NHS action towards clean air, climate change and health

UK Clean Air Programme Regional Workshop

Delivered in partnership with West Midlands Combined Authority

Tuesday 13th May 2025

University of Birmingham Medical School

contact@ukcleanair.org
https://www.ukcleanair.org/
@UKCleanAir
@UKCleanAir

environment@wmca.org.uk
https://www.wmca.org.uk/
@WestMids_CA
@WestMidsCA

Welcome and Overview

Dr Suzanne Bartington
Clinical Associate Professor in Environmental Health
University of Birmingham | UKRI Clean Air Champion

Clean Air Programme
West Midlands Combined Authority
Met Office
UK Research and Innovation

Welcome and Introduction

Dr Jackie Homan
Head of Environment, West Midlands Combined Authority

Clean Air Programme
West Midlands Combined Authority
Met Office
UK Research and Innovation

Keynote Lecture

Air pollution's insidious impact on health; why we need to act now

Professor Sir Stephen Holgate
UKRI Clean Air Champion | University of Southampton

Clean Air Programme
West Midlands Combined Authority
Met Office
UK Research and Innovation

West Midlands Combined Authority

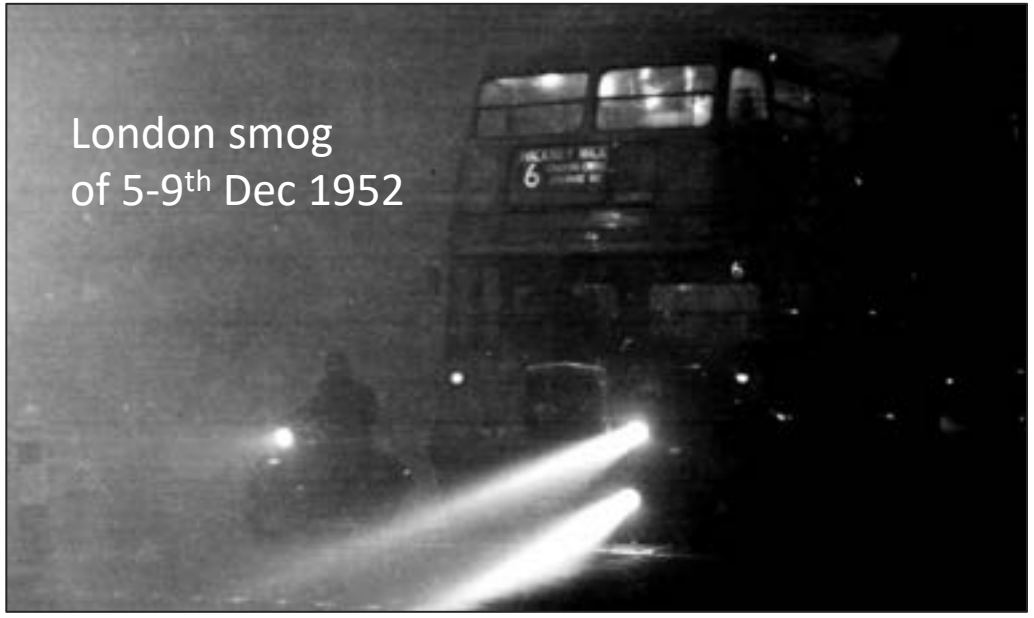
Clean Air Programme

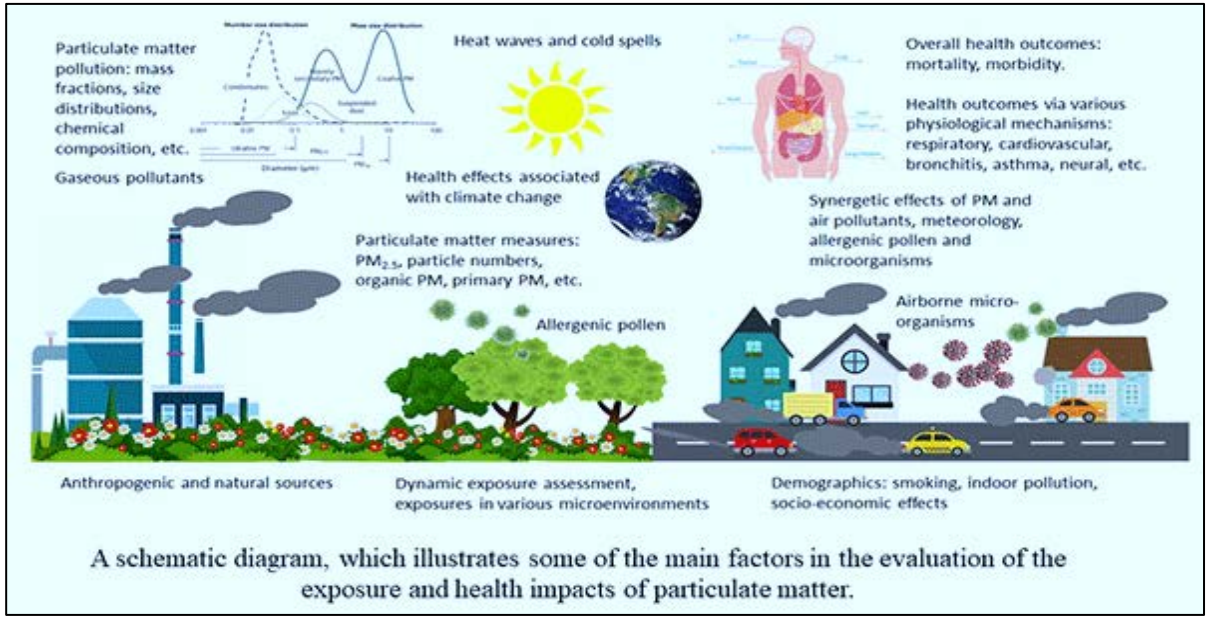
Air pollution's insidious impact on health: Why we need to act now.

Stephen T Holgate

University of Southampton

MRC Clinical Professor of Immunopharmacology, UKRI Clean Air Champion and Special Advisor to the RCP on Air Quality





A schematic diagram, which illustrates some of the main factors in the evaluation of the exposure and health impacts of particulate matter.

Air quality dependencies and basis for Clean Air systems analysis framework

Failure of engagement and ownership of the health problems by medical community

Communication barriers between physical and biological/health scientists

Lack of public understanding

Little motivation for behaviour change

X X X X

Feedbacks

Global/Local Weather

- Weather forecast
- Multi year weather analysis
- Nested finer scale local weather models
- Climate change

Emissions

- Anthropogenic and biogenic
- Temporal and spatial variation
- Street, local, national, regional, global
- Observations

Air Quality

- Street to global
- Hourly to climatic variation
- Gas and aerosol chemistry, deposition, etc
- Weather and climate feedbacks
- Observations

Impacts

- Hazard x Vulnerability x Exposure
- Economic cost/benefit
- Health and Environmental
- Measurement of impact/mitigated impact

Action

- Long term policy e.g. energy mix, vehicle, clean air zones, international
- Tactical e.g. health advice, industrial and traffic management, individual choice

X

Lack of interfaces to promote innovations

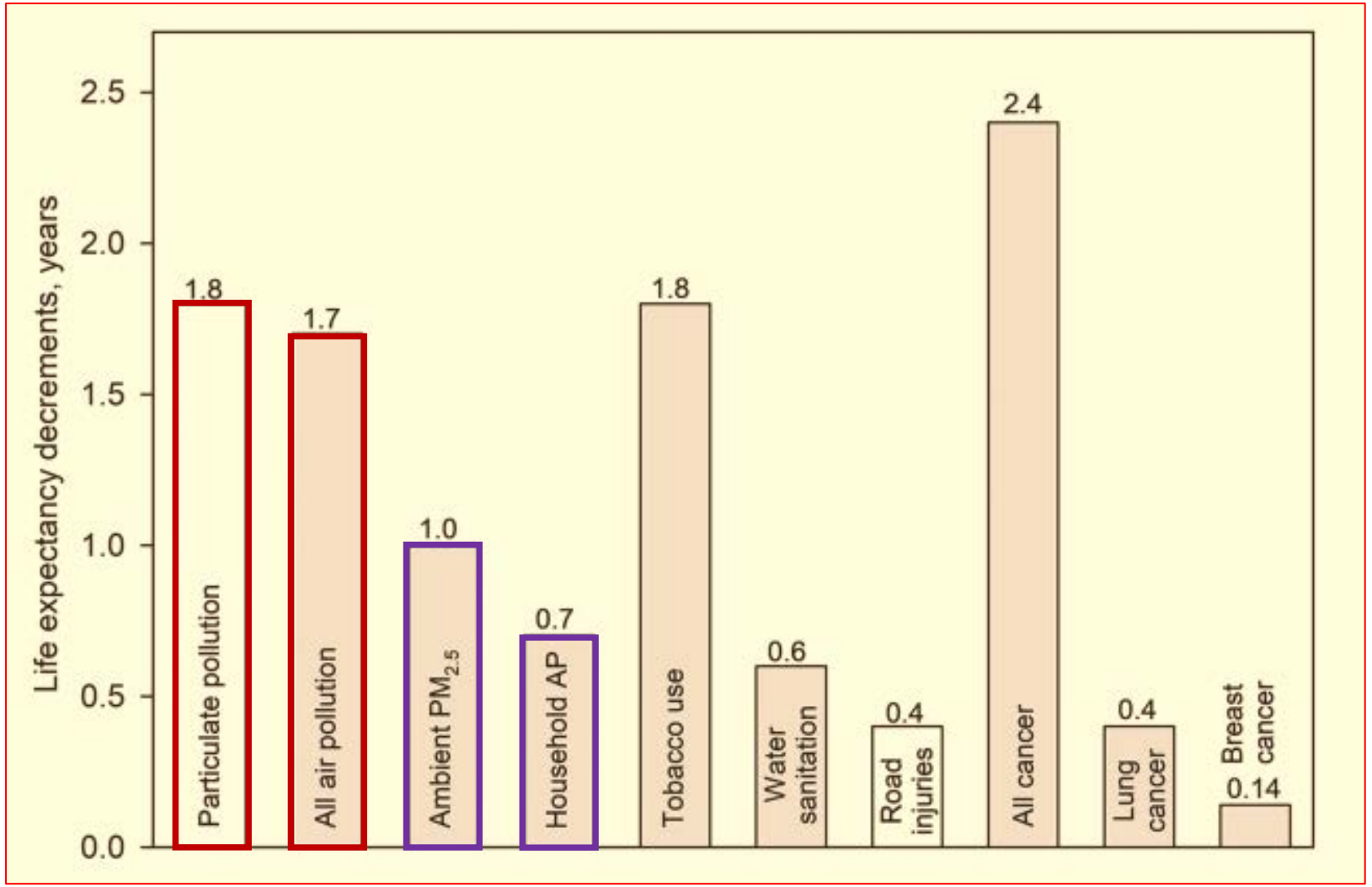
X

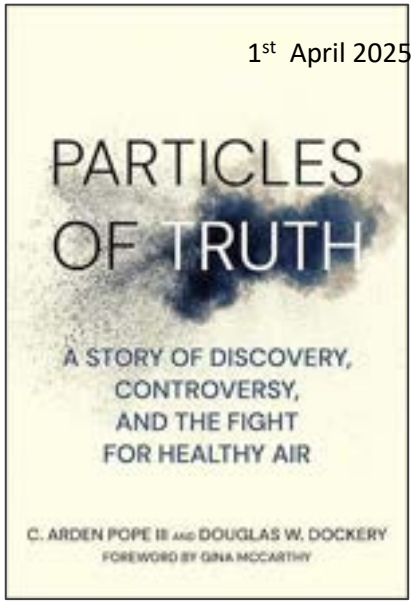
Industry/economic pushback

Capability/Linkages limited, fragmented and not aligned: Street ⟺ Global a particular challenge

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

Worldwide, accounts for 7 million premature deaths/yr
UK: 27-43,000 deaths/yr



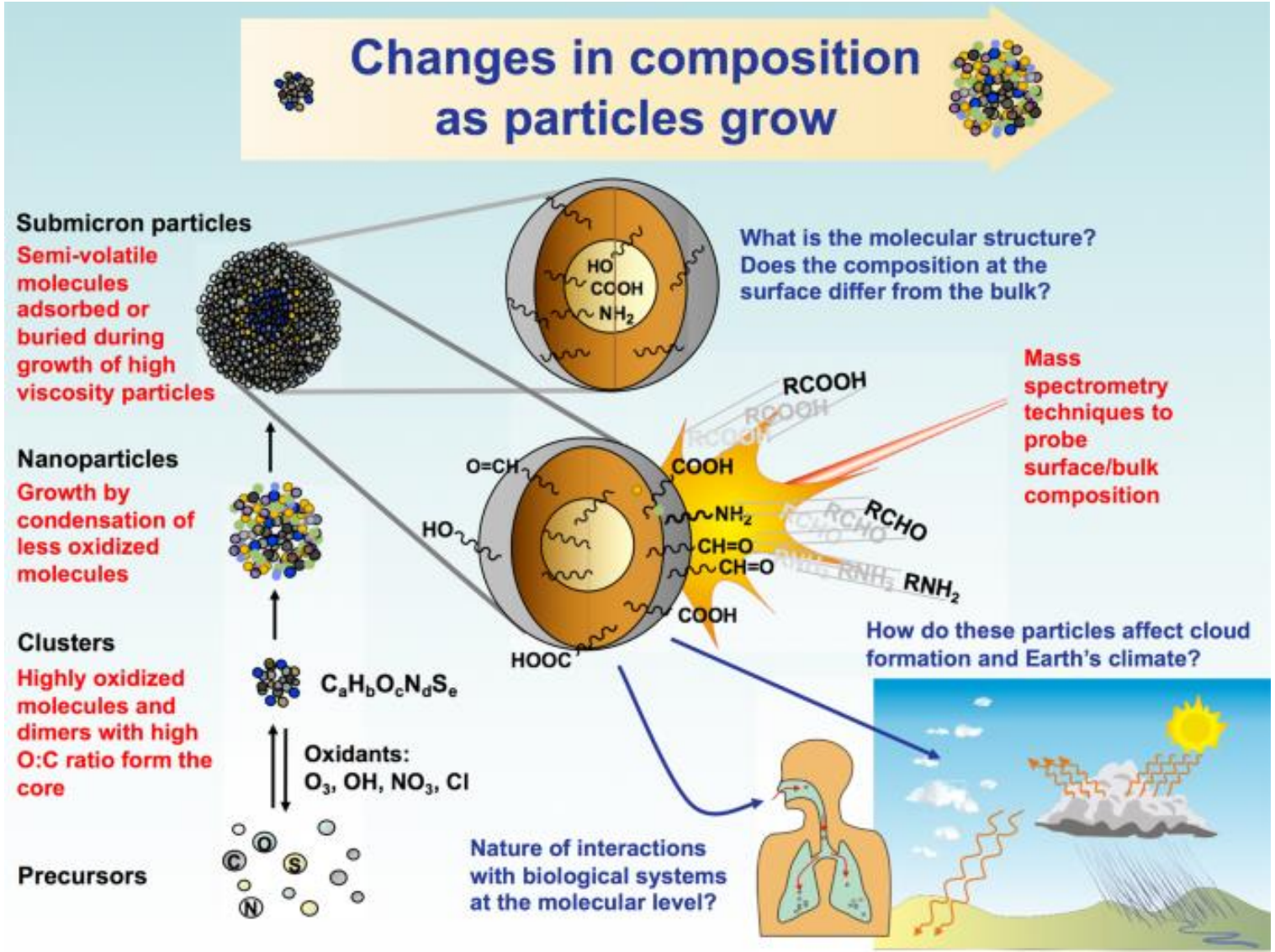


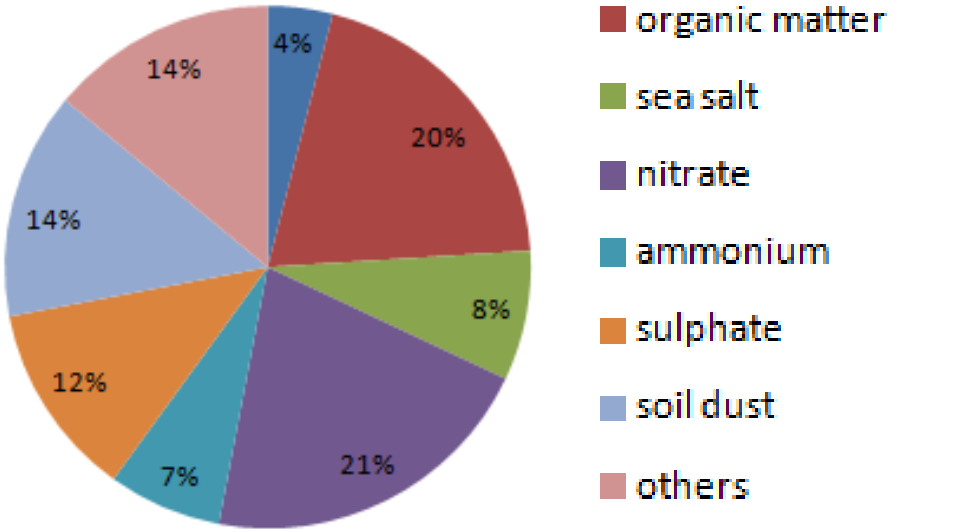
Air pollution has officially overtaken high blood pressure and smoking as the leading contributor to global disease.
RCPCH Sept 19th, 2024

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

Open questions on the chemical composition of airborne particles.

Finlayson-Pitts, B.J. et al. Commun Chem. 2020; **3:** 108.



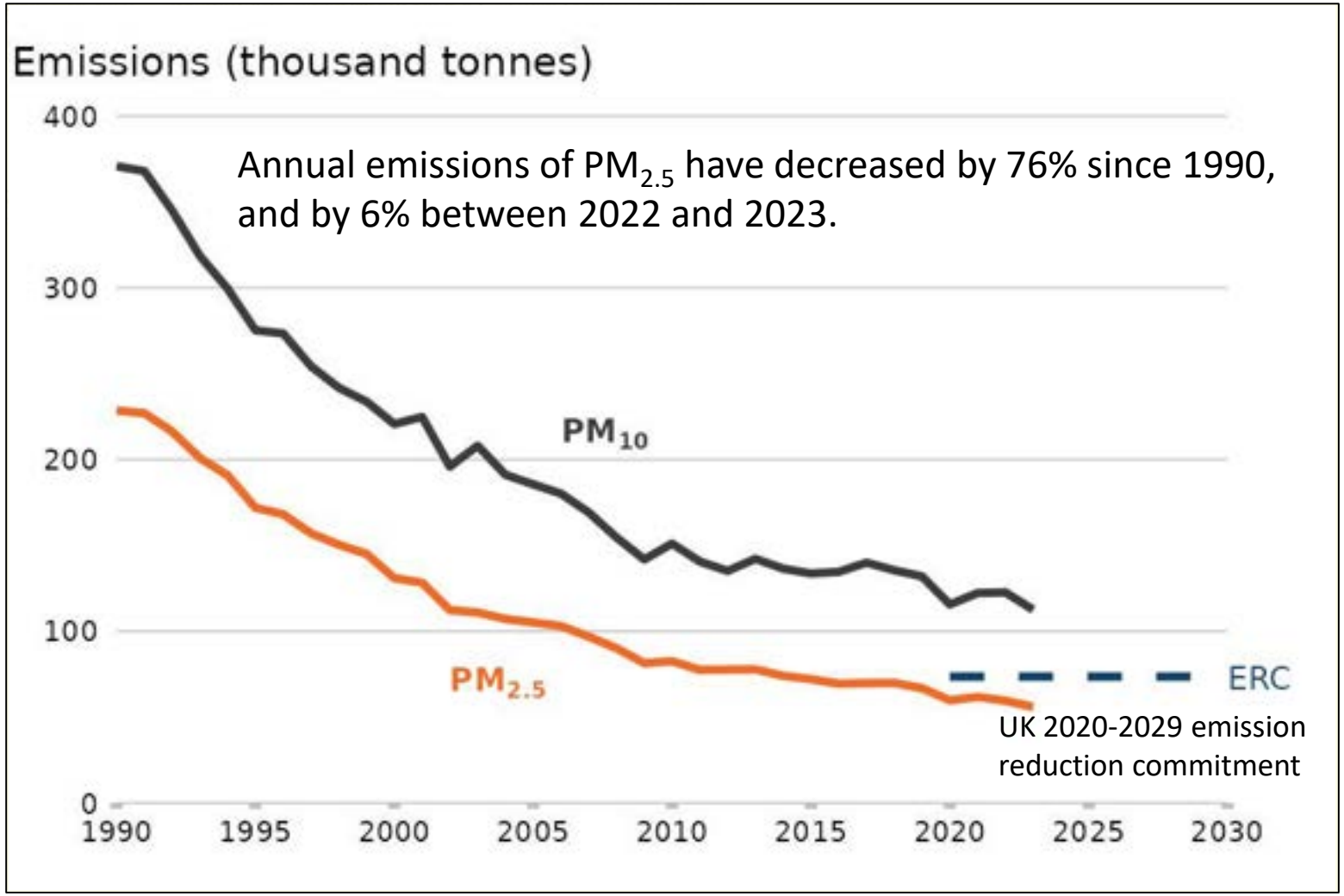


Trojan Horse

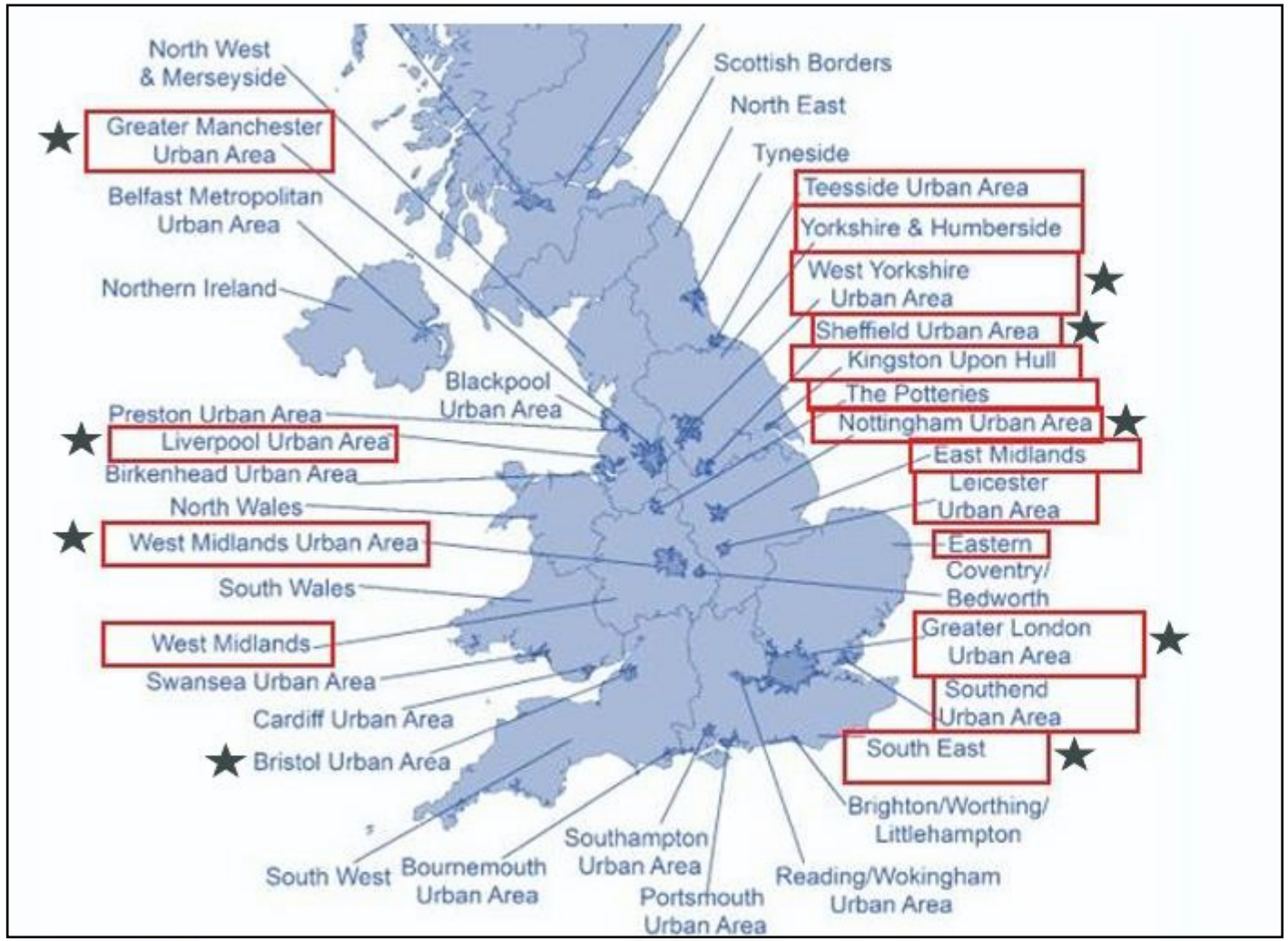
Emissions of air pollutants in the UK from National Emissions Inventory

Trends in annual UK emissions of particulate matter (PM_{10} and $PM_{2.5}$), nitrogen oxides (NOx), ammonia NH_4, non-methane volatile organic compounds (NMVOCs) and sulphur dioxide, 1970–2022 (1980–2022 for ammonia).

- The index line shows the level of annual emissions if they had remained constant at 1970 levels (1980 for NH_4).
- The values of the y-axis represent the percentage of 1970 levels (1980 for NH4).



