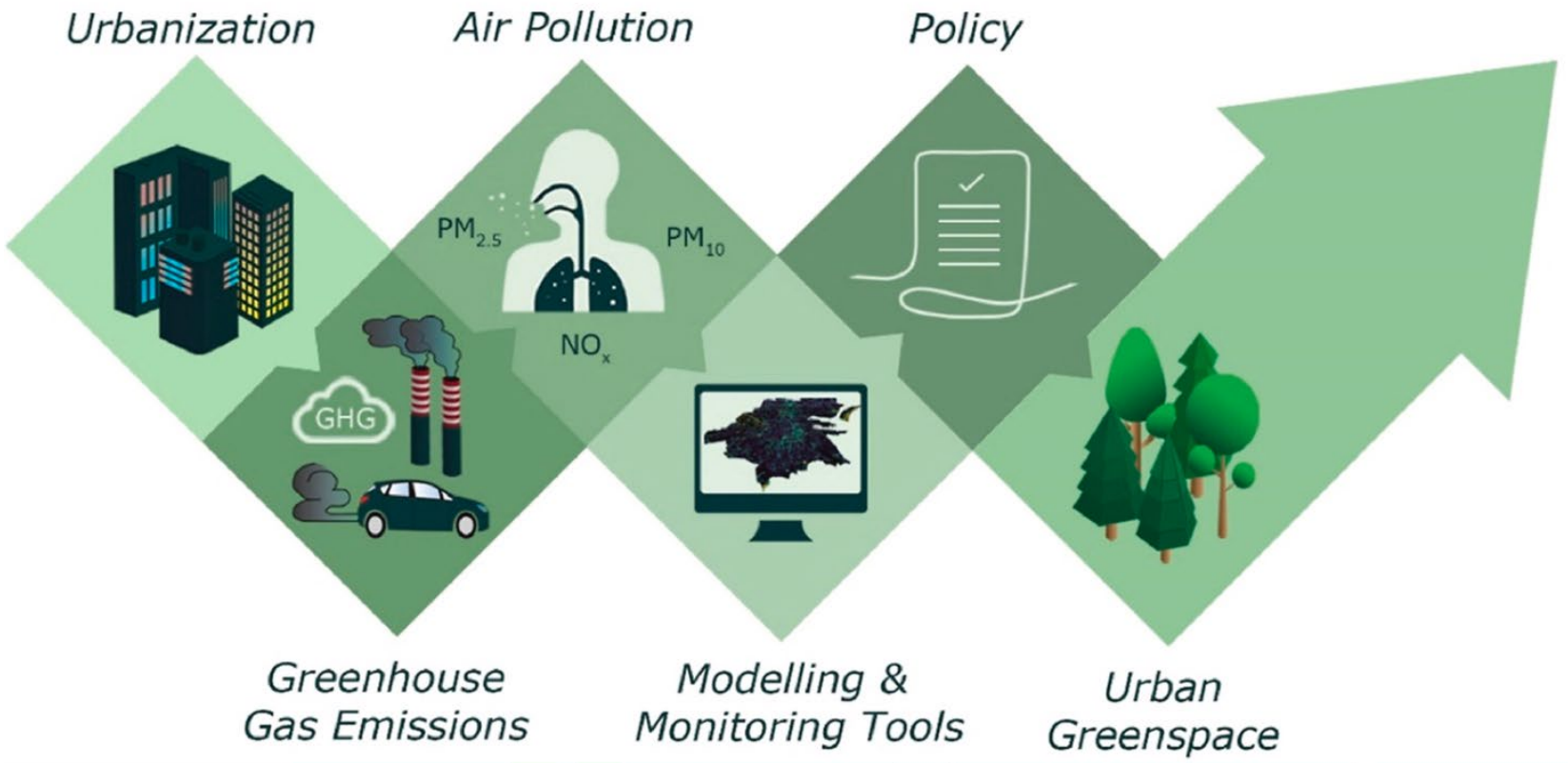
Towards Sustainable and Net-Zero Cities



Net zero policies are an opportunity to deliver co-benefits that improve air quality and address climate change.