Regional breakdown: A more complex reality



18 zones that exceeded limit value (10ug/m3) for annual mean PM2.5

★ 9 zones that exceeded limit value (40ug/m3) for annual mean NO2

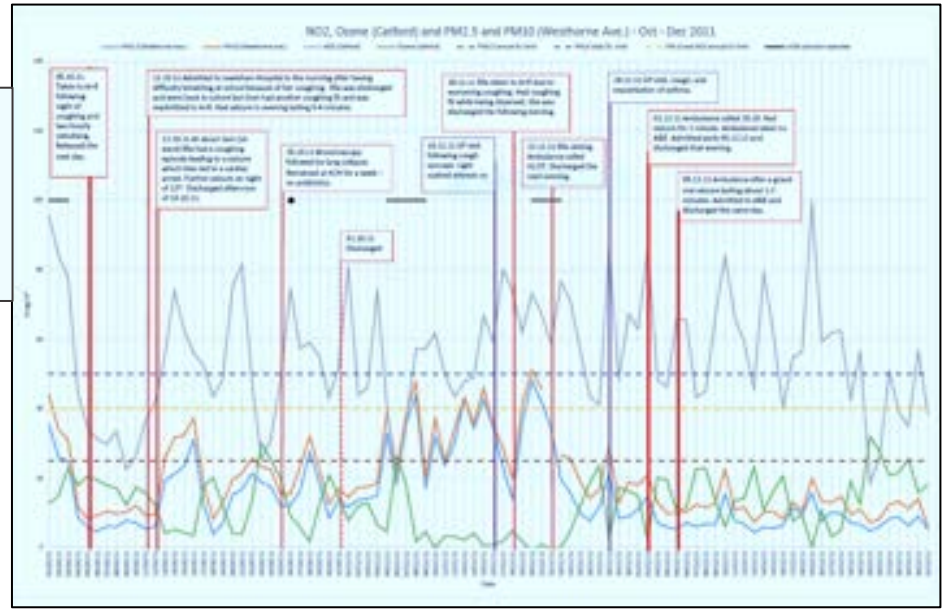
Regional exceedances of air quality targets

- The UK is divided into 43 zones for air quality assessment.
- In 2023, 18/43 zones exceeded the UK PM2.5 annual mean target of 10ug/m3.
- In 2023, 9/43 zones still exceeded the UK NO2 annual mean legal limit of 40ug/m3.
- Zones that exceeded limit values for both annual mean PM2.5 and NO2:
  1. Greater London
  2. West Midlands Urban Area
  3. Greater Manchester
  4. West Yorkshire
  5. Sheffield
  6. Liverpool
  7. Nottingham
  8. South East.
- 7/8 zones listed above are located within Combined Authorities (the exception is South East). It is therefore clear that the most polluted areas of the UK are the main urban areas

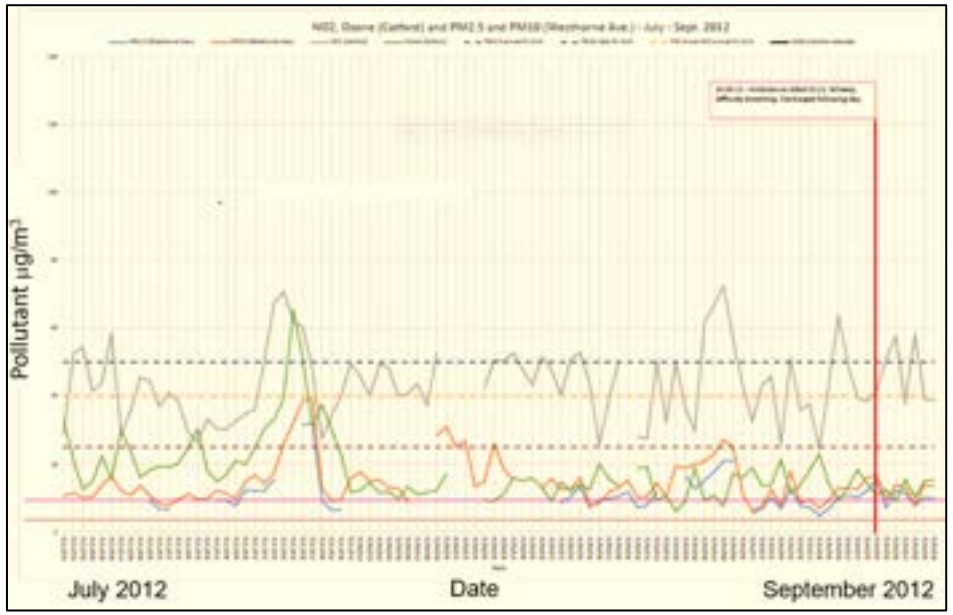
Ella Roberta Kissi-Debrah 2004-2013

Between 2010 and 2013 had over 30 emergency hospital admissions between first diagnosis of asthma and her death

WINTER



SUMMER



The Standard

Daniel Omahony
20 February 2017

NEWS | LONDON

London's air was the 'silent killer' of my daughter, claims mother

Record of Inquest

Following an Inquest opened on the 17 December 2019, And an inquest hearing at Main on the 30 November 2020 heard before Philip Barlow in the coroner's area for London Inner South ,

The following is the record of the inquest (including the statutory determination and, where required, findings).

1. Name of Deceased (if known)

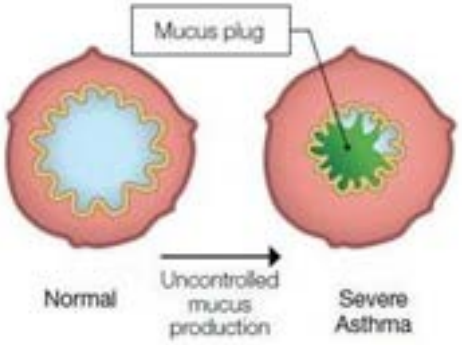
Ella Roberta ADOO KISSI-DEBRAH

2. Medical cause of death

1a Acute Respiratory Failure

1b Severe Asthma

1c Air Pollution exposure



In a landmark case, H.M. Assistant Coroner for Inner South London, Philip Barlow, has found that air pollution was a contributory cause of illness and death.

This finding will have far-reaching consequences "*for other people and other cases*" as acknowledged by the Coroner, and once again highlights the need for further action from governments around the world to reduce dangerous levels of air pollution. Issued a Prevention of Future Deaths Report.

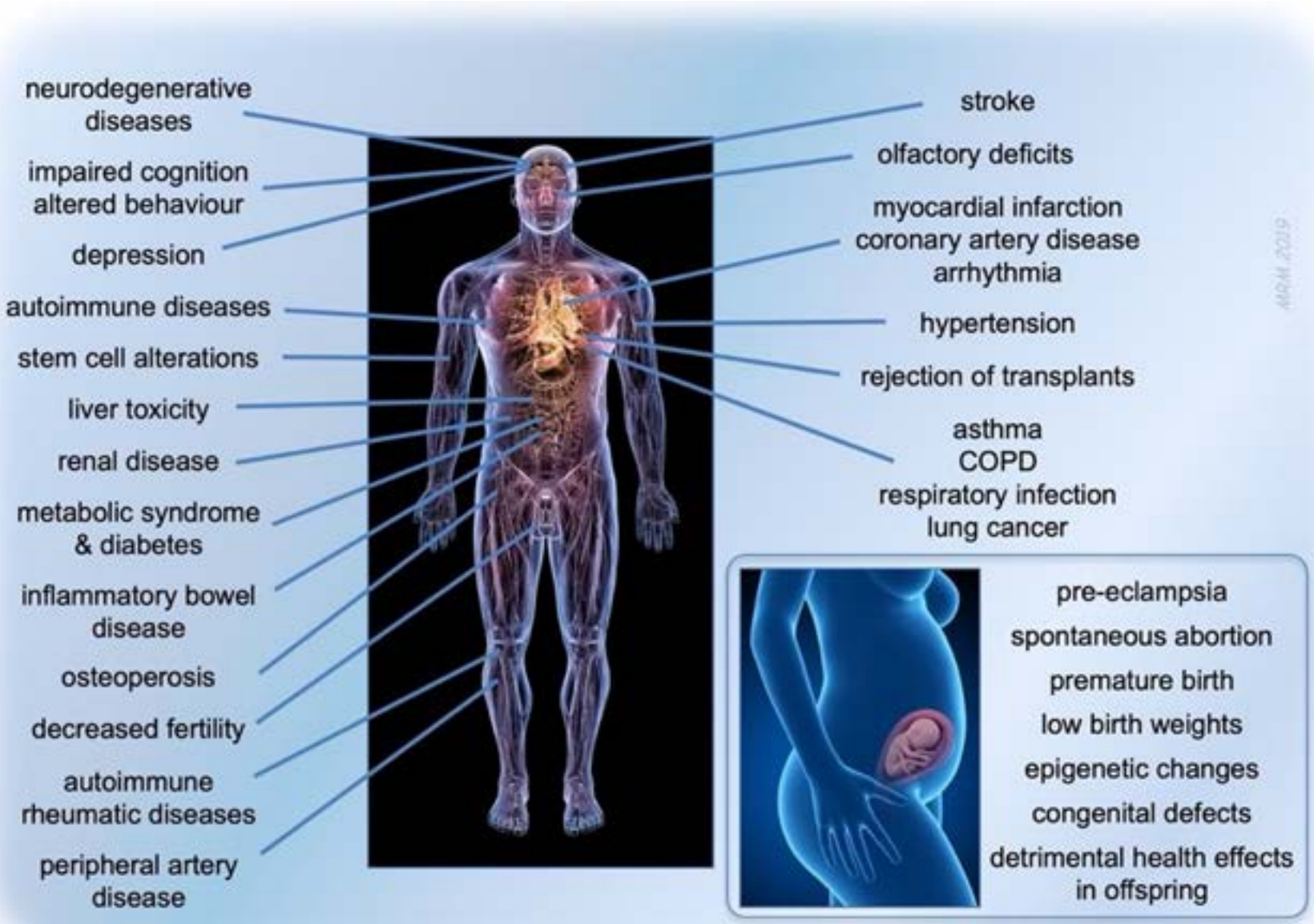
Touching on the Death of Ella Kissi-Debrah - REGULATION 28: REPORT TO PREVENT FUTURE DEATHS April 21st 2021, The Assistant Coroner Philip Barlow

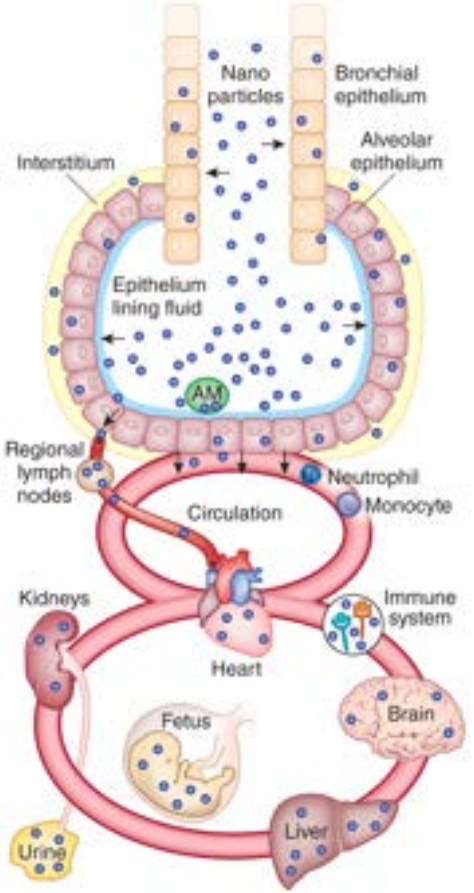
There was no dispute at the inquest that atmospheric air pollution is the cause of many thousand premature deaths every year in the UK. Delay in reducing the levels of atmospheric air pollution is the cause of avoidable deaths.

1. **Legally binding targets based on WHO guidelines** would reduce the number of deaths from air pollution in the UK .
2. **Greater awareness would help individuals reduce their personal exposure to air pollution** needs to be addressed by national as well as local government.
3. **Adverse effects of air pollution on health are not being sufficiently communicated to patients and their carers by medical and nursing professionals**.

Scientific research and the creation of evidence is the reason why we now realise how damaging air pollution is to human development and health. Research in all its forms is highly influential in driving ambitious new polices to clean up the air we all depend upon for life.

Exposure to air pollution has detrimental effects throughout the body that impairs the functioning of organs and promotes disease.

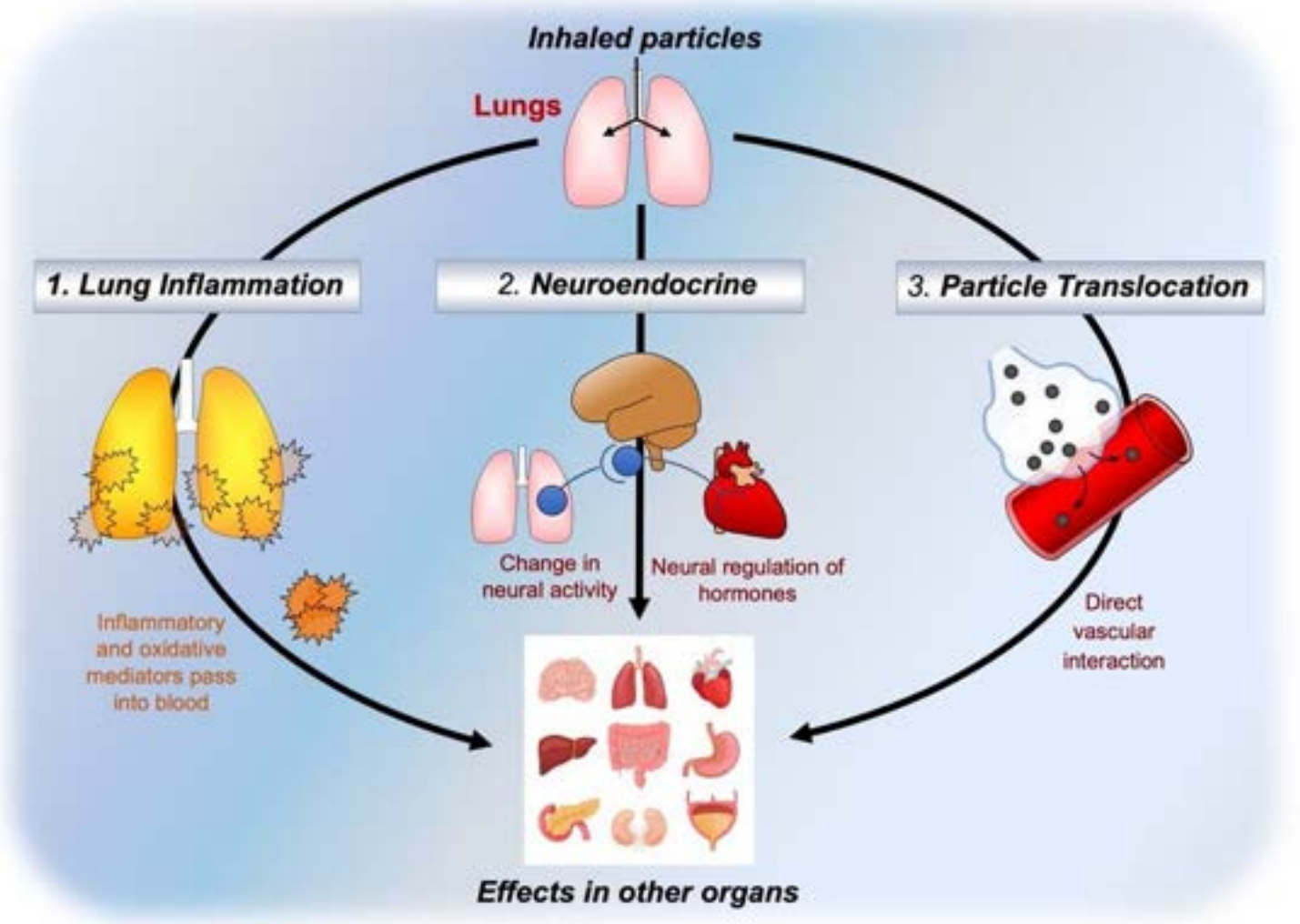


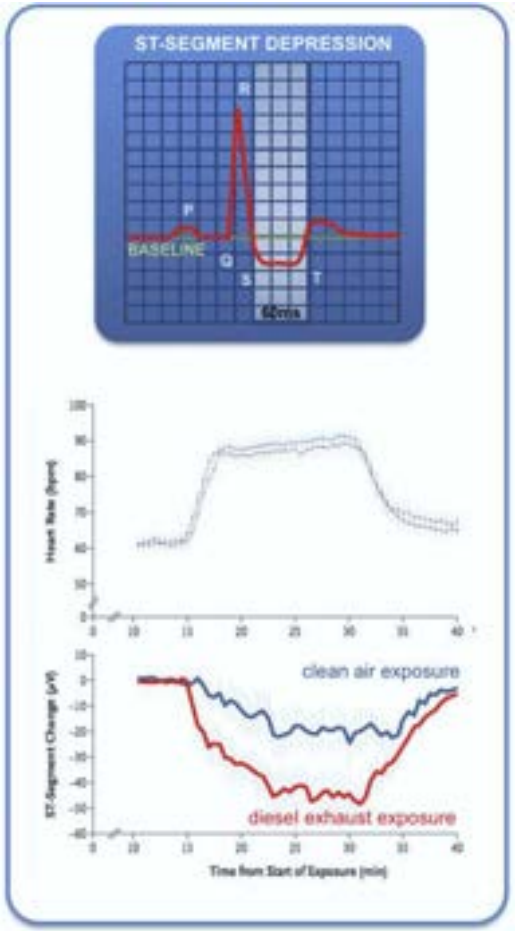


Small particles with along with their pollutant chemical “cargo” circulate both freely and inside blood cells and deposit in all tissues.

Three key biological mechanisms linking inhalation of pollutants to effects in systemic organs.

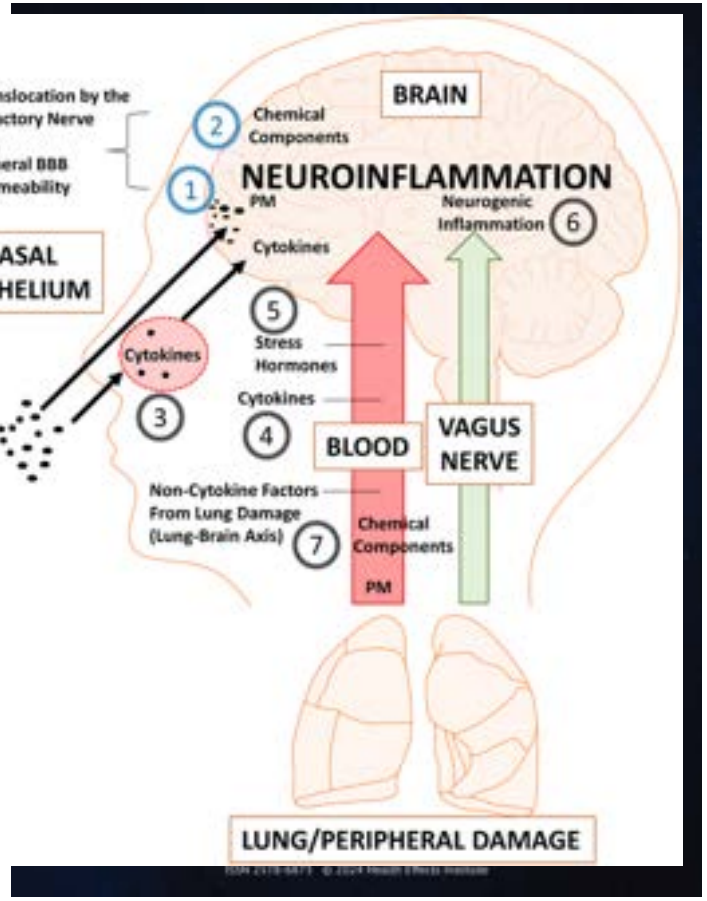
A 2h exposure to 300 µg/m^3 Diesel Exhaust in patients with ischemic heart caused a 2-fold increase in S-T segment depression induced in an exercise test.





ST depression represents myocardial ischemia

World Health Organization

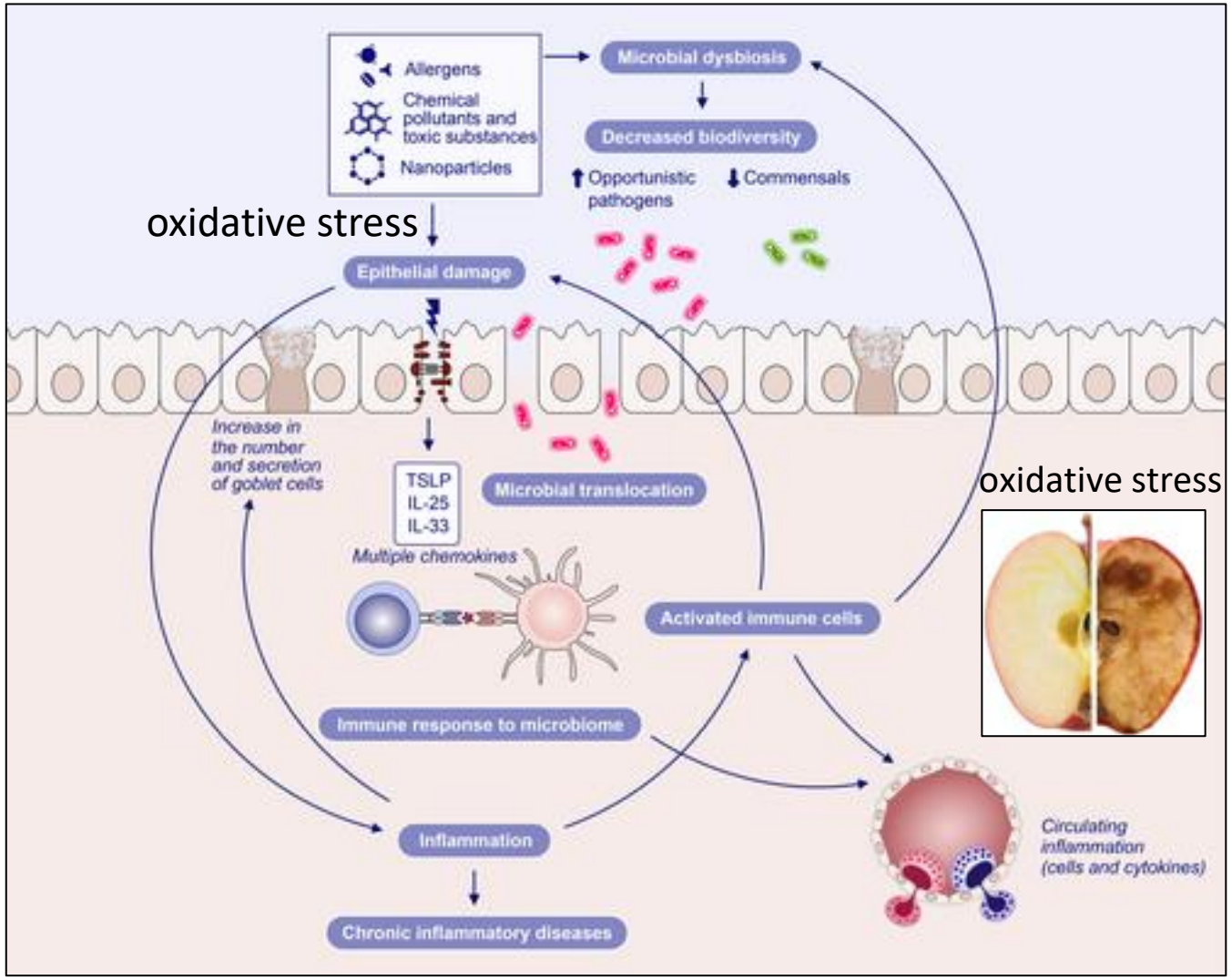


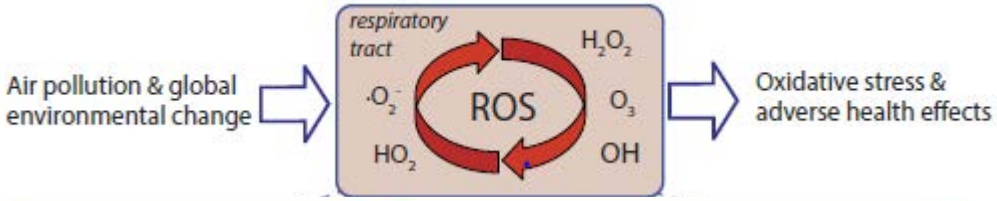
The most stunning spotlight has been on **brain health** that scientists have tracked through different stages of growth — from the foetus in the womb to late adulthood.

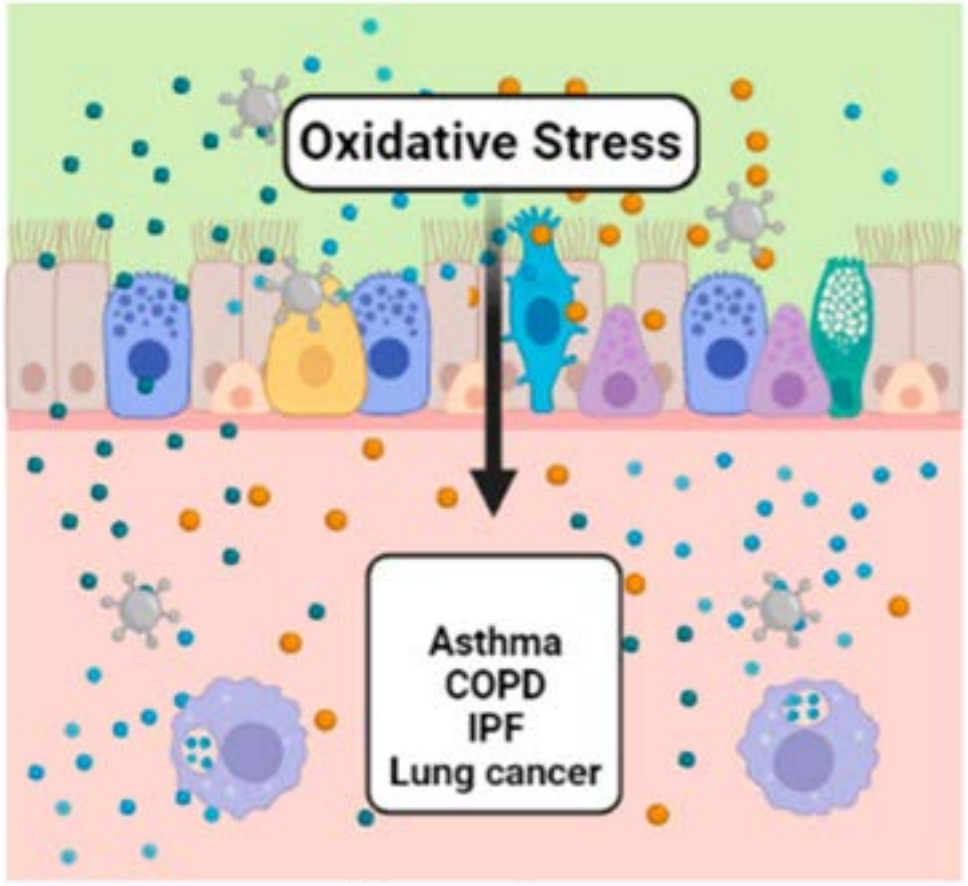
Stark evidence shows the changes in brain function and structural connectivity in the pre-natal stage, decreased motor and cognitive functions in infancy, increased neurodevelopmental disorders, anxiety, depression, psychosis, and suicides among young adults Increased risk for cerebrovascular diseases and dementia among the elderly.

The epithelial barrier theory and its associated diseases.

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





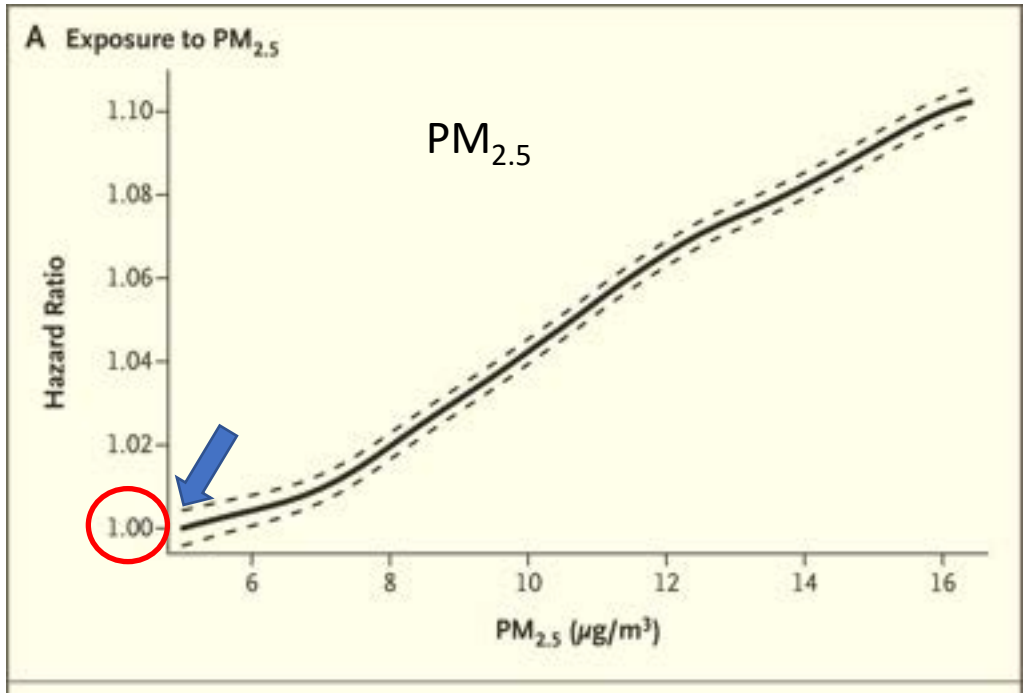


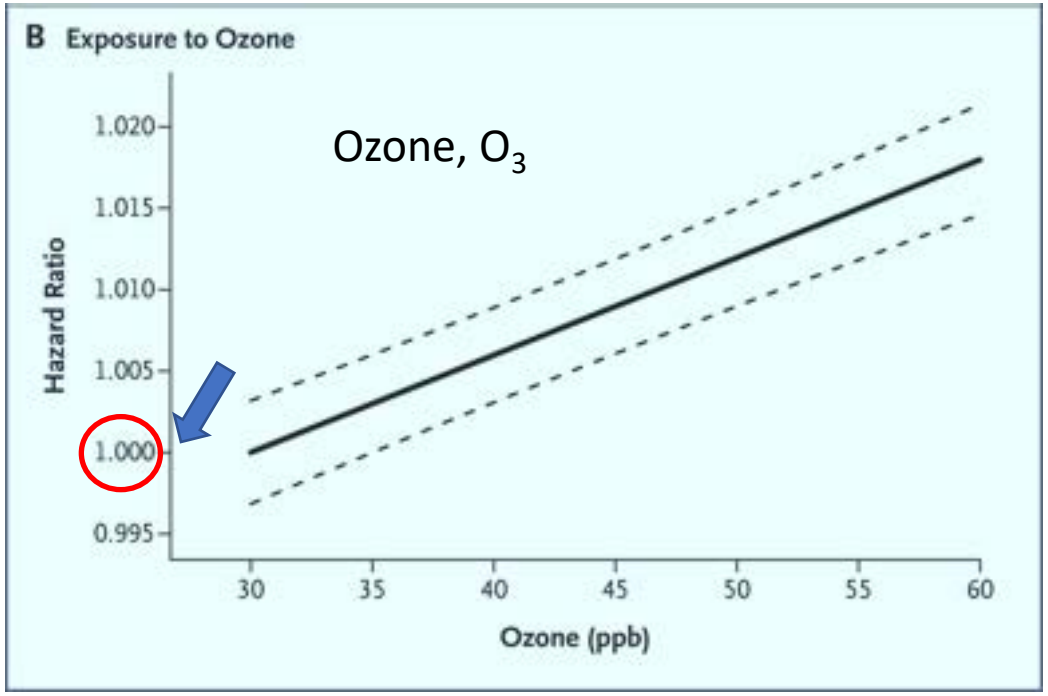
Air pollution and mortality in the Medicare population

Di Q, et al. N Engl J Med. 2017; 376: 2513-22

An open cohort of all US Medicare beneficiaries (60,925,443, 65 yrs or older).

There are NO safe levels of air pollution





Assessing the health burden from air pollution

A broader approach to assessing the burden of disease from air pollution is required

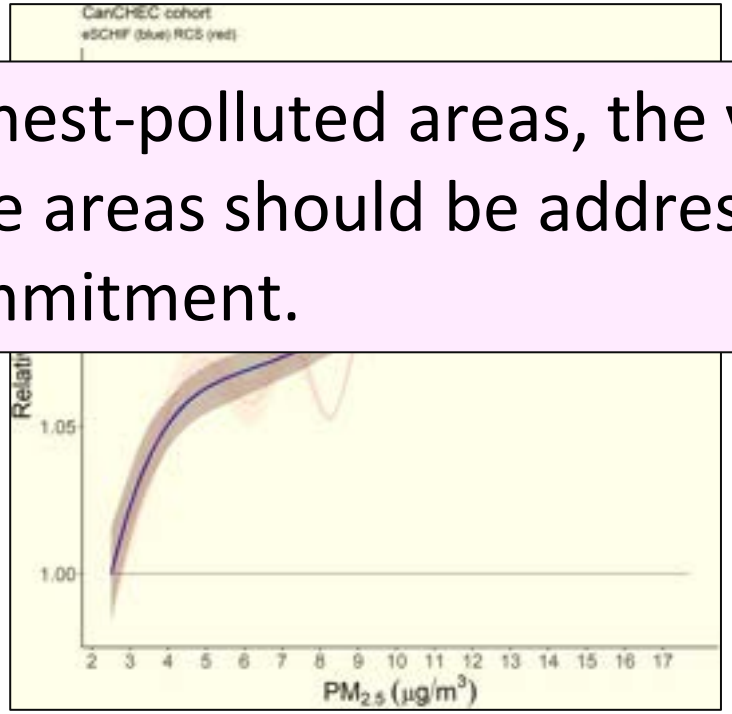
Sigsgaard T, Hoffmann B. Assessing the health burden from air pollution. Science. 2024; 384: 33-4.

- Mega-cohorts (several million participants) from high income countries with exposure to relatively low air pollutant levels shows effects on health below the WHO Air Quality Guideline values

Canadian Census Health and Environment Cohort

7.1 million adults in one of the world's lowest exposure environments reveal a supralinear concentration-response relationship between $PM_{2.5}$ and mortality at very low (<5 µg/m^3) concentrations.

Weichenthal S, et al. Sci Adv. 2022; 8: eabo3381.



Hence, while maintaining focus on the highest-polluted areas, the very real effects of air pollution in low-exposure areas should be addressed with equivalent commitment.

- The supralinear relationship between air pollution and health effects shows benefits from reductions are still possible at low levels of air pollution, with effects greater per unit of reduction.

Current air quality limit values in the UK are far in excess of those for health set by the WHO in 2022

World Health Organization

99% of Londoners live in areas that exceed the WHO's recommended guidelines for $PM_{2.5}$

Current UK air quality objectives compared to WHO guidelines

Pollutant ug/m³	WHO guidelines	England	Scotland	Wales	Northern Ireland
Annual mean $PM_{2.5}$	5	20	10	20	20
Annual mean NO_2	10	40	40	40	40

Chronic Obstructive Pulmonary Disease (COPD – chronic bronchitis + emphysema)

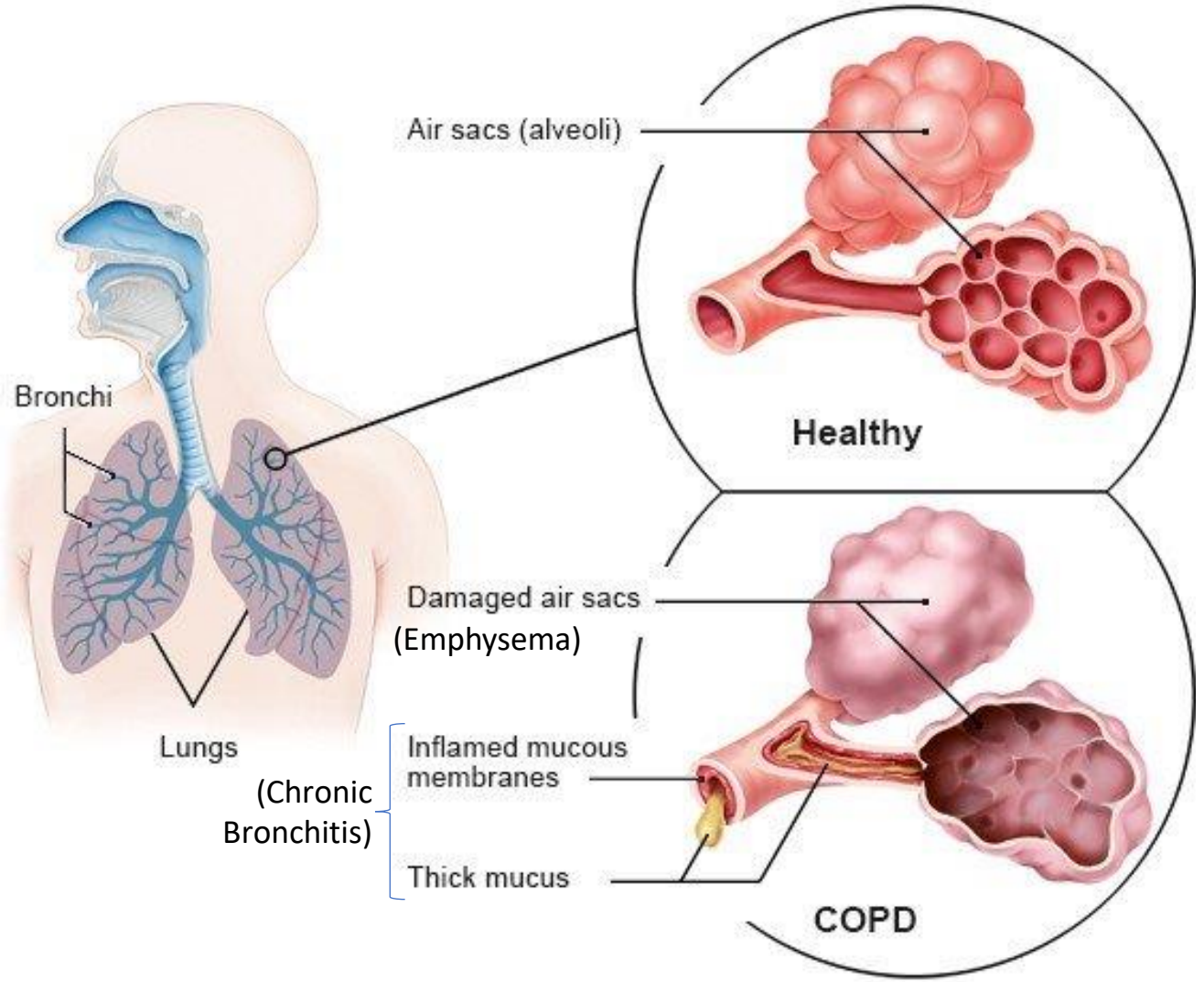
COPD affects about 3 million people in the UK, but around 2 million of them are undiagnosed

The lung tissue is damaged so there is less pull on the airways.

Mucus blocks part of the airway.

The airway lining becomes inflamed and swollen.

Frequent exacerbations, especially in winter.



The effects of exposure to NO_2, $PM_{2.5}$ and PM_{10} on health service attendances with respiratory illnesses: A time-series analysis.

Mebrahtu TF, et al. Environ Pollut. 2023; 333: 122123.

Professor Rosie McEachan, Director of the Born in Bradford study

- Retrospective cohort study (Born in Bradford) using linked routine health and pollution data collected between January 2018 and December 2021. Participants visiting GP or A&E for respiratory illness. Time-series analysis, distributed lagged models, was used to address the potential non-linearity and delayed effects of exposure.
- High levels of exposure above the **WHO 24-hr mean thresholds** increased pressure on health care services persisting **up to 100 days after an exposure event**.
- **Up to 50% of emergency and 35% of GP respiratory illness visits may be caused by high levels of pollution, leading to a substantial financial burden to healthcare providers.**
- Given the substantial health and societal impact of pollution the implementation of policies at a city scale to reduce air pollution are warranted.

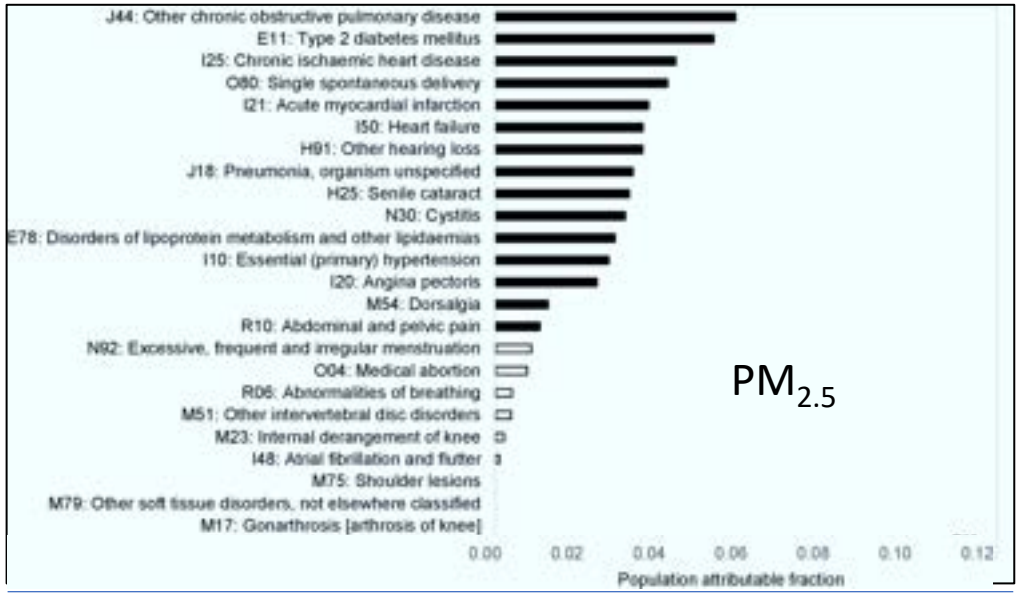
Air pollution and human health: a phenome-wide association study.

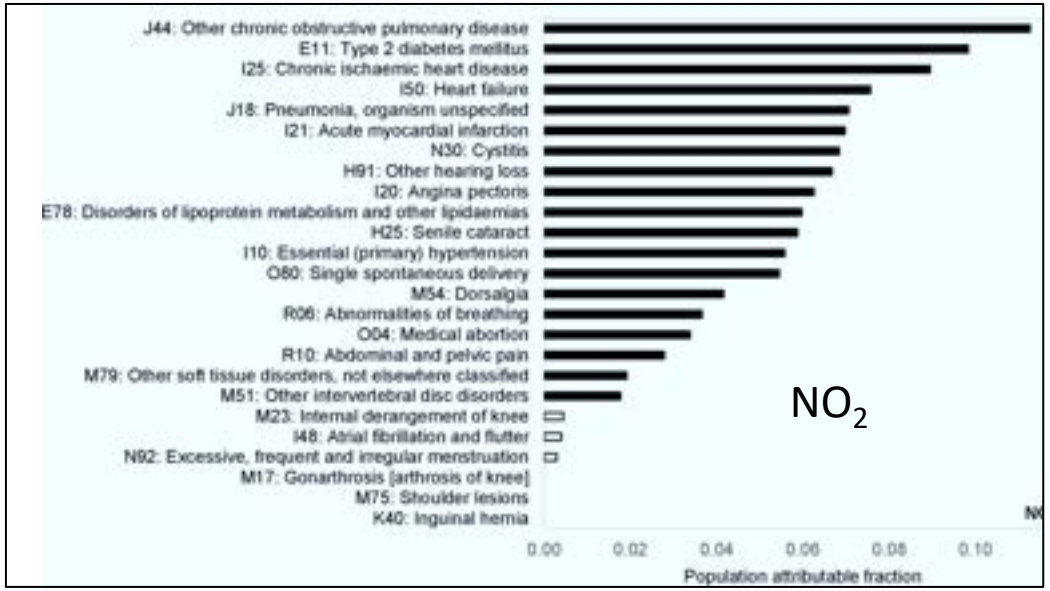
Hegelund ER et al. BMJ Open 2024; 14: e081351.

$PM_{2.5}$ concentration is currently 1.5 times the World Health Organization annual $PM_{2.5}$ guideline value

- 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 of more than >700 health conditions (ie, >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 conditions



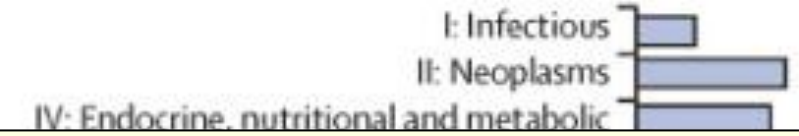


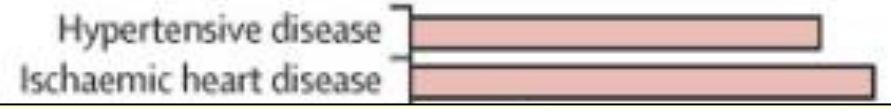
Associations of long-term NO_2exposure with a wide spectrum of diseases: a prospective cohort study of 0·5 million Chinese adults.

Xia X…China Kadoorie Biobank Study Group. Lancet Public Health. 2024; 9: e1047-e1058.

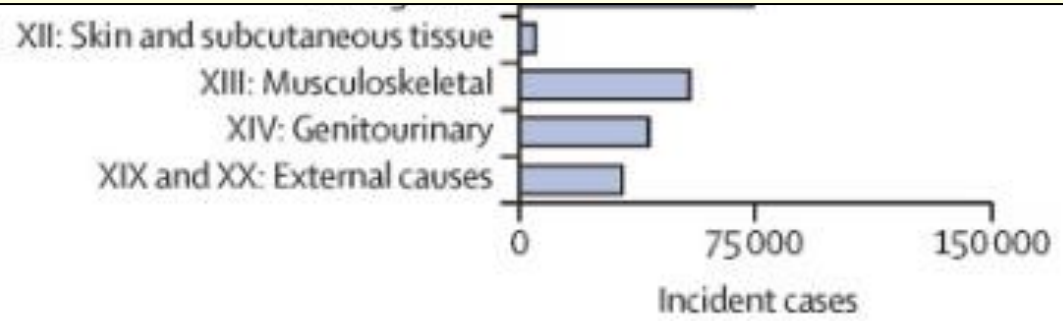
- Prospective cohort study recruited 512,724 adults aged 30-79 years during 2004–08, from ten diverse areas across China.
- Estimated ground-level NO_2 concentrations across mainland China with a high-resolution (1 km × 1 km) satellite-based random-forest model.

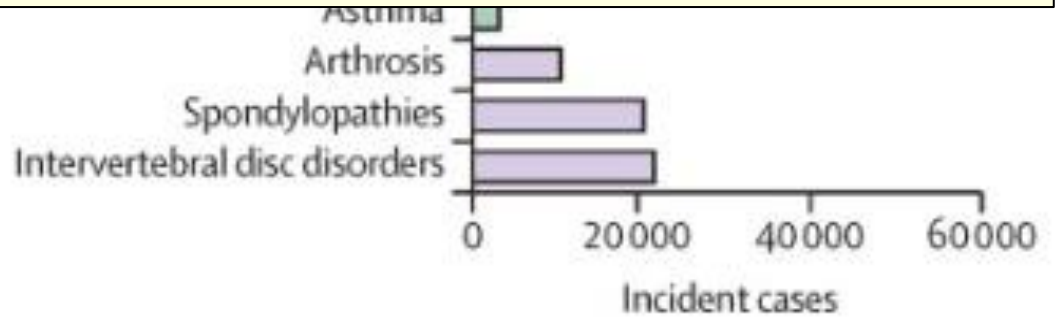
Long-term NO_2 exposure with disease incidence across 14 ICD-10 based endpoints and 12 different diseases.



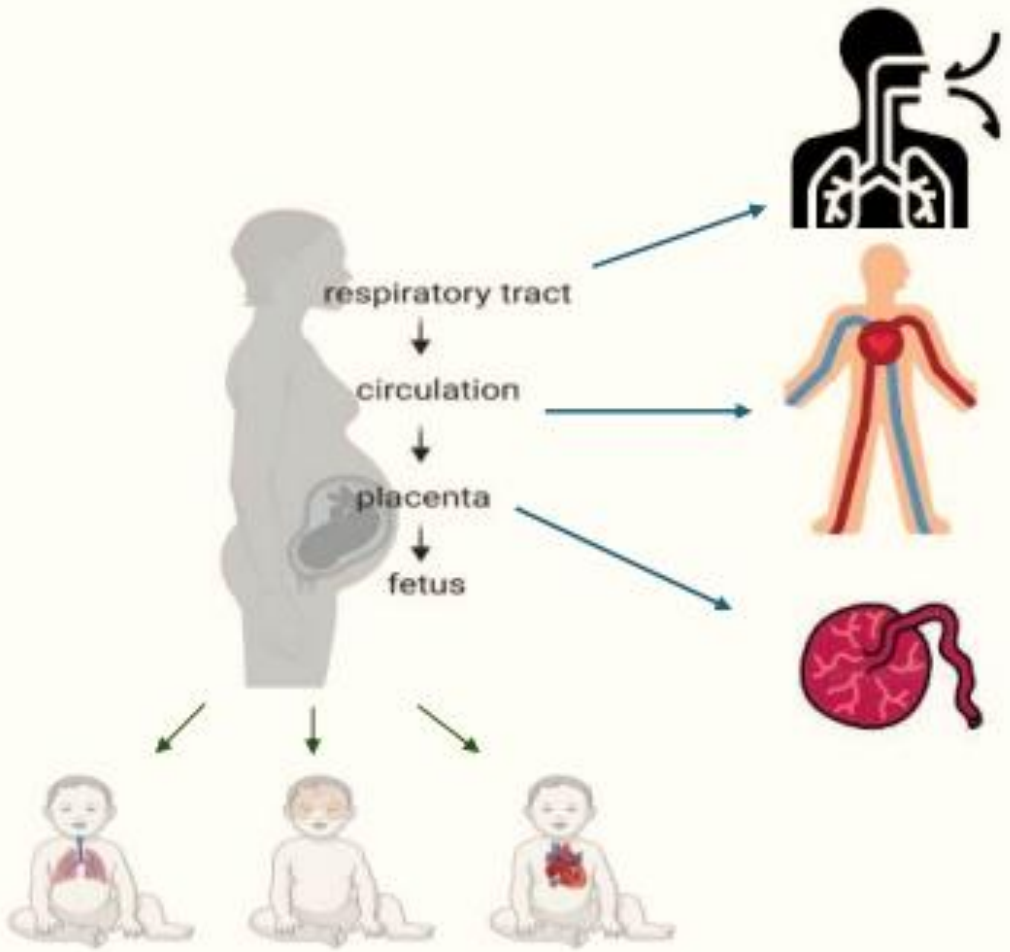


- In China, long-term NO_2 exposure was associated with a range of diseases, particularly cardiovascular, respiratory, and musculoskeletal diseases.
- These associations underscore the pressing need to implement the recently tightened WHO air quality guidelines.