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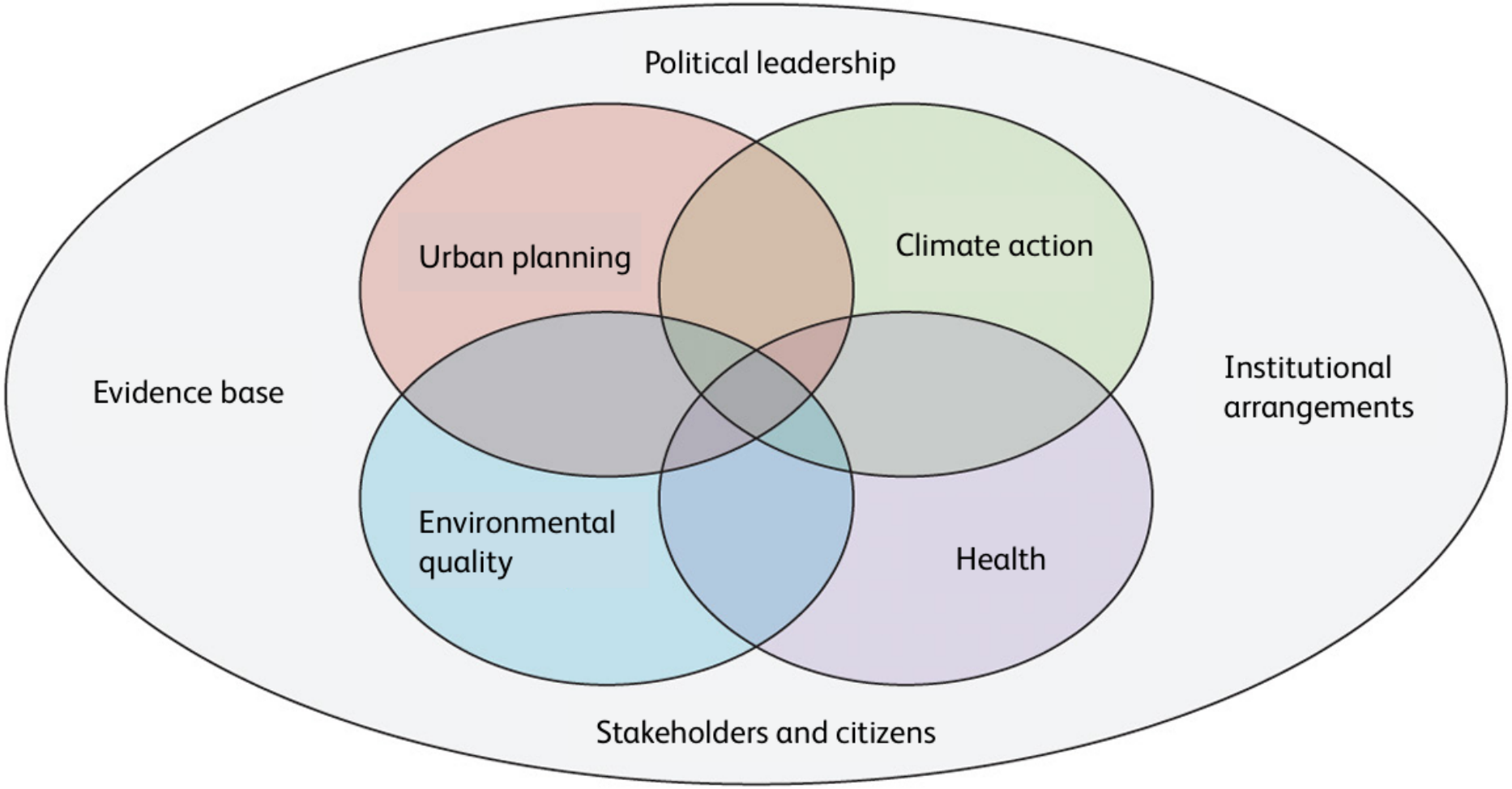
Close collaboration between urban planning, environment, climate action and health is essential for a transitional and healthy change.

Nieuwenhuijsen MJ. Climate crisis, cities, and health. Lancet 2024;404:1693–700.



Thank you

https://www.ukcleanair.org/