Foetal development and childhood as a time of vulnerability to air pollutants



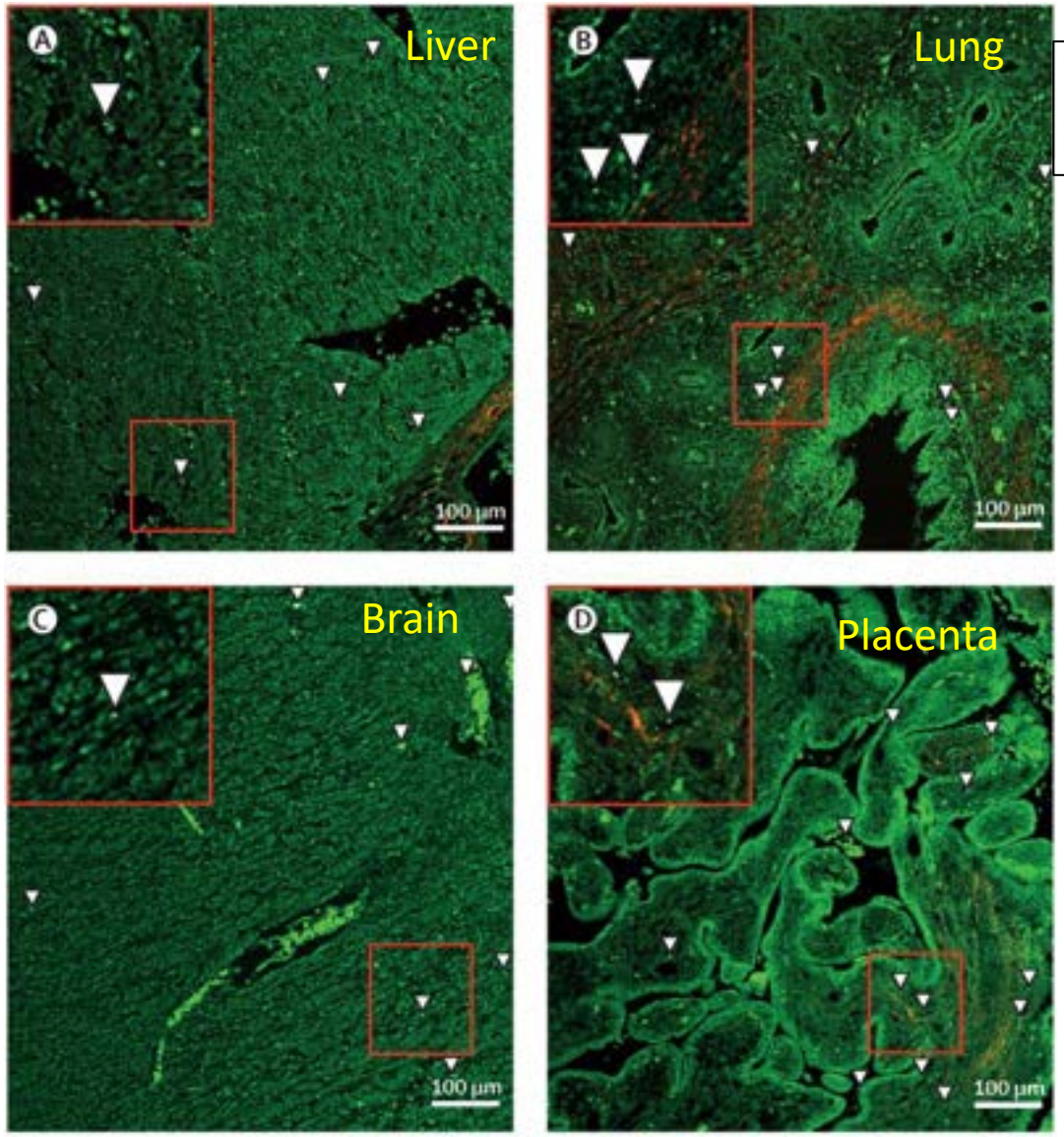
- Translocation of ultrafine particles
- Local response to air pollutants that is systemically propagated

- Supports translocation of ultrafine particles to maternal tissues and placenta
- Enables systemic propagation of signals from airways and other maternal tissues exposed and responding to air pollution

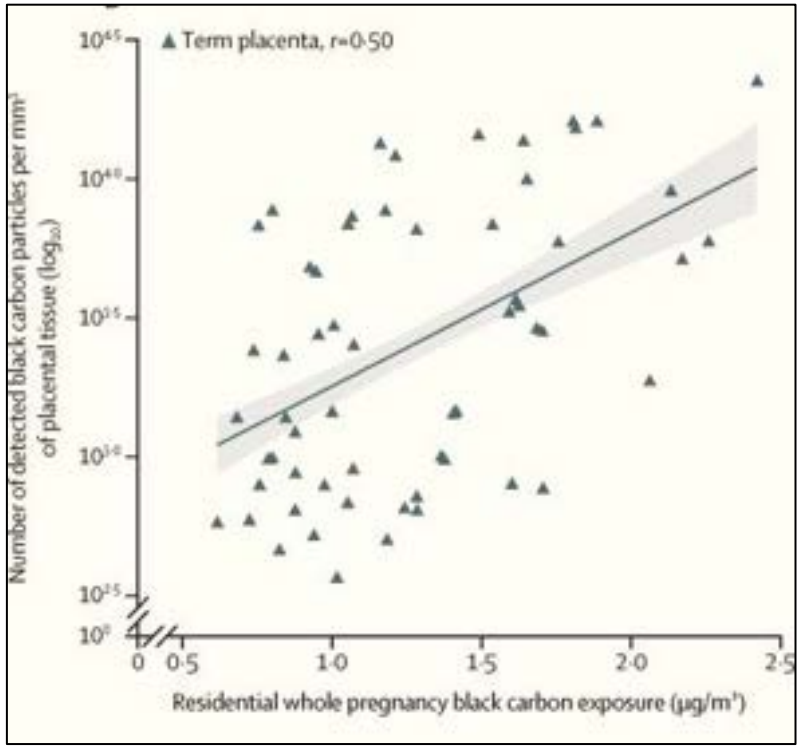
- Translocation of ultrafine particles to fetus
- Local response to ultrafine particles or systemically propagated maternal signals
- Propagation of maternal or placental-derived signals onwards to fetal tissues

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

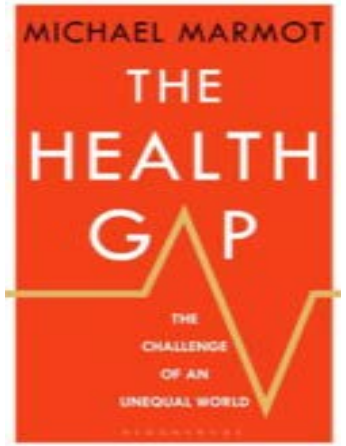
Bongaerts E, et al. Lancet Planet Health. 2022; 6: e804-e811



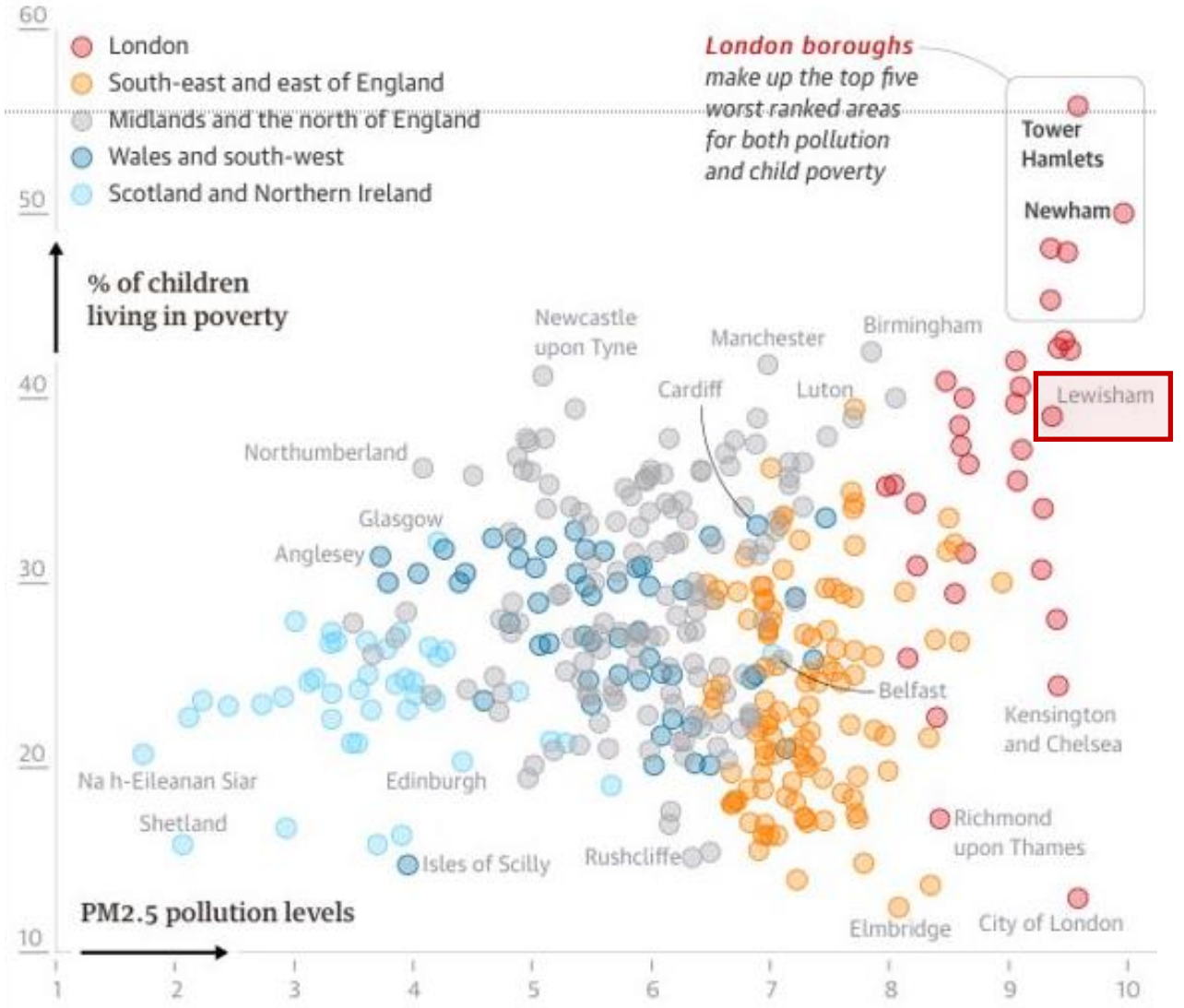
Presence of intra-tissue black carbon particles foetal tissues, gestational age 7-20 weeks



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



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



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)

Research and analysis

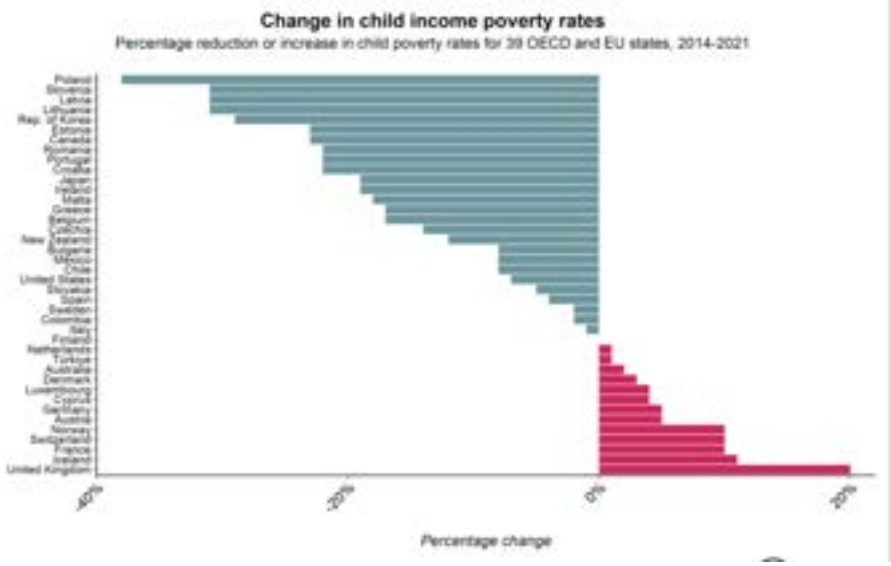
Health inequalities in health protection report 2025

Published 2 May 2025

UK Health Security Agency

UNICEF's review of child poverty in 39 OECD and EU countries child poverty has increased faster in the UK than in any other country.

unicef



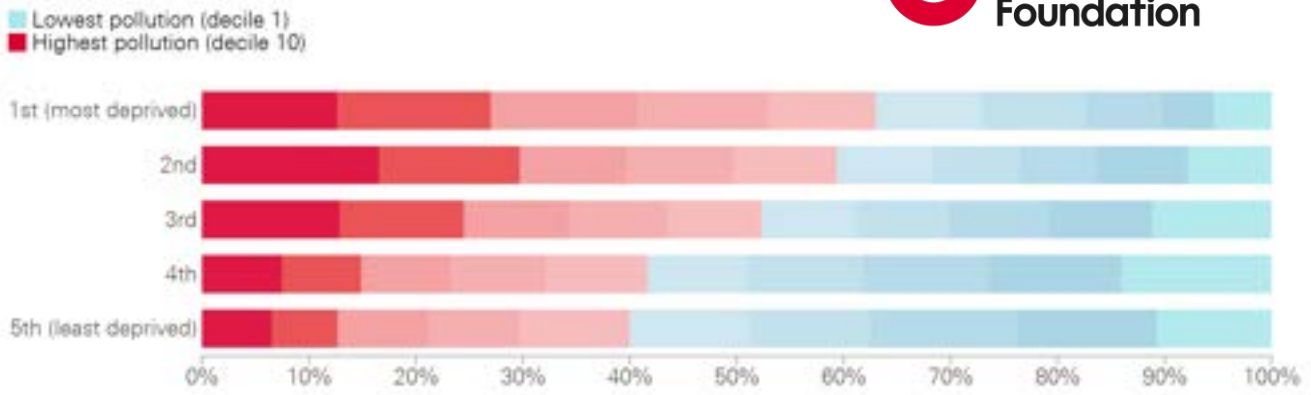
Fraction of mortality attributable to particulate air pollution, 2023 Proportion – %

Area	Value
England	5.2
London region (statistical)	6.2
East Midlands region (statistical)	5.6
East of England region (statistical)	5.4
West Midlands region (statistical)	5.1
Yorkshire and the Humber region (statistical)	5.1
South East region (statistical)	5.1
North West region (statistical)	4.9
North East region (statistical)	4.6
South West region (statistical)	4.3

Data taken from the DHSC fingertips dashboard.

Inequalities in likelihood of living in polluted neighbourhoods. 11th July 2024

The Health Foundation



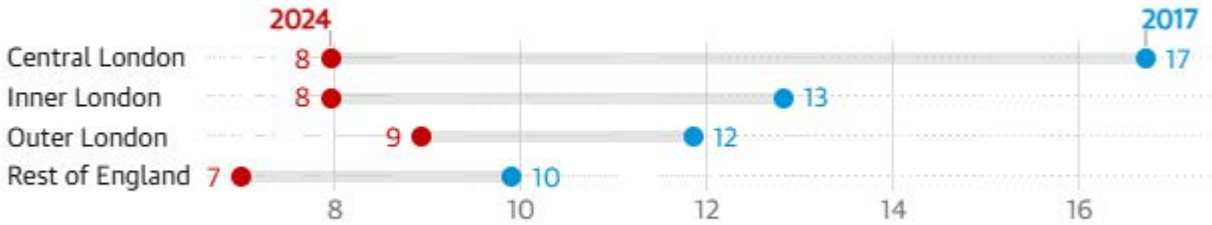
The Ultra Low Emission Zone (ULEZ, April 2019) is a 24/7 air quality zone that covers all of London to reduce harmful emissions by discouraging older, more polluting vehicles from driving in London.

Dramatic fall in London's levels of deadly pollutants after Ulez expansion

People in capital breathing much cleaner air, with significant improvements in capital's most deprived areas

People in London have been breathing significantly cleaner air since the expansion of the ultra low emission zone (Ulez), a study has found.

Annual average roadside PM2.5 concentration, micrograms per cubic metre



Guardian graphic. Source: Greater London Authority, data to Sep 2024. Note: PM2.5 refers to particulate matter in the air measuring 2.5 microns or less in diameter

Small-particle emissions ($PM_{2.5}$) from vehicle exhausts were 31% lower in outer London in 2024 than they would have been had Ulez not been expanded in 2023.

Air quality has improved at 99% of monitoring sites across London since 2019.

Statue unveiled of girl whose air pollution death inspired Sadiq Khan's Ultra Low Emission Zone. April 4th, 2025

London Evening Standard

The Mayor of London, Sadiq Khan, said:

"This statue is a powerful tribute to the life of a much-missed young Londoner and will also help educate people about the dangers of toxic air. Air pollution is not only an environmental crisis but a matter of social justice, which affects us all, from cradle to grave".

The decision to introduce and expand the ultra-low emissions zone (ULEZ) was inspired by Ella's death, Sadiq Khan attending the unveiling ceremony with Ella's mother, Rosamund

Session 1: NHS action towards clean air, climate change and health

Achieving the goals of net zero, adaptation and improved air quality in the West Midlands

Session Chair: Noel Nelson

Clean Air Community Engagement Ambassador, Met Office

Speakers (West Midlands Combined Authority)

Elle Winning, Air Quality Lead

Bethany Haskins-Vaheesan, Project Manager – Climate Adaptation

Nancy Towers, Senior Policy Officer – Healthy Communities & Mental Wellbeing

Clean Air Programme

West Midlands Combined Authority

Met Office

UK Research and Innovation

Air Quality in the West Midlands

Working in partnership for cleaner air in the West Midlands

West Midlands Combined Authority

Greener Together

Air quality in a West Midlands context

Pollutants in the West Midlands
The main pollutants of concern in the West Midlands are nitrogen dioxide (NO_2), particulate matter (PM10, $PM_{2.5}$) , and ground level ozone (O3).

Most NO_2 emissions (82%) come from road transport.

Combustion from residential, industrial, agricultural and commercial processes is the primary source of $PM_{2.5.}$ Domestic combustion is the primary source of PM_{10}, followed closely by production processes and road transport.

In the West Midlands…

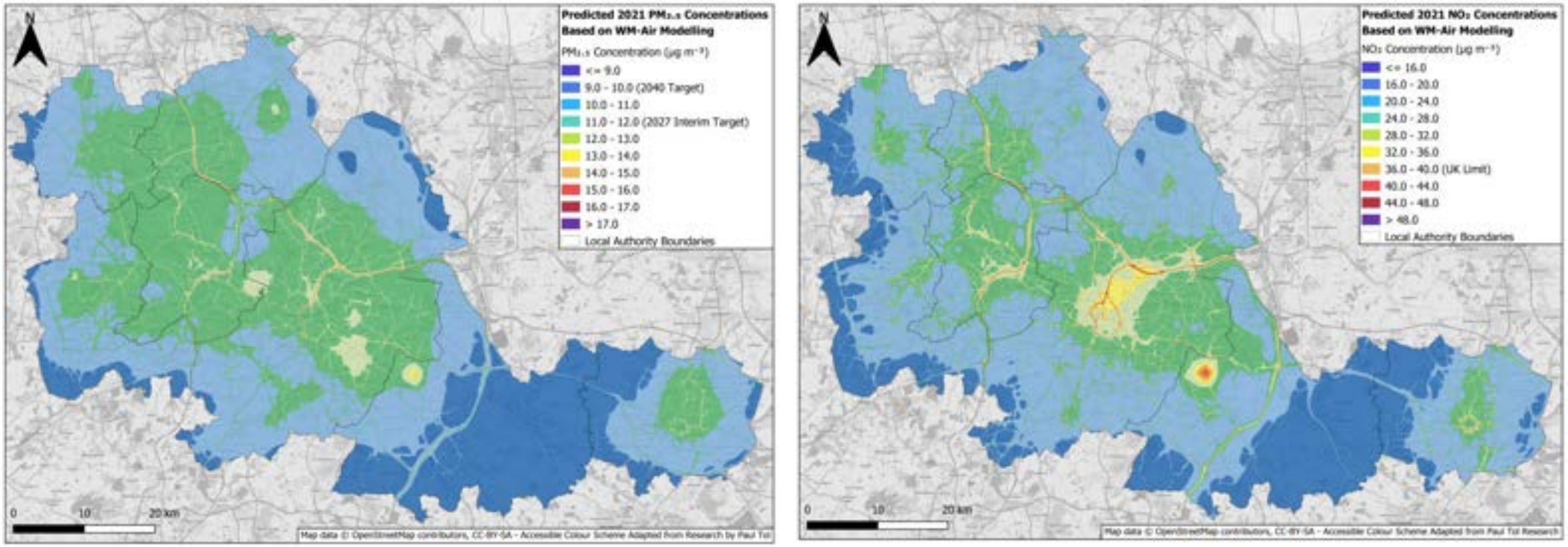
Health Impacts:
- Premature deaths: Air pollution contributes to up to 2,300 early deaths annually in the WMCA region.

- Disease diagnoses: Each year, air pollution is associated with approximately:
  - 3,300 new asthma cases
  - 1,400 coronary heart disease diagnoses
  - 300 lung cancer cases
  - 1,000 strokes.

Economic Impacts:
- **Healthcare costs:** Reducing air pollution to meet WHO guidelines could lead to an estimated £3.2 billion in economic benefits over 20 years for the region, through decreased healthcare and social care demands, and improved productivity.

Environmental Impacts:
- Air quality levels: All local authorities within the WMCA exceed WHO guidelines for nitrogen dioxide (NO_2) and particulate matter ($PM_{2.5}$), indicating widespread air quality issues.

Air quality in the West Midlands: impact is not felt evenly by people across the region



Modelled 2021 annual average concentrations of $PM_{2.5}$ (left) and NO_2 (right) in the West Midlands. Provided by WM-Air at The University of Birmingham.

The highest annual average $PM_{2.5}$ concentrations in the West Midlands are modelled in central Birmingham, Coventry, Sandwell and Walsall.

The least advantaged areas (highest IMD score) tend to have the worst air quality. This is because areas with the highest IMD tend to be those with the busiest roads and industrial sources.

West Midlands Air Quality Framework and Framework Group

- The WMCA Air Quality Framework **was adopted in November 2023**.
- **It was developed in collaboration with key stakeholders** including the seven constituent local authorities.
- **The Framework sets out actions** the WMCA, in collaboration with regional partners, could undertake to improve air quality across the region, building on the work local authorities currently deliver.
- The **Air Quality Framework Implementation Plan** sets out actions which should be prioritised for delivery between 2024 – 2026. The Framework and Implementation Plan are available on the resources section of https://cleanair.wmca.org.uk/.
- An **Air Quality Framework delivery group** has also been set up to help strategically and collaboratively align air quality work in the region.

WMCA Defra air quality project

Project Aims:

- To improve spatial coverage of particulate matter monitoring as well as increased analysis on $PM_{2.5}$ concentrations, gaining a better understanding of pollutants across the region.
- Enable health, wellbeing and environmental improvements within the West Midlands through dissemination of air quality information to the public, through informative platforms and behaviour change campaigns.
- Improve collaboration and integration of local stakeholders including Local Authorities in tackling air pollution across the West Midlands.

90 low-cost sensors have been installed across the West Midlands region, working closely with local authorities. This is now the largest regional sensor network outside London. In addition, 3 reference sensors have been procured to support the network.

The University of Birmingham have supported data gathered from the network, as well as understanding '**hot spots**' identified through previous modelling work.

A **dedicated air quality platform** has been launched for people to understand the air quality in their area. This will be supplemented with a forecast and alert system paid for by WMCA.

7 behaviour change trials have been completed (one in each local authority), looking at different ways to communicate and manage air pollution issues with a view to scaling and replicating the most effective campaigns.

We worked with a local artist and community groups to develop an **air quality art exhibition** that toured the region, talking to people about air quality. In addition, an **air quality literacy programme** has been developed to engage and support policymakers.

Air quality sensor network

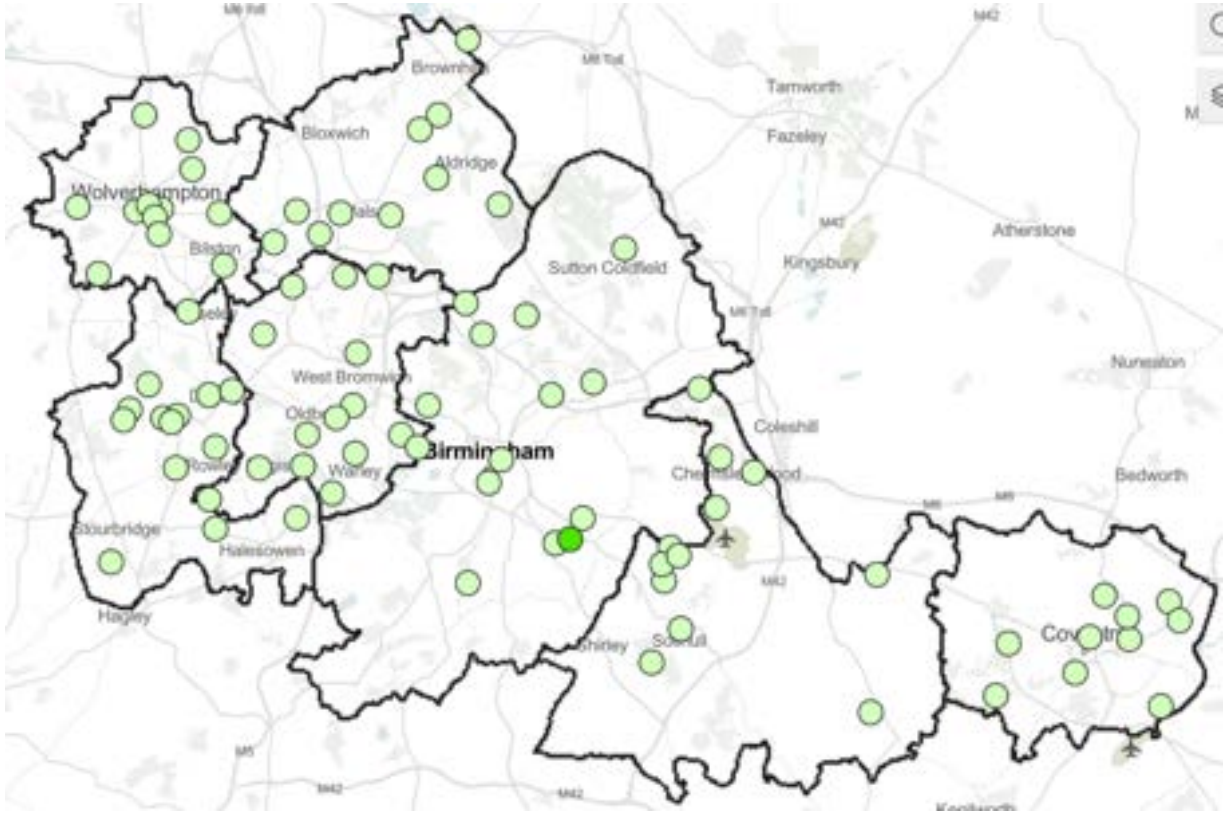
The West Midlands region wide sensor network was launched at the end of January 2025 and is made up of 90 sensors. The network focuses on the monitoring of $PM_{2.5}$ and NO_2 concentrations.

The network provides greater spatial resolution on air pollutant concentrations across the region to:

- Help the WMCA, local authorities, and other regional stakeholders to gain a greater understanding of air quality within the region.

- Provide the public with easily accessible information on concentrations through a public facing data platform.

The data platform is hosted on the new WM air quality website, which also provides wider air quality information to the public and regional partners, helping to raise awareness on how to reduce pollutant concentrations and personal exposure.



The QR code will link to
https://cleanair.wmca.org.uk/

Defra project: behaviour change trials

WMCA commissioned WSP and the Behaviouralist to develop behaviour change trials in each local authority to investigate the best ways we might change behaviours to reduce $PM_{2.5}$ concentrations, as well as personal exposure.

Trials were co-designed with local authorities and all seven contributed to answering these questions:

1. Identify what type of behavioural change campaigns have a scalable and demonstrable impact.

2. Identify what interventions are likely to result in the largest impact to public health.

Across all seven trials we engaged with a total of 2,731 residents.

Air quality focus in each trial

Health focused trials

Dudley: Encouraging modal shift in park groups

Trial: Encouraging sustainable travel behaviours among council park groups through peer-led surveys, social norms, financial incentives, and personal goal setting.

Findings:

- **Social norming** (working as a team) was the most effective mechanism at encouraging **behaviour change**.
- Participants were motivated by not wanting to let down their team and by encouragement from team members.
- **Convenience** is the primary factor motivating car use.
- Most participants stated they were likely/very likely to continue using active travel modes.

Walsall: Measuring daily exposure to air pollution

Trial: Used low-cost sensors to capture the average person's exposure to pollutants across their day and to provided tailored advice on the best ways to mitigate their exposure through practical and actionable advice.

Findings:

- Carrying an air quality sensor made participants **more aware** of the topic of air quality and **all participants stated they have made behavioural changes** to minimise their exposure to air pollution following the trial.

Birmingham: Debunking air quality myths

Trial: Assessed which myth-busting approach was most effective at improving people's knowledge about air quality through a survey-based experiment.

Findings:

- **Myth followed by fact** approach is effective at improving people's **knowledge** about air quality.
- **Short, punchy bullet point** statements resonate better with readers.
- People want to know upfront what actions they can take to reduce or avoid emissions.

Solihull: Engaging with people with pre-existing respiratory conditions

Trial: Worked with pharmacists to disseminate information on air quality to patients with pre-existing health conditions.

Findings:

- Participants **engaged with pharmacists in a face-to-face setting** and were interested in talking about air quality.
- The flyers alone were **not effective** at motivating people to find out more about air quality. Only one recipient chose to scan the QR code to find out more.
- People with pre-existing health conditions generally **had better knowledge and awareness** of the impacts of air quality compared with others.

Engagement and communications

Engagement and communications have been delivered through the following:

1. Delivering data digitalisation workshops with local community groups.
2. Delivering ‘pop up’ events and attending wider community events with the community artwork.
3. Launch of the Small Sparks Fund.
4. Developed and launched air quality literacy training.
5. A new air quality communications toolkit has also been launched along with specific toolkits for the NHS and schools to promote the air quality sensor network.

A sample of communication toolkit assets

Framework priority activities for 25/26

Priority Work Package	Description
Launch a regional air quality forecast & alert system	• Aim of the system is to help people within the West Midlands better understand daily air quality concentrations and provide advice on how to reduce personal exposure and reduce emissions during heightened air pollutant events. • The alert system will have tailored messaging to subscribers based on health and lifestyle. • The system will be hosted on the WM air quality website and comms and engagement channels established within regional partners such as the NHS and community groups will be used to promote uptake of the system and daily forecast levels.
Research regional air quality stretch targets	• WMCA is working with the University of Birmingham to investigate the potential to set further “stretch” air quality targets for the West Midlands, reflecting policy ambition for the protection of health. • Research includes modelling future scenarios to determine potential future air quality levels and what is achievable for the region.
Continue to work with UK Government on devolution opportunities	• WMCA will continue to work with Defra to identify opportunities for devolution and funding to the region.

Thank you!

Visit our webpage for resources and more information

The QR code will link to
https://cleanair.wmca.org.uk/

Email environment@wmca.org.uk

West Midlands Combined Authority | Greener Together

West Midlands Climate Adaptation and Health

NHS action towards climate change, air quality and health

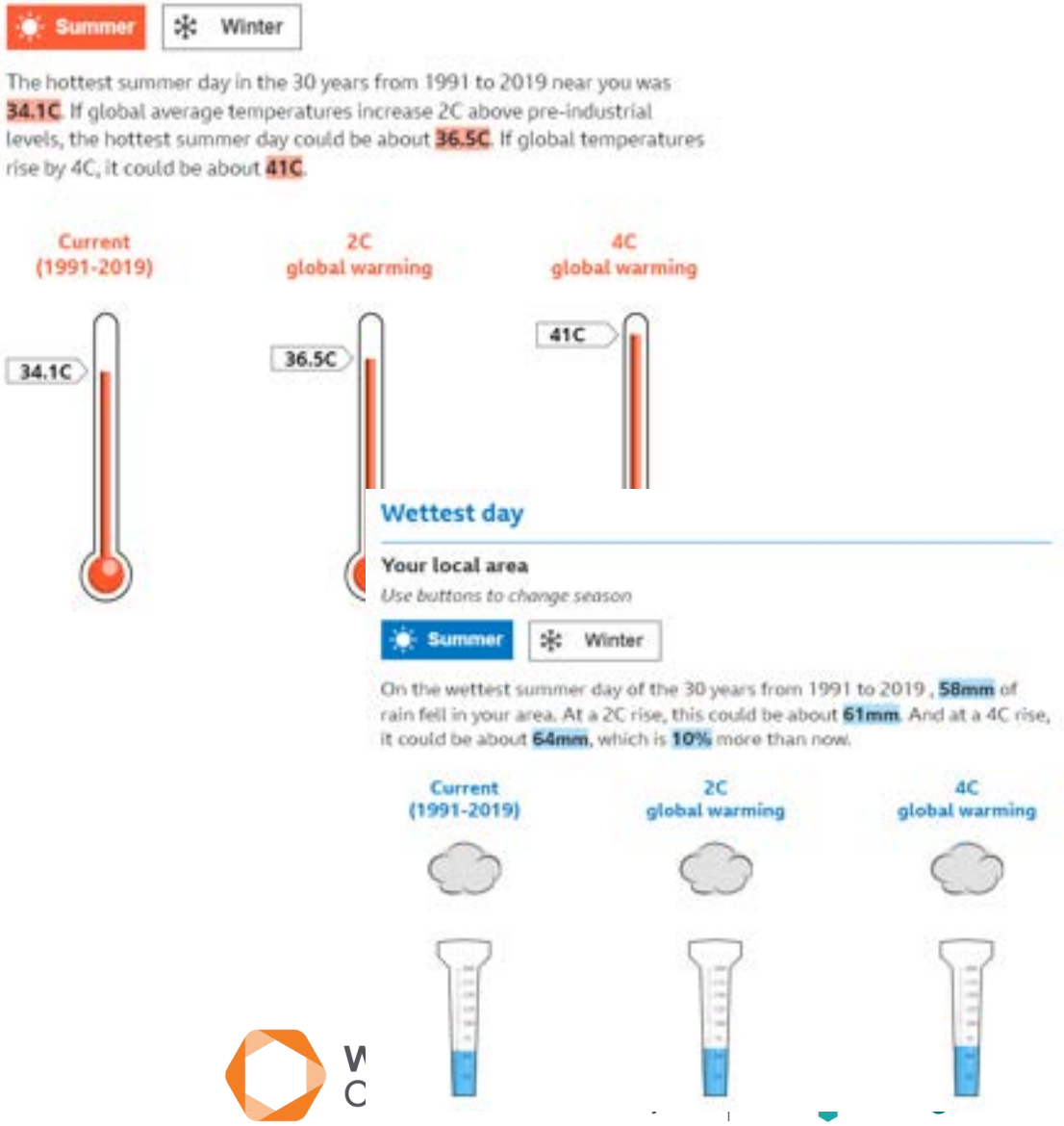
13th May 2025

West Midlands Combined Authority

Greener Together

Climate change & its impacts

- Under current policies and actions **by the end of this century warming will be as high as 2.9C.**
- Increasingly hotter, drier summers & warmer, wetter winters + more extreme weather events.
- Climate change focus has been on net zero & carbon reductions.
- **Increasing importance on the need for adapting to climate risks and opportunities.**



An urban area unprepared for extreme weather

Heavy rainfall and storms leading to...

1. Surface water flooding obstructs roads and pavements.
2. Contaminated water pools on poorly managed derelict site.
3. Surface water floods housing where drains struggle with heavy rainfall.
4. Increased emergency service demand in response to flooding.
5. High river levels flood roads and houses.

High and extreme temperatures leading to….

6. Poor ventilation and sun exposure lead high-rise flats to overheat.
7. Heat stress of staff lead shops to close due to poor ventilation and no air conditioning.
8. Tightly packed, densely populated housing, with poor energy efficiency and ventilation, experience heat stress with emergency services supporting vulnerable residents.
9. Communal carparking has limited public green space and natural shading for respite and shelter.

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An urban area ready for extreme weather

Adaptation to high and extreme temperatures can look like …

5. Urban cooling as derelict site is repurposed as a public park that offers cool recreational space.
6. Shops install awnings to shade shop fronts and pavements.
7. High-rise flats cooled by window shutters and solar-powered air conditioning. Green roof intercepts rainfall.
8. Terraced houses retrofitted with wall insulation, window shutters, solar panels, heat pumps, and improved ventilation, improving indoor air quality, reducing overheating risk and reducing energy demand for cooling buildings.
9. Car parks include green space, trees and shaded seats for respite in hot weather.

Adaptation to rainfall changes and increasing storms can look like …

1. Pond and park space drains surface water.
2. Biodiverse sustainable drainage drains rainfall from hard surfaces.
3. Vegetation, water butts and reduction of paved surfaces drain rainfall and prevent flooding.
4. Re-naturalised (re-shaped) river, flood defence and raised highways reduce flood risk and improves nature.

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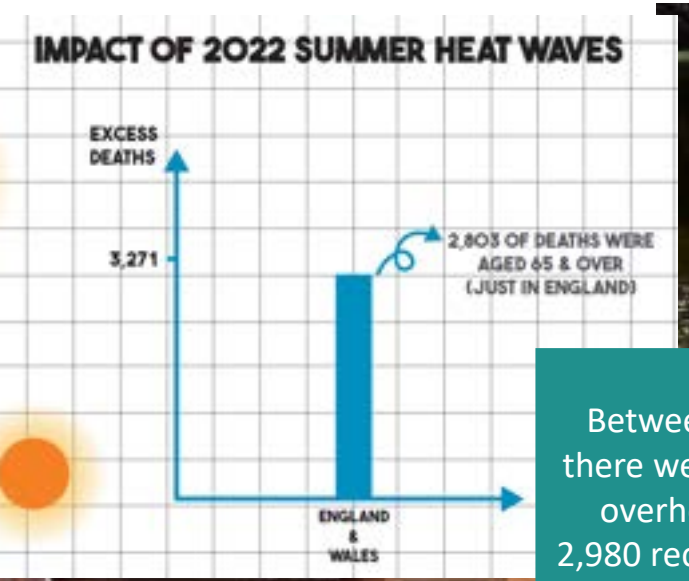
Examples of impacts already being felt …




Hall Green © West Midlands Fire Service

Between April 2021 and March 2022 there were a total of 5,554 instances of overheating at NHS sites - up from 2,980 recorded between 2016 and 2017

GVA reduction in the WMCA area a year due to climate change

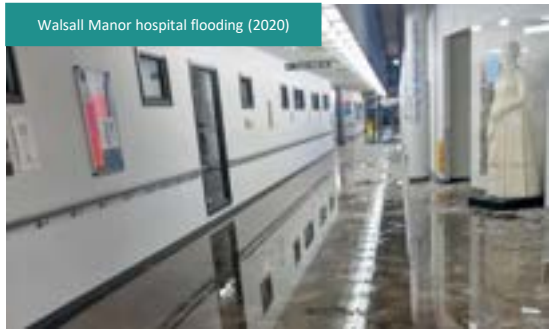
£350-£638m
By 2030

£1.5bn-£2.9bn
By 2050

£21m

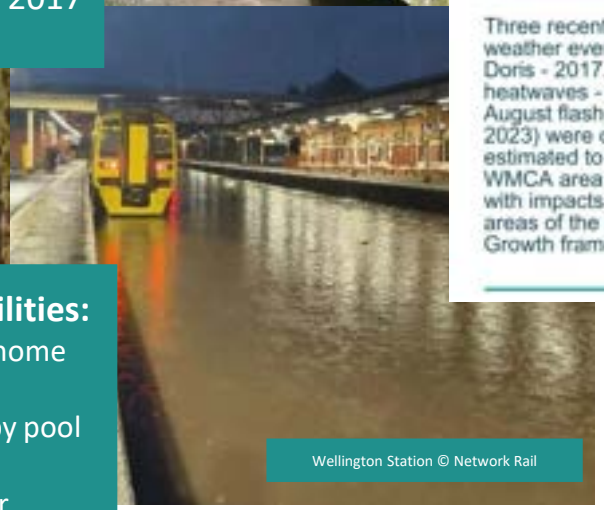
THREE RECENT WEATHER EVENTS

Three recent severe weather events (Storm Doris - 2017, Summer heatwaves - 2022 & August flash flooding - 2023) were collectively estimated to cost the WMCA area around £21m, with impacts affecting all areas of the Inclusive Growth framework.


Walsall Manor hospital flooding (2020)


Walsall grass fire (2022)


Flooding and a stranded resident in Alum Rock, East Birmingham (2019)


Wellington Station © Network Rail

Examples of incidents in NHS facilities:

- Patients awaiting dialysis were sent home because of water supply issues
- Green algae growth in a hydrotherapy pool
- Power lost in an operating theatre
- Sewage leaked into a waiting area for ophthalmology
- Parts of a ceiling collapsed in a clinical area
- Operating theatre reached 29C because of a broken air conditioning unit

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Climate & Extreme Weather Adaptation

Adaptation: *the immediate **and** long-term adjustments needed to be taken by individuals, communities, cities, regions, and countries to cope with and benefit from actual or expected climate changes.*

Climate & extreme weather resilience: *to withstand, cope with and rebound from the effects of hotter, drier summers, warmer, wetter winters and more extreme weather events.*

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Climate adaptation action might look like

Green walls and roofs

Changes to the built environment

Community and staff engagement on severe weather preparedness

Sustainable drainage systems in areas of surface water flooding

Likelihood						
	5 Very high	5	10	15	20	25
	4 High	4	8	12	16	20
	3 Medium	3	6	9	12	15
	2 Low	2	4	6	8	10
	1 Very low	1	2	3	4	5
		1 Minimal	2 Minor	3 Significant	4 Major	5 Critical
		Impact				

Climate risk assessment of assets and operations

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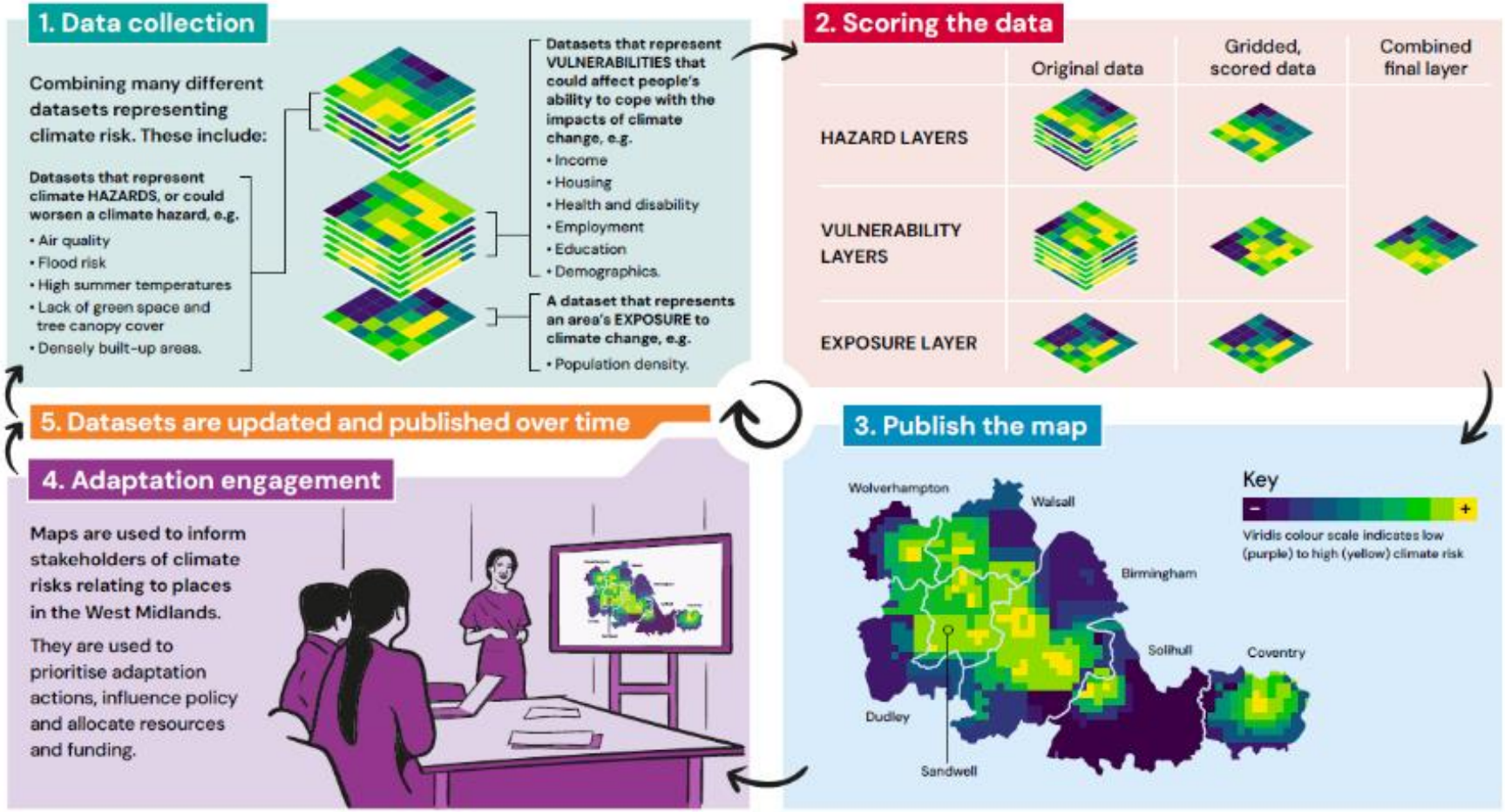
Climate Risk & Vulnerability Assessment (CRVA) mapping



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Climate Risk & Vulnerability Assessment (CRVA) mapping

Overview

This map presents overall climate risk scores (a combination of climate hazard, socio-economic vulnerability and exposure data) for lower super output areas (LSOAs) in the WMCA area.

Use the tool tip to see a LSOA's overall climate risk score and the scores of component layers.

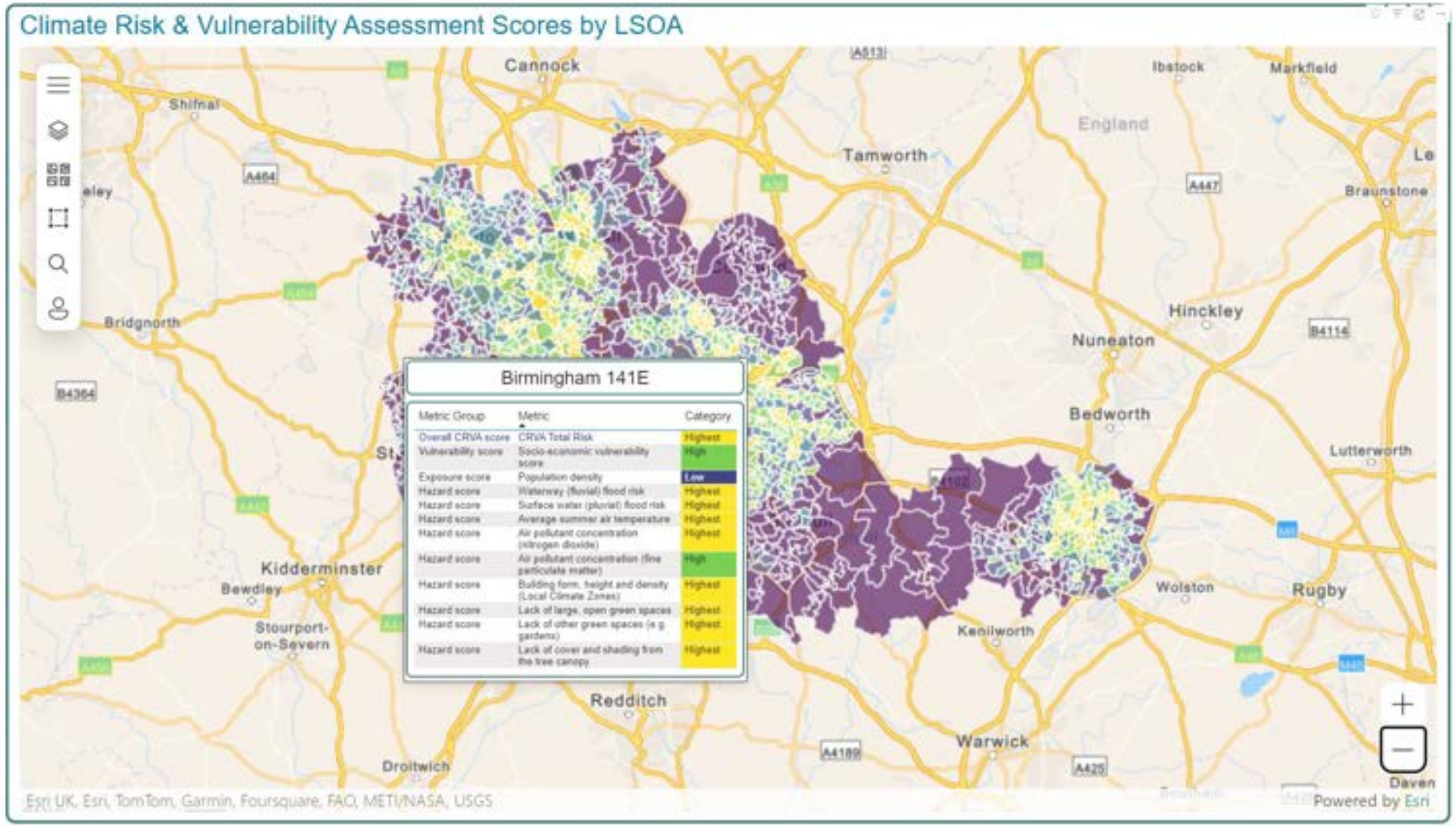
Fourteen vulnerability layers have been combined into one, averaged vulnerability layer to support user experience of this page.

Click here for more information on the method and datasets used.

Key

Viridis colour scale indicates low (purple) to high (yellow) climate risk

Hover over an area for more information on the area's ratings.



UK Research and Innovation

UNIVERSITY OF BIRMINGHAM

West Midlands Combined Authority

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West Midlands Regional Adaptation Network (RAN)

A West Midlands Regional Adaptation Network (RAN) is being established to connect and build the skills and knowledge of people who have a role in preparing the region for climate change. The Network is part of the new WM-Adapt project.

The West Midlands RAN will:

- provide information, training, mentoring and support for members to improve climate adaptation understanding across sectors
- identify shared barriers to climate adaptation planning and delivery, including skills, knowledge and resource gaps
- contribute to the region's evidence base for climate adaptation delivery
- build partnerships to co-develop shared adaptation solutions, evidence and shape the regional vision
- inform data requirements and community engagement in other WM-Adapt workstreams

Role of RAN members:

- Attend 2-hour RAN meetings on a quarterly basis
- Contribute to calls for evidence and provide input to climate adaptation work
- Assess their existing skills, knowledge and capacity, identifying cross-sector barriers to adaptation planning and delivery

WM-Adapt

- WM-Adapt is a £2m UKRI- funded research project led by University of Birmingham in collaboration with West Midlands Combined Authority (WMCA).
- WM-Adapt will drive a step change in local adaptation delivery through three key workstreams: 1) Community-scale adaptation 2) Climate Risk & Vulnerability Assessment (CRVA) data enhancements and 3) the convening of a Regional Adaptation Network (RAN).

Click here to find out more and sign up for the Network

WMCA Climate Adaptation Programme

Health and Climate Indicator List

- The Centre for Thriving Places have reviewed the possible datasets that might help the WMCA, local system partners to:
  1) Understand the current and future health impacts of climate change
  2) Identify and address health inequalities and system pressures
  3) Support the integration of adaptation into planning, investment, and decision-making
  4) Facilitate cross-sectoral alignment by connecting evidence across policy domains

- Next steps:
  - Circulation with system partners for monitoring at an individual level
  - Potential to develop a regional climate and health monitoring framework – where the host and how to resource?

Causal Theme 1	Causal Theme 2	Causal Theme 3	Outcome Theme 1	Outcome Theme 2	Outcome Theme 3	Name or description of indicator	Indicator Relevance: Core, Secondary, Peripheral.	Literature Source	Interim indicators
Extreme Heat			Cancer			Exposure to solar ultraviolet (UV) radiation	Core	HECC Report	UV Index
Extreme Heat			Cancer			Ultraviolet light (UV) exposure-related impacts: skin cancer rates	Core	SOSCHI	Urgent suspected cancer referral suspected skin cancer
Extreme Heat			Heat-related illness	Infrastructure Disruption	System Pressure	Maximum monthly average temperature	Core	SOSCHI	Maximum Monthly Air Temperatu
Extreme Heat	Extreme Cold		Heat-related illness	Infrastructure Disruption	System Pressure	Monthly average temperature	Core	SOSCHI	Mean Monthly Air Temperature

Example Health and Climate Change indicators

Causal theme	Outcome theme	Name and description of indicator
Extreme heat	Cancer	Ultraviolet light (UV) exposure-related impacts: skin
Extreme heat	Respiratory Conditions	Exposure to Wildfires and Wildfire smoke
Extreme heat	Subjective wellbeing	**The mental health impacts of subjective overheating**
Extreme heat	Heat-related illness/system pressure	Weekly number of excess deaths
Extreme heat	Infrastructure disruption	**No. of overheating incidences in healthcare facilities per heat period**
Extreme cold	Mental Health	Fuel Poverty
Extreme cold	Cold related illness/system pressure	Excess winter deaths (over 85) index
Flooding and storms	System pressure	Number of floods/% population flooded
Flooding and storms	Mental health	Populations with estimated frequency of flooding of more than a 1% chance in any year
Flooding and storms	Infrastructure disruption	The number of residential and non-residential properties at risk of flooding from rivers, seas and surface waters
Flooding and storms	Infrastructure disruption	**No. of healthcare facilities flooded during a heavy rain period**
Air quality	Respiratory conditions	Mortality attributable to PM2.5
Air quality	Respiratory conditions	Rates of asthma flare-ups
Food and water security	Infrastructure disruption	Drinking water quality
Food and water security	Water and Foodborne Diseases	Unable to eat healthy and nutritious food
Vulnerable populations and health inequalities	Cardiovascular disease/Respiratory/Mental health	Long term health conditions

Health and Climate Indicator List

Discussion

- How are you identifying climate risks and monitoring climate adaptation in your Green Plan delivery?
  - Do you know what data is available for:
    - Understanding climate risks to health services and outcomes
    - Monitoring climate adaptation delivery
      - List examples – mind map
- What data is missing at the regional/local scale?

Prioritise missing data that would make sense to coordinate at the regional scale and is most urgent to understand – tally on your paper or sticky dot on the flip chart

Collaborating to improve air quality

Discussion

- How would you like to collaborate going forward to help improve air quality and reduce people's exposure?
  - What areas of most interest to you? *Research and trials, communications, data etc.*
  - How do we engage with your clinical and estates/facilities teams?

- Would you like us to engage with you on specific areas such as air quality and climate adaptation, or on all environment work such as the natural environment, energy and reducing waste through the circular economy?

West Midlands Resource Reuse Network

- The West Midlands Resource Reuse Network is working to promote a circular economy in the West Midlands through facilitating business to business resource exchanges.
- Sustainable and cost effective way to dispose of spent medical waste including x-rays, dressings and key hole surgery sutures.
- The team can also assist with reducing waste in capital projects.
- More information on the project can be found here or by emailing Ian.Humphreys@international-synergies.com for an assessment of how the team can assist your trust.

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Session 2: NHS action towards clean air, climate change and health

Successful clean air partnerships in the healthcare sector: case studies

Session Chair: Dr Douglas Booker

UKRI Regional Clean Air Champion (North-West – West Midlands) | University of Leeds

Clean Air Programme

West Midlands Combined Authority

Met Office

UK Research and Innovation

Session 2: NHS action towards clean air, climate change and health

Cleaner air, healthier hospitals: Implementing the UK's Clean Air Hospital Framework

Babatunde Okeowo
Research Student, Northumbria University

Clean Air Programme

West Midlands Combined Authority

Met Office

UK Research and Innovation

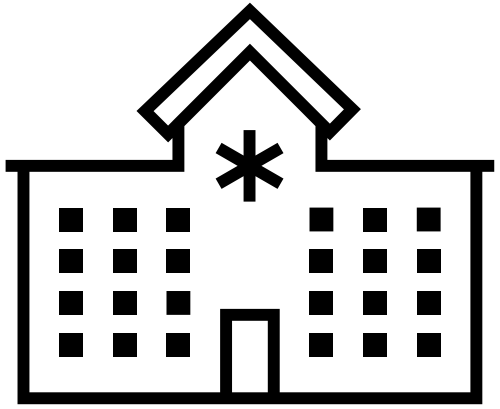
Cleaner Air, Healthier Hospitals: Implementing the UK's Clean Air Hospital Framework at the Royal Victoria Infirmary and Freeman Hospitals in Newcastle

NHS Action Towards Clean Air, Climate Change and Health

Research Student
Babatunde Okeowo

Academic Supervision
Michael Deary (Assoc. Prof), Geography and Environment, Northumbria University

Industry Supervision
Anna-Lisa Mills, Sustainability Manager, Newcastle NHS Trust



Clean Air Hospital Framework

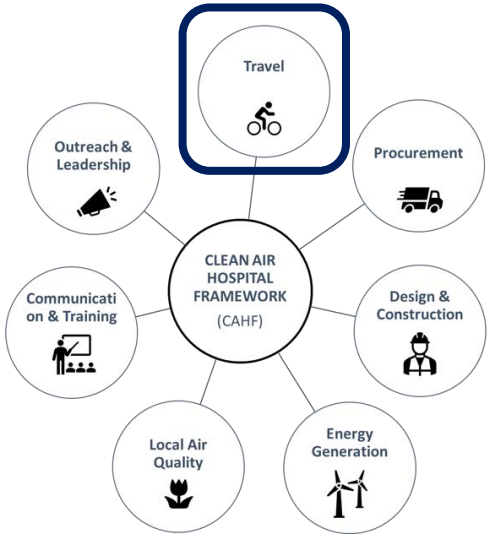
The Clean Air Hospital Framework (CAHF) was developed by the Great Ormond Street Hospital and the Global Action Plan, an environmental charity in the UK, to provide a structured self-driven support for hospitals towards achievement of clean air environment within the hospital and within the wider community.

CAHF Focus Areas	Category Weighting
Travel	28%
Procurement	14%
Design and Construction	18%
Energy generation	6%
Local air quality	6%
Communication & Training	18%
Hospital Outreach & Leadership	10%

215 Total CAHF Actions

The Clean Air Hospital Framework showing all 7 focus areas under the framework

Clean Air Hospital Framework



Travel

- Hospital travel planning
- Walking and cycling infrastructure / facilities
- Zero emission vehicle infrastructure
- Parking for all vehicles
- Travel to and from the hospital (patient transport & ambulances)
- Routes to minimise travel
- Reporting progress

61 Travel Policy Actions

Clean Air Hospital Framework

The hospital is a key partner in local groups and is committed to developing initiatives and strategies to improve public health.

Clinicians in cardiac, respiratory and maternity units keep up-to-date on the latest health information on air pollution to inform patient advice.

You monitor air pollution levels across the hospital, showcase the results and use the information to improve air quality on site and set targets for improvement.

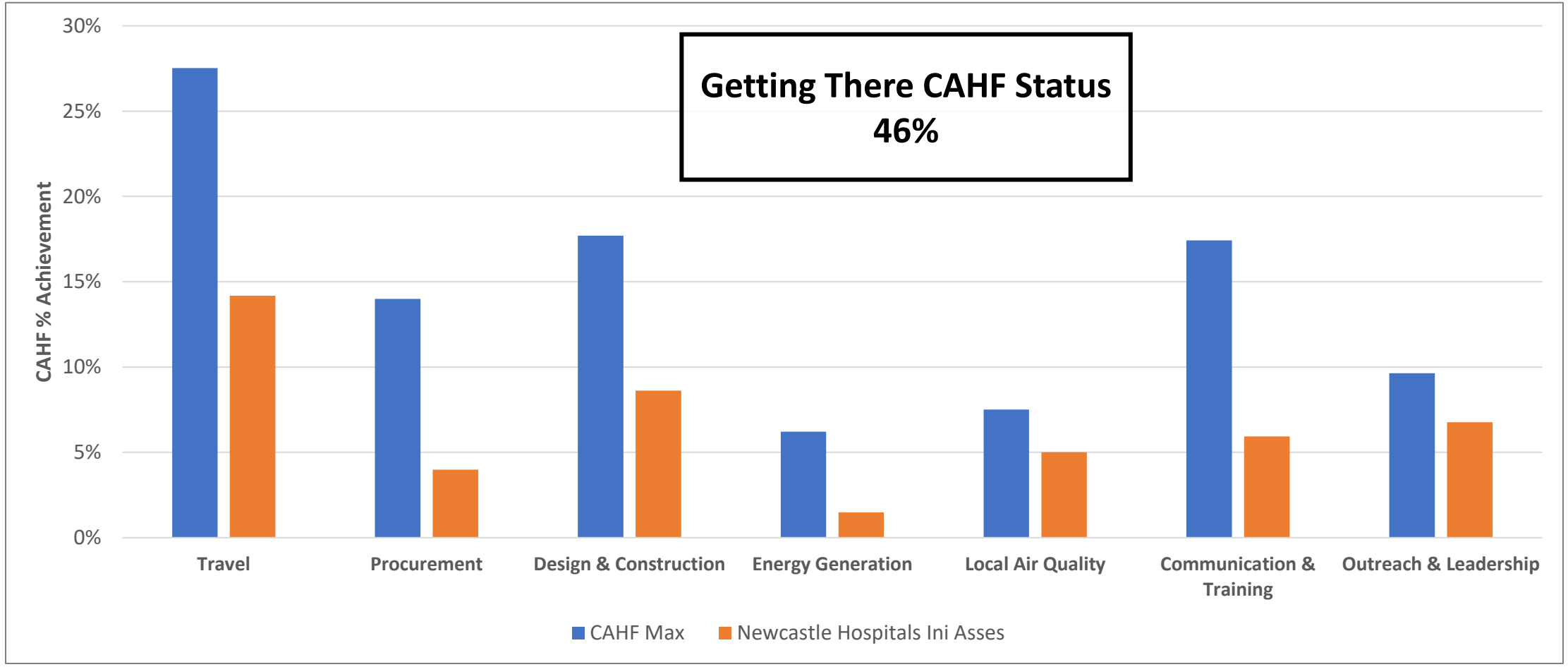
New technologies are developed and trialled such as telemedicine, IT networks, video conferencing, pneumatic tube systems etc.

Couriers only use ultra-low/zero tailpipe emission vehicles.

Promising technologies to improve air quality are trialled in the hospital where appropriate.

The hospital generates 100% of its own energy from renewable sources (which may be a mix of onsite and offsite)

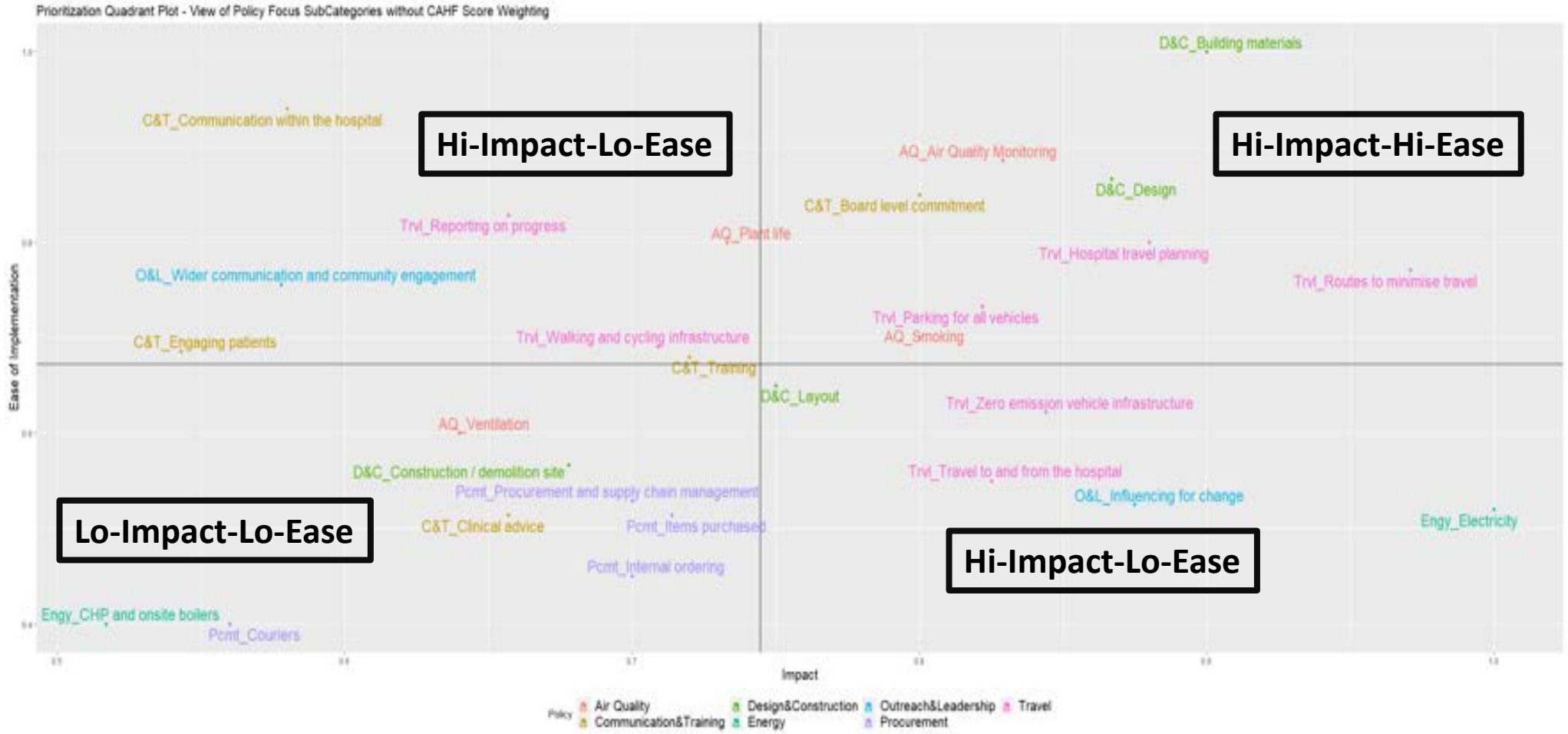
CAHF Status at Newcastle Hospitals



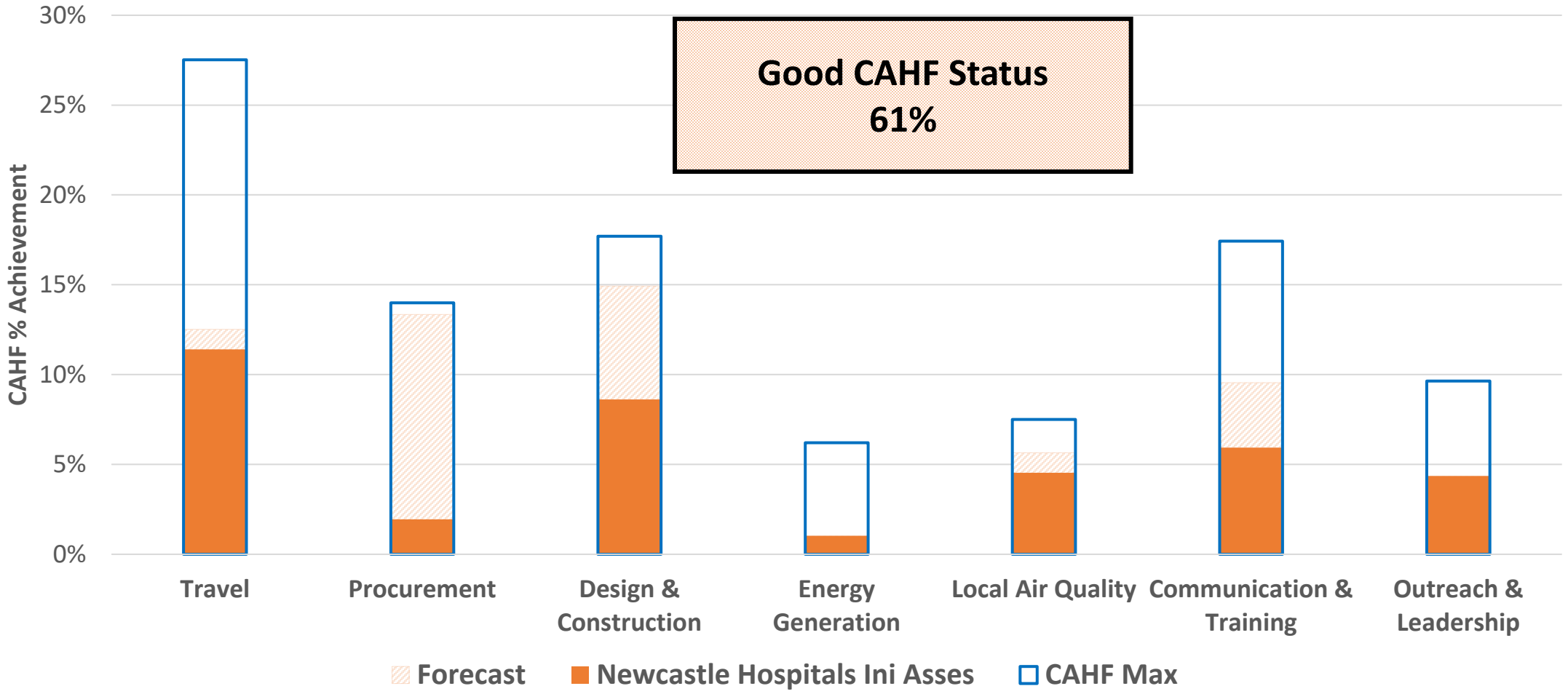
Newcastle Hospitals' adopted baseline across all 7 CAHF Policy Areas at a 46%, "Getting There" CAHF Status

Research Progress and Findings

- **Prioritization Matrix**



CAHF Status at Newcastle Hospitals



Newcastle Hospitals' adopted baseline Hi-HE Actions Forecast impact across all 7 CAHF Policy

Air Quality Monitoring

Above: Air Quality Monitor Location at **Royal Victoria Infirmary (RVI)**

Below: Air Quality Monitor Location at **Freeman Hospital**, Newcastle upon Tyne

Location indicators colour-code: red, ambient diffusion tubes (NO_2 only); cyan, ambient continuous monitoring instrument (NO_2, PM_{10} and $PM_{2.5}$); and blue, Purple Air indoor particulate monitors (PM_{10} and $PM_{2.5}$).

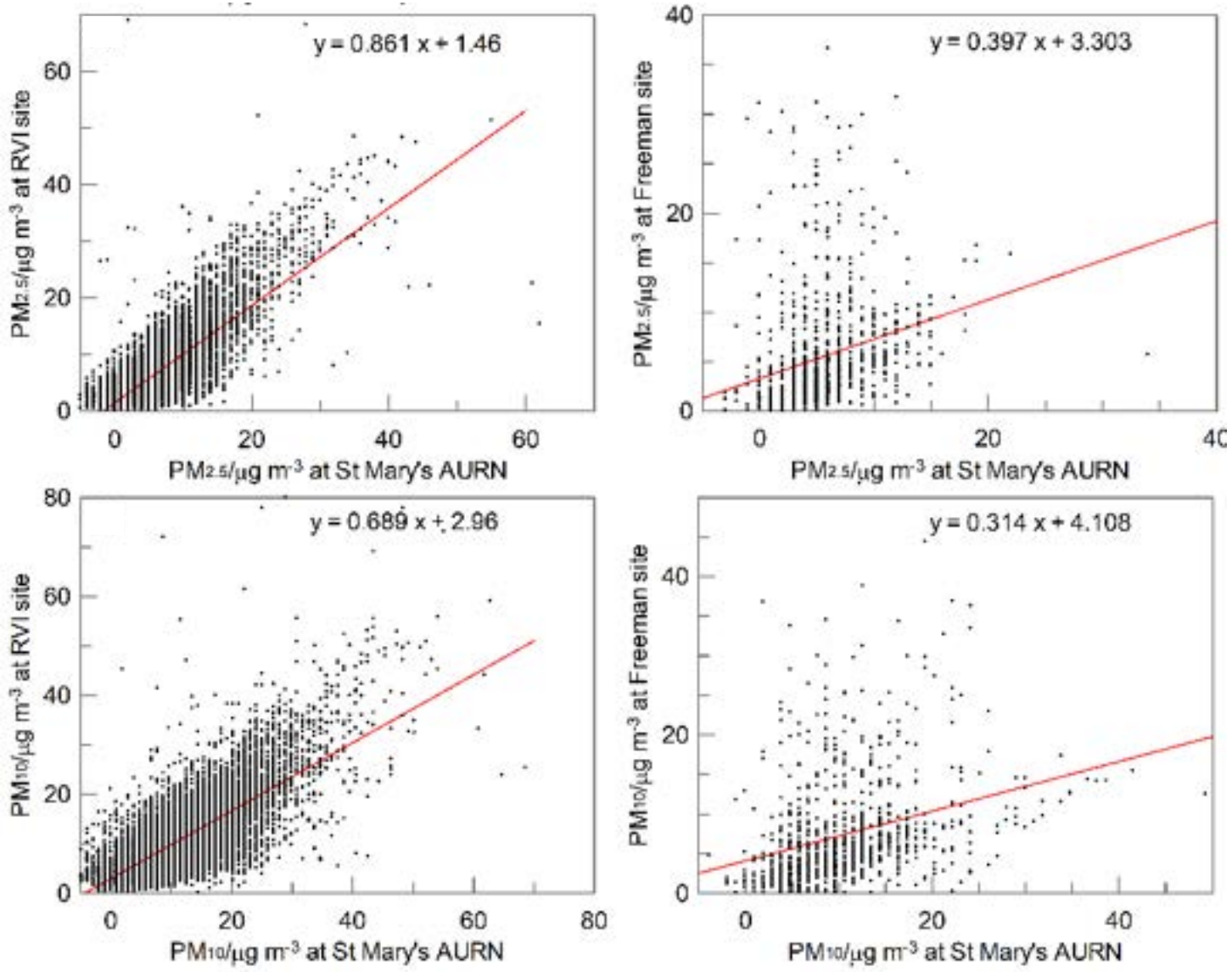
Air Quality Monitoring

Project Air Quality Monitors

Monitoring Environment	Monitor Type	Pollutants	Monitoring Technology
Indoor Air Quality	Purple Air	PM_{10} & $PM_{2.5}$	• Laser particle counters
Ambient Air Quality	Purple Air	PM_{10} & $PM_{2.5}$	• Laser particle counters
	Diffusion Tubes	NO_2	• Passive diffusion process
	AQMesh	PM_{10}, $PM_{2.5}$, & NO2	• Light-scattering optical particle counters for particulates • Electrochemical sensors for NO_2
	Urban Observatory Monitoring Unit	PM_{10}, $PM_{2.5}$, & NO2	• Fine dust aerosol spectrometer for particulates • Chemiluminescent Gas Analyser for NO_2

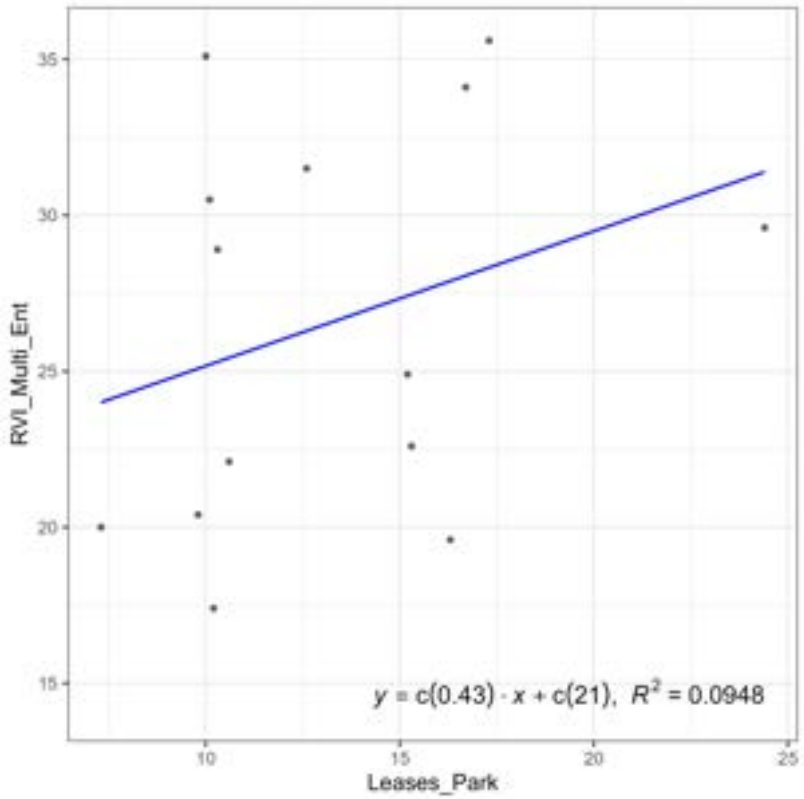
Air Quality Monitoring

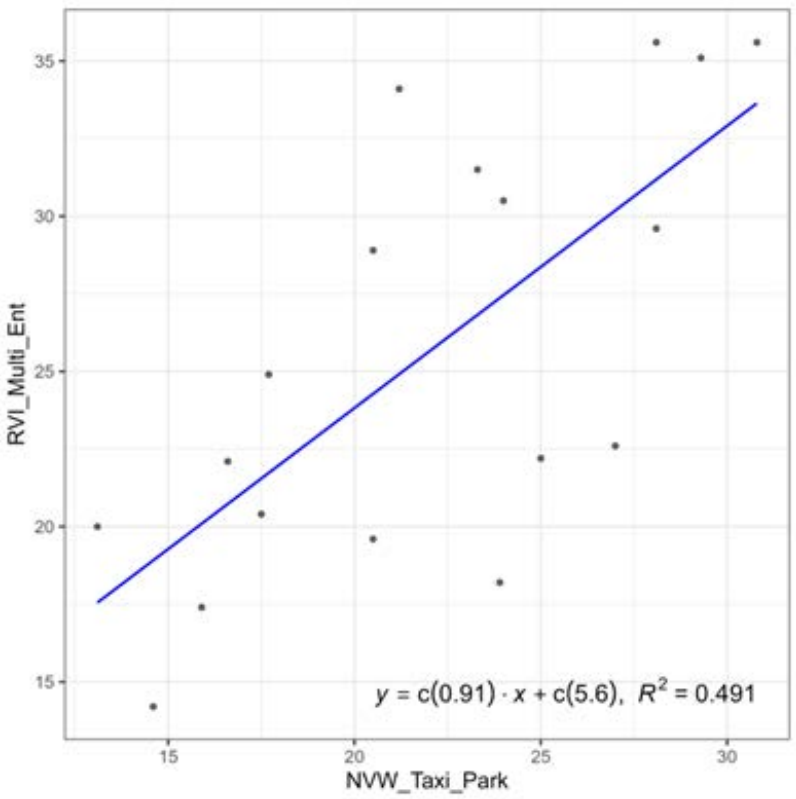
Correlations between airborne pollutant concentrations at the RVI and Freeman with St Mary's monitoring station



Air Quality Monitoring

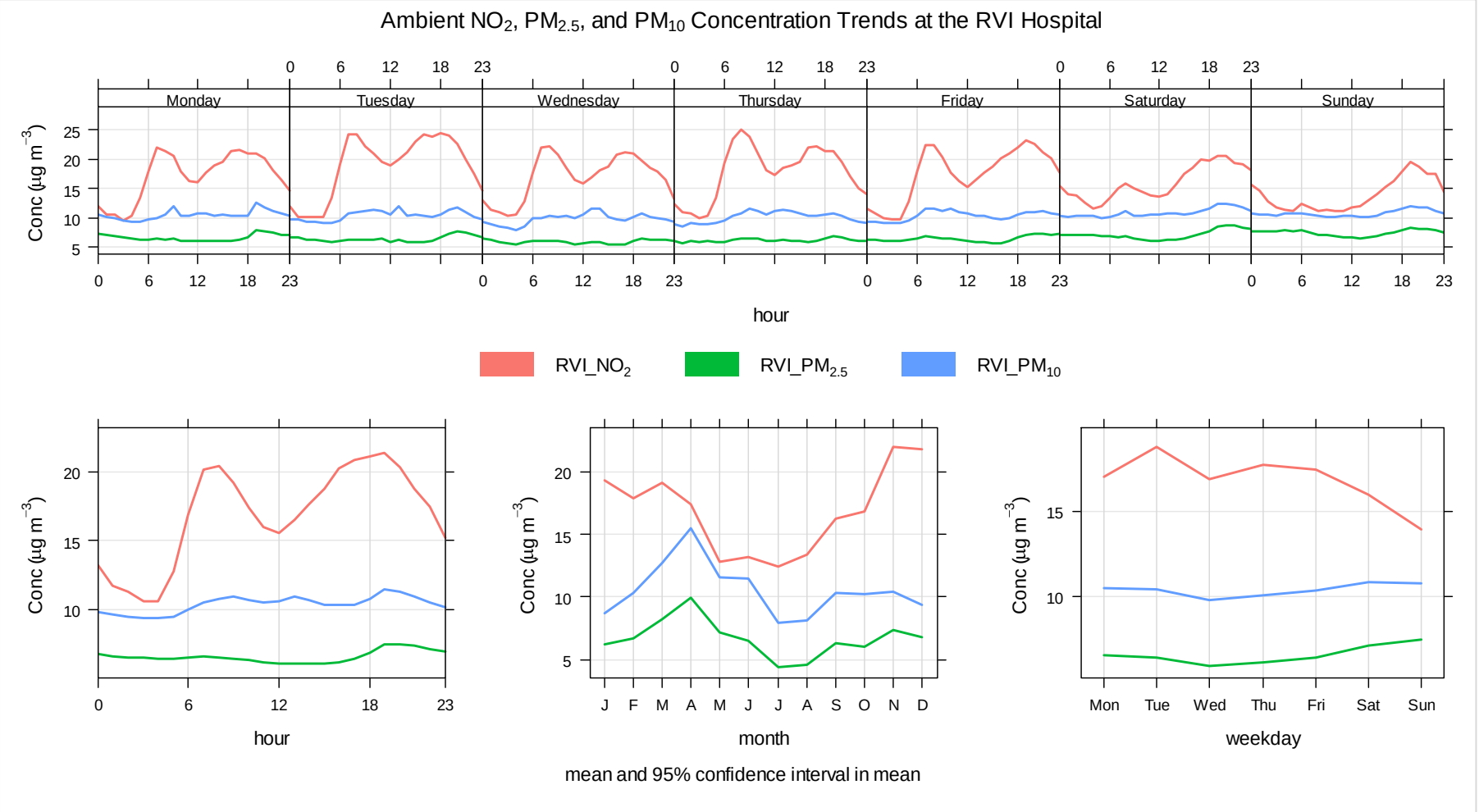
Correlations between passive diffusion tubes monitoring of Nitrogen dioxide concentrations between sites at RVI





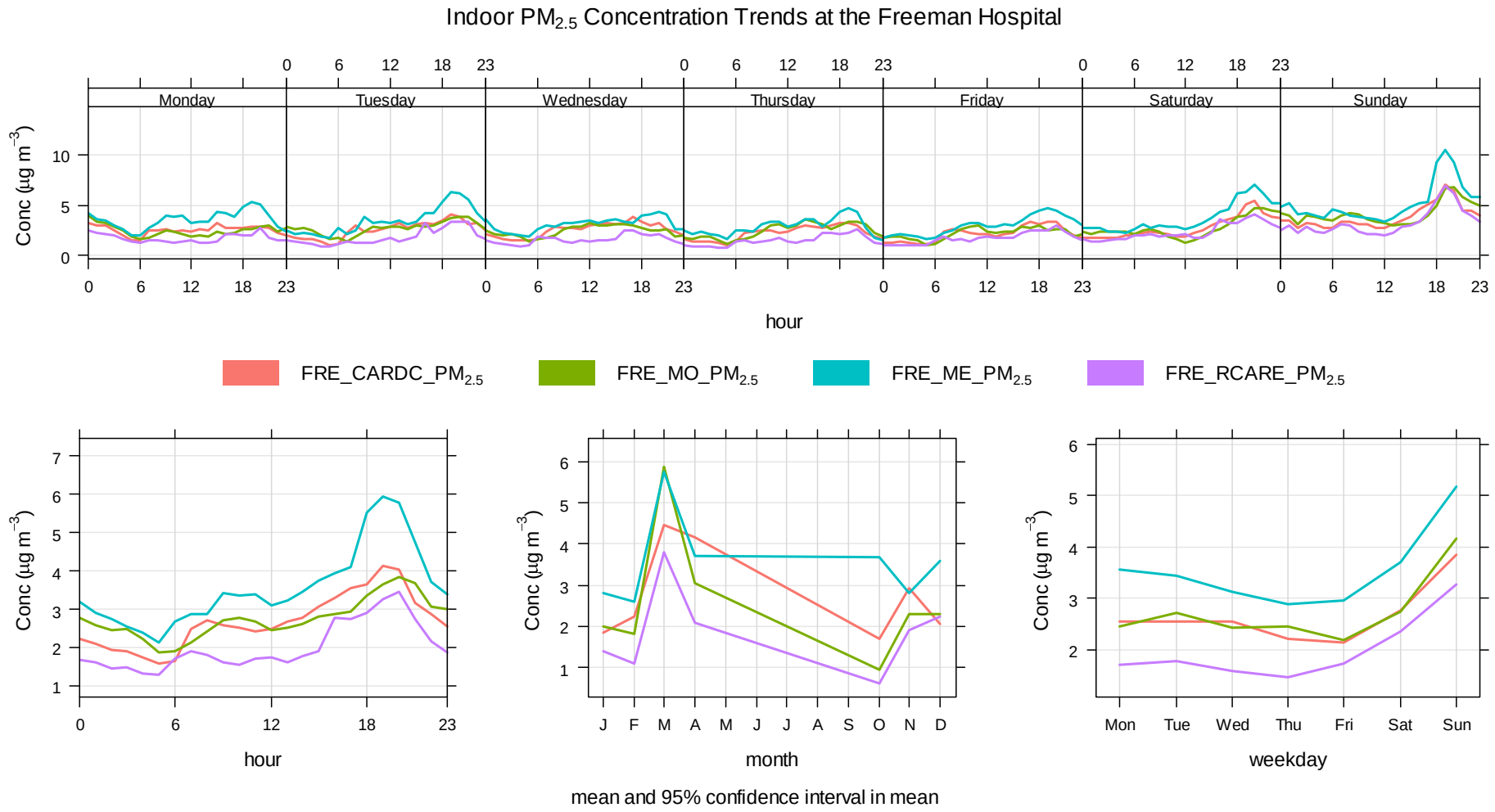
Air Quality Monitoring

Early Data From Ambient AQ Monitoring of NO2, PM10 & PM2.5 at the RVI Hospital



Air Quality Monitoring

Early Data From Indoor AQ Monitoring of PM2.5 at the Freeman Hospital

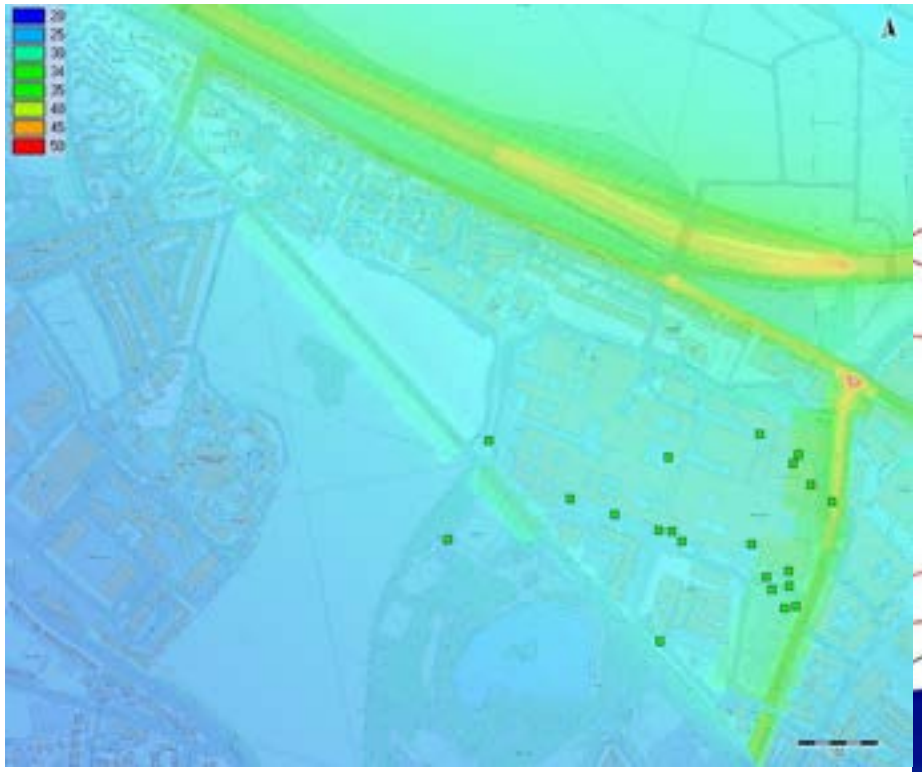


Air Quality Monitoring

NO_2, $PM_{2.5}$, and PM_{10} Exceedances of the WHO and UK guideline values at the RVI and Freeman Hospitals

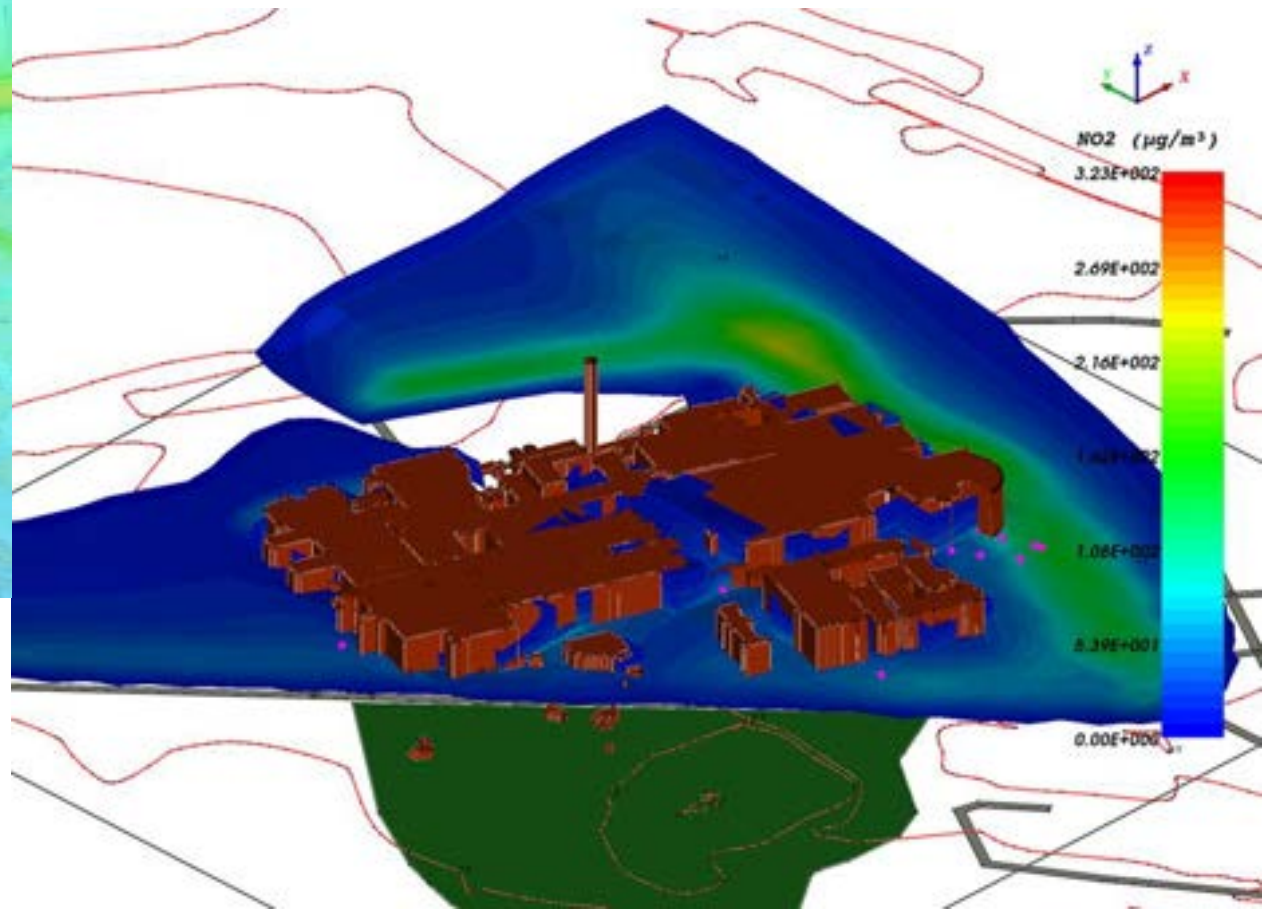
Pollutant and Limit value / guideline	Exceedance status for RVI (2023)	Exceedance status for Freeman (monitoring period)
NO_2		
UK annual (40 µg m^{-3})	Not exceeded	No data
UK 1 hr (200 µg m^{-3})	Not exceeded	No data
WHO 24 hr (25 µg m^{-3})	Exceeded (57 times)	No data
WHO annual (10 µg m^{-3})	Exceeded	No data
$PM_{2.5}$		
UK annual, current (20 µg m^{-3})	Not exceeded	Not exceeded (period mean)
England annual, 2040 (10 µg m^{-3})	Not exceeded	Not exceeded (period mean)
WHO 24 hr (15 µg m^{-3})	Exceeded (16 times)	Exceeded (3 times)
WHO annual (5 µg m^{-3})	Exceeded	Exceeded (period mean)
PM_{10}		
UK annual (40 µg m^{-3})	Not exceeded	Not exceeded (period mean)
WHO 24 hr (45 µg m^{-3})	Not exceeded (1 exceedance, whereas 3 allowed)	Not exceeded (for period)
WHO annual (15 µg m^{-3})	Not exceeded	Not exceeded

Air Quality Modeling



Above:
Contour plot for an ADMS-Urban dispersion model of NO_2 concentrations at the RVI hospital and surrounding area.

Below:
A rendering of the Ground and Obstacle Domain dispersion plot of NO2 at the RVI using Fluidyn CFD



Research Impact

- **Collaboration with major healthcare anchor institutions in the Northeast England**
  - Newcastle NHS Trust together with Northumbria Healthcare and Northeast Ambulance Service (NEAS) signed No Idling Joint statement. This strengthens the No Idling Policy within the Newcastle Trust and extends its Leadership and collaborative effort towards improved air quality environment.
- **Prioritization matrix developed to support CAHF implementation at the Newcastle NHS**
  - Chelsea and Westminster Hospital NHS Trust adopting this matrix
  - Garnered interest at the conference in Australia

Research Impact

- **Parking Policy Changes**
  - Hospital parking policy is reviewed to encourage more active travel and less polluting vehicle access in areas closest to the hospital entrance at the New Victoria Wing Hospital

- **Biodiversity and Green Spaces**
  - Deliberate efforts at integrating Green spaces into the hospital environment

Research Impact

- **Air Quality Monitoring Strategy**
  - Guidance for development and installation of an AQ monitoring strategy at Northumberland Hospital NHS Trust

- **Clean Air Day Awareness**
  - Annual events organised during the clean air day in June to raise awareness and facilitate conversations impacting on Air Quality at the hospital and the wider community

Research Impact

- **Contribution to National Policy discussion** with potential influence on UK's Clean Air Act and Policy implementation such as Parking Policy at Newcastle Hospitals
- Public Health Equality Campaign support at the Newcastle Hospitals such as the **Smoke Free Hospital Project**
- **Supporting implementation of CAHF and AQ monitoring at other Trusts** for example Chelsea and Westminster Hospital, and Northumberland Hospital NHS Trusts
- **Optimisation of HVAC** for enhancing the BMS control of HVAC to minimize energy use from unoccupied theatres

Planned Actions

- Integrate post code air quality data into patient electronic health records

Northumbria University NEWCASTLE

ReNU Renewable Energy Northeast Universities

NHS The Newcastle upon Tyne Hospitals NHS Foundation Trust

THANK YOU!!!

Northumbria University NEWCASTLE

ReNU Renewable Energy Northeast Universities

NHS The Newcastle upon Tyne Hospitals NHS Foundation Trust

THANK YOU!!!

`Babatunde.okeowo@northumbria.ac.uk

LinkedIn

Session 2: NHS action towards clean air, climate change and health

Evaluating air quality actions at the Queen Elizabeth Hospital, Birmingham

Dr Catherine Muller

Project Manager (WM-Air, WM Net-Zero, INHABIT), University of Birmingham

Clean Air Programme

West Midlands Combined Authority

Met Office

UK Research and Innovation

WM-AIR

WM-AIR@CONTACTS.BHAM.AC.UK

@WMAIR_UOB

WM-AIR.ORG.UK

WM-AIR

CLEAN AIR SCIENCE FOR THE WEST MIDLANDS

Evaluating air quality actions at the Queen Elizabeth Hospital, Birmingham

Dr Catherine Muller

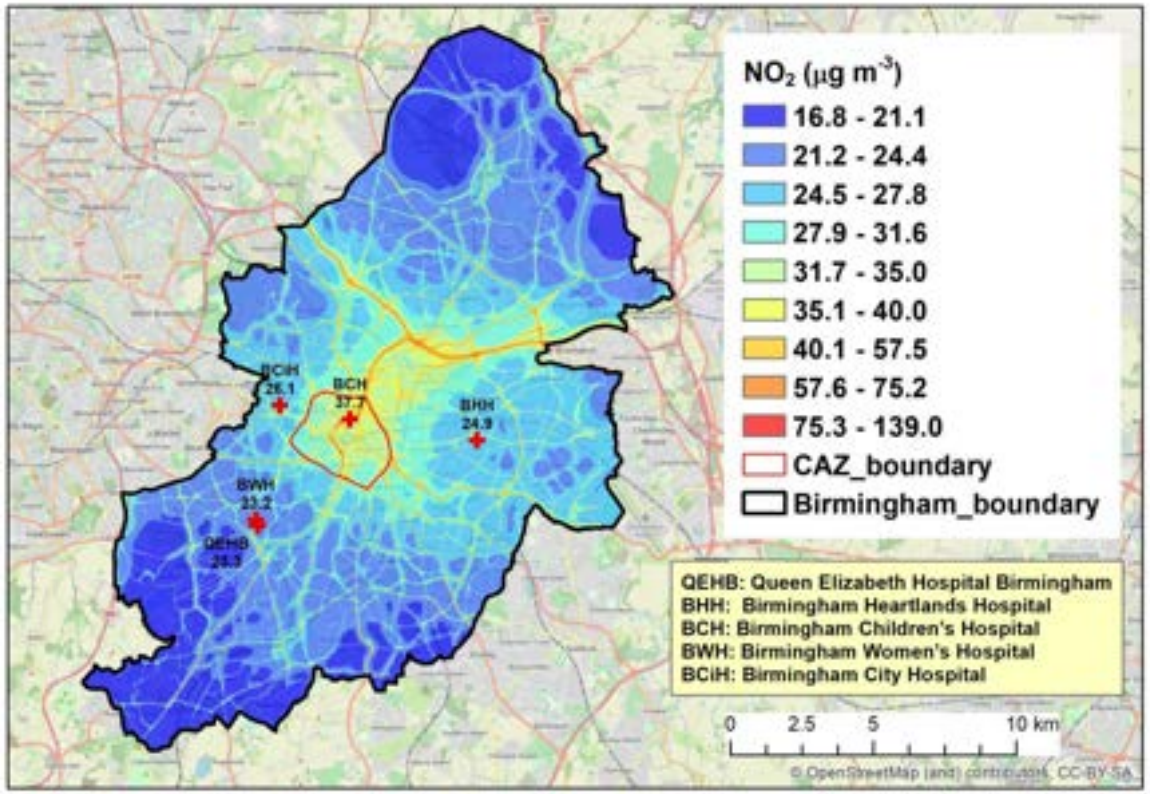
Project Manager - facilitating the translation of research into impact

UNIVERSITY OF BIRMINGHAM

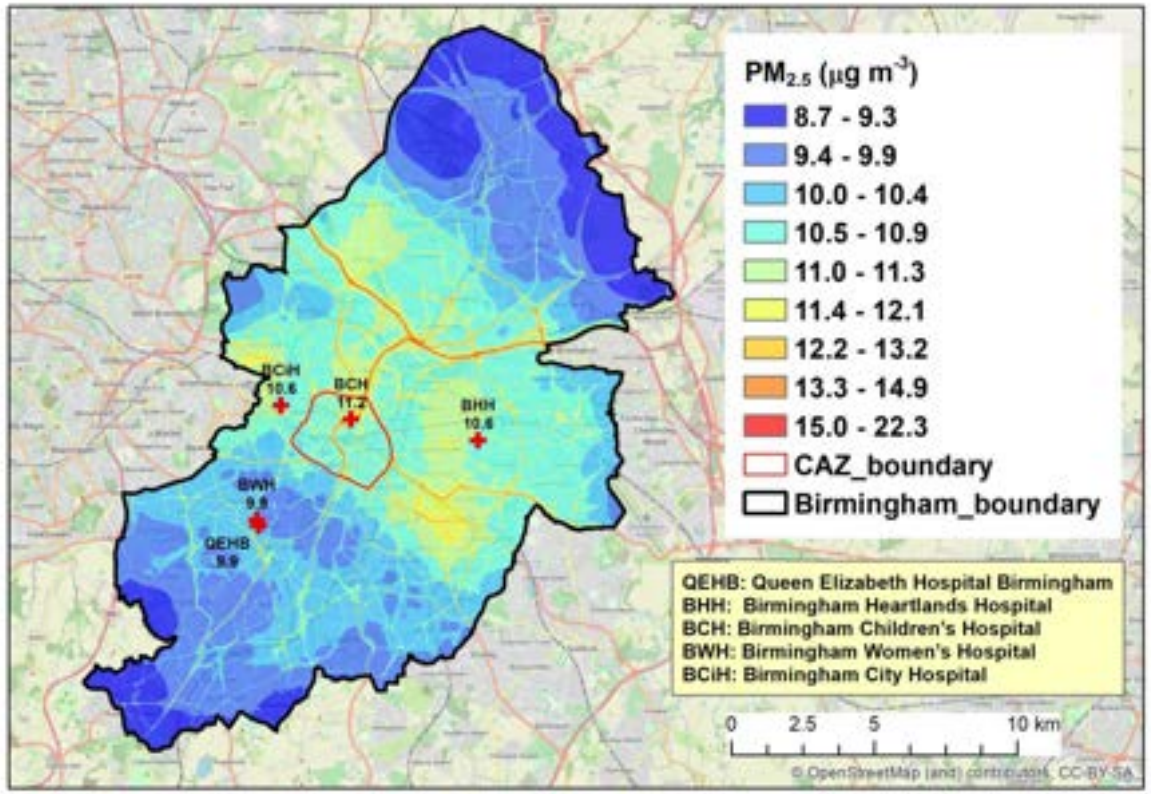
UKRI Natural Environment Research Council

Background: Air Quality in Birmingham (2021)

a) Annual air quality map of mean NO_2 over Birmingham for 2021



b) Annual air quality map of mean $PM_{2.5}$ over Birmingham for 2021



Zhong et al, 2019. Using task farming to optimise a street-scale resolution air quality model of the West Midlands (UK). Atmosphere 12(8): 983; 2019. https://doi.org/10.3390/atmos12080983

Queen Elizabeth Hospital Birmingham (QEHB)

- University Hospitals Birmingham NHS Foundation Trust (UHB)
  - 2 million outpatient attendances and 370,000 admissions each year (UHB, 2021)
- QEHB: ~1,200 bed tertiary NHS and military hospital in Edgbaston, Birmingham

- Large campus (patient care, research, education)
- Well-placed for transport modal shift initiatives
  - University station
  - Canalside cycleway
  - Bus routes and stops

Clean Air Hospital Framework + Green Plan

Our committment to improving Air Quality: West Midlands Air Quality Improvement Programme (WM-Air) [1]

Through the Birmingham and Solihull Sustainability and Transformation Partnership (STP), UHB participates in WM-Air, a five-year initiative to support the improvement of air quality, and associated health, environmental and economic benefits, in the West Midlands.

Air pollution in the West Midlands affects some 2.8 million people, reducing average life expectancy by up to 6 months, and is responsible for economic costs estimated at £860m per year.

Launched in January 2019, WM-AIR will provide an improved understanding of pollution sources and levels in the region. It will support the application of these to specific case studies across the West Midlands, ranging from major infrastructure projects, such as HS2, to making effective use of Green Infrastructure across the city.

As part of the project, the air quality across our sites is being measured, with the aim of understanding what mitigating actions might be necessary to improve air quality for our patients, staff and visitors.

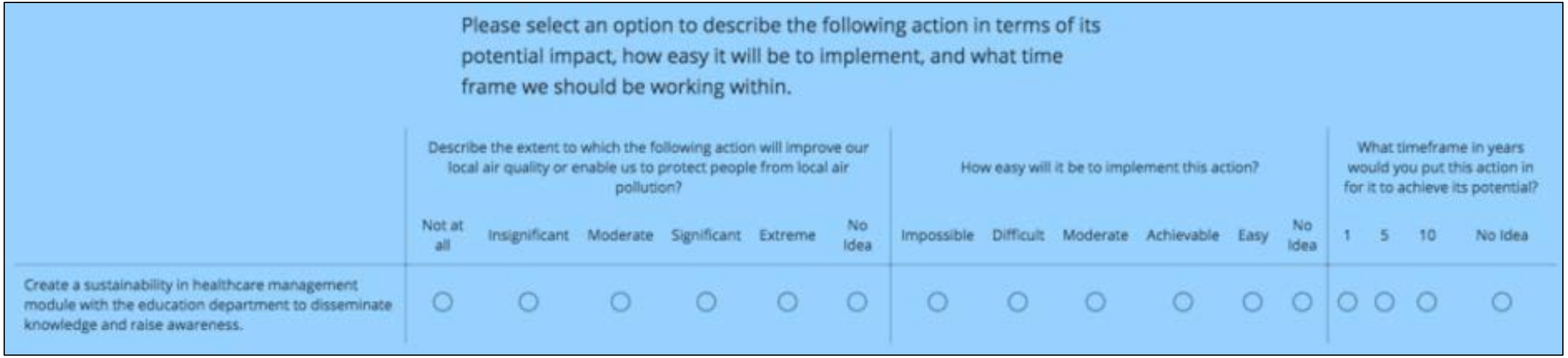
https://www.cleanairhub.org.uk/news-stories/launch-of-the-first-ever-clean-air-hospital-framework

https://www.uhb.nhs.uk/media/xhwirhxh/sustainability-strategy.pdf

1) Clean Air Hospital Framework Evaluation: Study Design

<u>Mixed - Methods Study</u>

1) Scoping - actions to reduce air pollutant emissions and/or protect from exposure
2) Data collection – interviews (qualitative) and electronic staff survey (quantitative)
3) Data integration – ranking by impact, achievability, timeframe



Please select an option to describe the following action in terms of its potential impact, how easy it will be to implement, and what time frame we should be working within.

	Describe the extent to which the following action will improve our local air quality or enable us to protect people from local air pollution?						How easy will it be to implement this action?						What timeframe in years would you put this action in for it to achieve its potential?			
	Not at all	Insignificant	Moderate	Significant	Extreme	No Idea	Impossible	Difficult	Moderate	Achievable	Easy	No Idea	1	5	10	No Idea
Create a sustainability in healthcare management module with the education department to disseminate knowledge and raise awareness.	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○	○

1) Clean Air Hospital Framework Evaluation: Recommendations

Operational: Data and Communications

- Collect patient and visitor travel data within check-in systems
- Embed sustainable transport options in patient correspondence

Operational: Monitoring and Performance

- Adopt performance indicators measuring performance against sustainability/air quality
- Build sustainability into procurement processes

Transport

- Embed remote hospital activity where possible
- **Improved cycle parking + facilities**
- **Modal shift away from single-occupancy car journeys**
- Replace diesel lorries and vans with low-emission alternatives
- Install EV charging in Trust car-parking facilities
- Review logistics to assess potential for cycle courier deliveries
- **Traffic management changes** (esp. to reduce congestion at main entrance)
- Create new roles: **sustainability officer** and transport coordinator

sustainability

MDPI

Article

Evaluating Actions to Improve Air Quality at University Hospitals Birmingham NHS Foundation Trust

Owain Simpson [1,*], Mark Elliott [2], Catherine Muller [3], Tim Jones [1], Phillippa Hentsch [1], Daniel Rooney [3], Nicole Cowell [3], William J. Bloss [3] and Suzanne E. Bartington [4]

[1] Queen Elizabeth Hospital, University Hospitals Birmingham NHSFT, Birmingham B15 2GW, UK
[2] Institute of Digital Healthcare, WMG, University of Warwick, Coventry CV4 7AL, UK
[3] School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham B15 2TT, UK
[4] Institute of Applied Health Research, University of Birmingham, Birmingham B15 2TT, UK
* Correspondence: owain.simpson@uhb.nhs.uk

Abstract: Air pollution is the single largest environmental risk to human health in the UK, exerting a major healthcare sector burden and exacerbating health and social inequalities. The NHS Long Term Plan commits the healthcare sector to reducing emissions from all sources, however, to date few Acute NHS Trusts have implemented air quality focused sustainability plans. In this case study, we assess potential air quality improvement actions at University Hospitals Birmingham NHS Foundation Trust's, Queen Elizabeth Hospital in Birmingham, UK as a test case for NHS sustainability actions. We generate an evidenced based, prioritized shortlist of actions to mitigate emissions and protect patients, staff, and local communities from air pollution exposure. The project supports adoption of an evidence-based, contextually relevant, approach to air quality management within healthcare provision. The methodology used could be employed by organizations with similar goals to address environmental concerns.

check for updates

Citation: Simpson, O.; Elliott, M.; Muller, C.; Jones, T.; Hentsch, P.;

Source: Simpson et al, 2022. Evaluating Actions to Improve Air Quality at University Hospitals Birmingham NHS Foundation Trust. Sustainability, 14(18), 11128. https://doi.org/10.3390/su141811128

2) Air Quality Monitoring and Evaluation: Study Design

Data Collection

- Diffusion tubes (NO_2) – monthly average concentrations (Aug 2020–Jul 2021 and April –July 2023)
- Small form (Earthsense Zephyr) sensors (PM) - hourly average concentrations (Sep 2021 – Aug 2022)
- Meteorological data – Birmingham Air Quality Supersite (BAQS)

Diffusion tube and small form sensor monitoring locations: Queen Elizabeth Hospital, Birmingham Women's and Children's Hospitals and University of Birmingham

2) Air Quality Monitoring and Evaluation: Results

- Concentrations exceeded WHO Global Air Quality Guidelines (annual average) at all locations

- Nitrogen Dioxide (NO_2)
  - Highest concentrations (34 µg m^{-3}) at the QEHB main entrance (all months)
  - There was a significant (monthly) reduction (24 µg m^{-3} between 2021 and 2023
  - Changes to the bus route via a bus lane + reducing drop off locations.

- Particulate Matter ($PM_{2.5}$)
  - Annual average concentrations ranged between 6.7 -7.8 µgm^{-3}.
  - Diurnal profile - morning/evening peaks
  - Close correlation between sampling locations

Main entrance loop

Lessons Learned

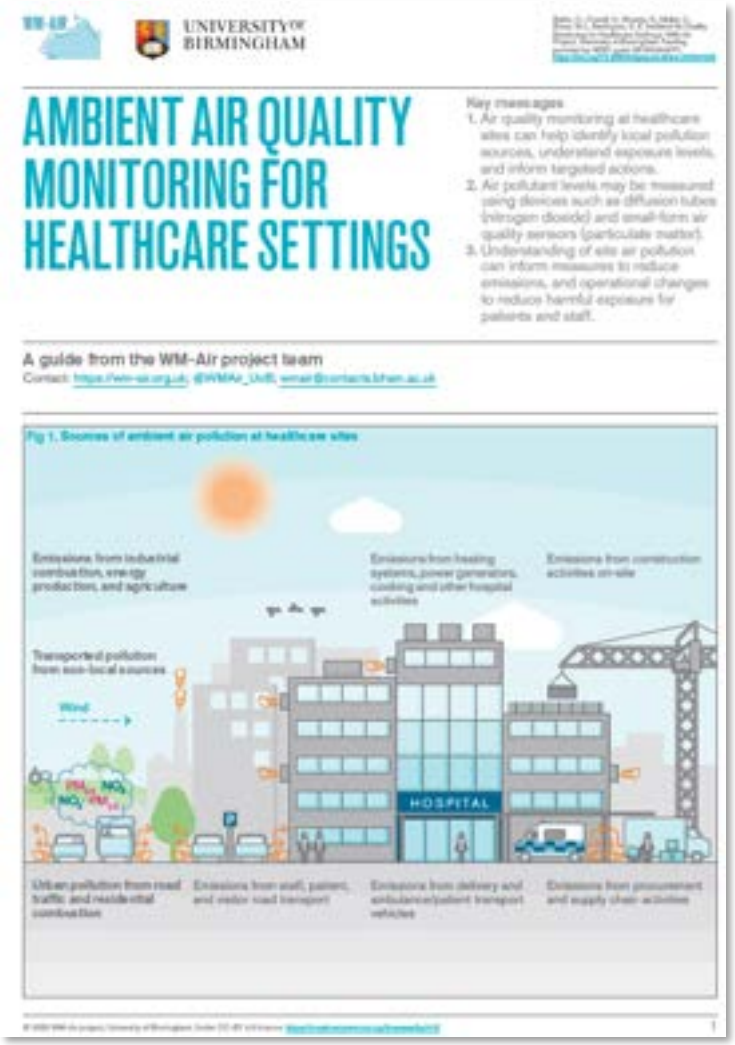
- Air quality monitoring and evaluation:
  - Viable in an acute healthcare setting (staff time and resource)
  - Diffusion tube monitoring more feasible than small form sensors (cost, analysis)
  - Key hotspots can be identified for targeted action

- Collaboration is essential:
  - Partnership working for effective cross-sector regional action
  - Academic institutions can provide scientific/digital/methodological support
  - Data integration from a range of sources (healthcare, local authority, research, transport)
  - Mixed methods research provides valuable insights (feasibility, lived experience)

"The data and guidance provided by WM-Air have been instrumental in informing our strategies and shaping our policies to encourage active travel."

- Mrs. Kawun Williams, Head of Sustainability - Strategic Developments, Sustainability & Property (SDSP), UHB NHS Trust

Air Quality Monitoring Guidance (WM-Air)



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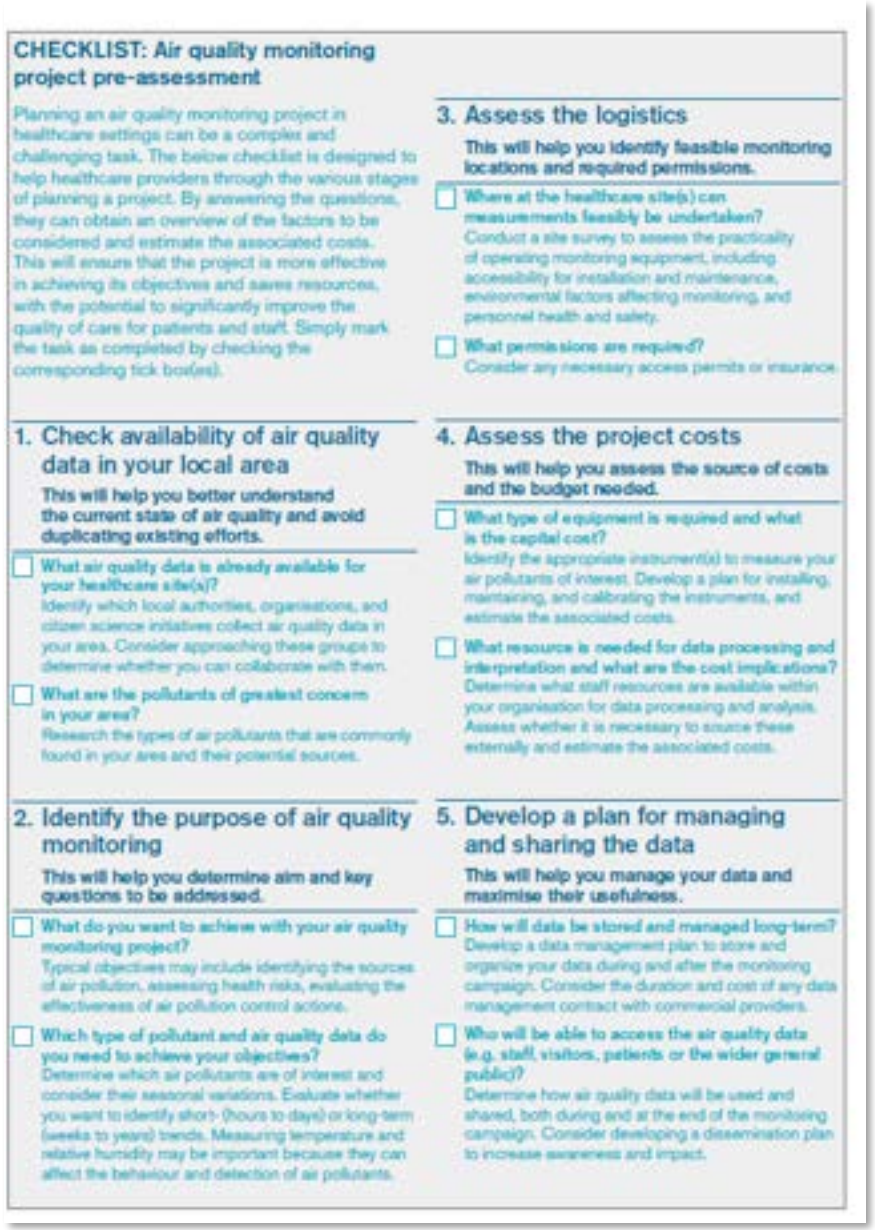
AMBIENT AIR QUALITY MONITORING FOR HEALTHCARE SETTINGS

Key messages
1. Air quality monitoring at healthcare sites can help identify local pollution sources, understand exposure levels, and inform targeted actions.
2. Air pollutant levels may be measured using devices such as diffusion tubes (nitrogen dioxide) and small-form air quality sensors (particulate matter).
3. Understanding of site air pollution can inform measures to reduce emissions, and operational changes to reduce harmful exposure for patients and staff.

A guide from the WM-Air project team

Fig 1. Sources of ambient air pollution at healthcare sites

Emissions from industrial combustion, energy production, and agriculture
Emissions from heating systems, power generators, cooking and other hospital activities
Emissions from construction activities on-site
Transported pollution from non-local sources
Wind
HOSPITAL
Urban pollution from road traffic and residential combustion
Emissions from staff, patients, and visitor road transport
Emissions from delivery and ambulance/patient transport vehicles
Emissions from procurement and supply chain activities



CHECKLIST: Air quality monitoring project pre-assessment

Planning an air quality monitoring project in healthcare settings can be a complex and challenging task. The below checklist is designed to help healthcare providers through the various stages of planning a project. By answering the questions, they can obtain an overview of the factors to be considered and estimate the associated costs. This will ensure that the project is more effective in achieving its objectives and saves resources, with the potential to significantly improve the quality of care for patients and staff. Simply mark the task as completed by checking the corresponding tick box(es).

1. Check availability of air quality data in your local area

This will help you better understand the current state of air quality and avoid duplicating existing efforts.

- ☐ **What air quality data is already available for your healthcare site(s)?**
  Identify which local authorities, organisations, and citizen science initiatives collect air quality data in your area. Consider approaching these groups to determine whether you can collaborate with them.
- ☐ **What are the pollutants of greatest concern in your area?**
  Research the types of air pollutants that are commonly found in your area and their potential sources.

2. Identify the purpose of air quality monitoring

This will help you determine aim and key questions to be addressed.

- ☐ **What do you want to achieve with your air quality monitoring project?**
  Typical objectives may include identifying the sources of air pollution, assessing health risks, evaluating the effectiveness of air pollution control actions.
- ☐ **Which type of pollutant and air quality data do you need to achieve your objectives?**
  Determine which air pollutants are of interest and consider their seasonal variations. Evaluate whether you want to identify short- (hours to days) or long-term (weeks to years) trends. Measuring temperature and relative humidity may be important because they can affect the behaviour and detection of air pollutants.

3. Assess the logistics

This will help you identify feasible monitoring locations and required permissions.

- ☐ **Where at the healthcare site(s) can measurements feasibly be undertaken?**
  Conduct a site survey to assess the practicality of operating monitoring equipment, including accessibility for installation and maintenance, environmental factors affecting monitoring, and personnel health and safety.
- ☐ **What permissions are required?**
  Consider any necessary access permits or insurance.

4. Assess the project costs

This will help you assess the source of costs and the budget needed.

- ☐ **What type of equipment is required and what is the capital cost?**
  Identify the appropriate instrument(s) to measure your air pollutants of interest. Develop a plan for installing, maintaining, and calibrating the instruments, and estimate the associated costs.
- ☐ **What resource is needed for data processing and interpretation and what are the cost implications?**
  Determine what staff resources are available within your organisation for data processing and analysis. Assess whether it is necessary to source these externally and estimate the associated costs.

5. Develop a plan for managing and sharing the data

This will help you manage your data and maximise their usefulness.

- ☐ **How will data be stored and managed long-term?**
  Develop a data management plan to store and organize your data during and after the monitoring campaign. Consider the duration and cost of any data management contract with commercial providers.
- ☐ **Who will be able to access the air quality data (e.g. staff, visitors, patients or the wider general public)?**
  Determine how air quality data will be used and shared, both during and at the end of the monitoring campaign. Consider developing a dissemination plan to increase awareness and impact.

Download:

Available at: https://wm-air.org.uk/information/

User Survey: WM-Air Air Quality Monitoring Guidance Note

https://forms.office.com/e/Ypv97WWnzt

Acknowledgements and Funding

- WM-Air Clean Air Science for the West Midlands https://wm-air.org.uk/
  - Lawrence Tallon (formerly at UHBNHSFT) and colleagues for their collaboration
  - Clean Air Hospital Framework Evaluation: Owain Simpson, Mark Elliot, Catherine Muller, Tim Jones, Phillippa Hentsch, Daniel Rooney, Nicole Cowell, William J Bloss, Suzanne Bartington
  - QEHB Evaluation: Nicole Cowell, Clarissa Baldo, Kawun Williams, Catherine Muller, Siqi Hou, Daniel Rooney, Jian Zhong, Scarlett Healey, William J Bloss, Suzanne Bartington
- Urban Observatories project EPSRC UKCRIC [EP/P016782/1]
- Birmingham Air Quality Supersite OSCA [NE/T001976/1]
- Global Action Plan https://www.globalactionplan.org.uk/

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Clean Air Programme

NHS UHB

Birmingham

global action plan

Session 2: NHS action towards clean air, climate change and health

Introducing the Integrated Care Service Clean Air Hospital Framework

Laura Burgess
Project Officer, Global Action Plan

Malcolm White
Clean Air Specialist, Global Action Plan

Clean Air Programme
West Midlands Combined Authority
Met Office
UK Research and Innovation

global action plan

Malcolm White and Laura Burgess

Introducing the Integrated Care Service Clean Air Framework

13.05.25

Session 3: NHS action towards clean air, climate change and health

UKRI-NIHR Research Hubs: Realising the health co-benefits of the transition to net zero

Session Chair: Dr Gary Fuller

UKRI Clean Air Champion | Imperial College London

Clean Air Programme

West Midlands Combined Authority

Met Office

UK Research and Innovation

UKRI-NIHR Research Hubs: Realising the health co-benefits of the transition to net zero

- **Healthy Low-Carbon Transport Hub -** Professor William Powrie, University of Southampton
- **Child and adolescent Health Impacts of Learning Indoor environments under net zero: The CHILI Hub –** Professor Pia Hardelid, University College London
- **Indoor HABItability during the Transition to Net Zero Housing Hub (INHABIT) –** Professor Zongbo Shi, University of Birmingham
- **THRIVING food futures (Transdisciplinary Health Research to Identify Viable Interventions for Net Zero Goals: food futures)** – Professor Peter Scarborough, University of Oxford
- **HEARTH: National Hub on Net Zero, Health and Extreme Heat -** Professor Rajat Gupta, Oxford Brookes University
- **The UK Hub for One Health Systems: Creating Sustainable Health and Social Care Pathways -** Professor Ed Wilson, University of Exeter
- **A transdisciplinary hub to decarbonise commissioning and delivery of healthcare -** Professor Mahmood Bhutta, Brighton and Sussex Medical School, University of Sussex and University of Brighton

NIHR | National Institute for Health and Care Research

UKRI Medical Research Council

UKRI UK Research and Innovation

Session 3: NHS action towards clean air, climate change and health

INdoor HABITability during the Transition to Net Zero Housing Hub (INHABIT)

Professor Zongbo Shi
Professor of Atmospheric Biogeochemistry, University of Birmingham

Clean Air Programme
West Midlands Combined Authority
Met Office
UK Research and Innovation

INHABIT – Improving indoor environments and health with net zero homes

Prof Zongbo Shi, Professor of Atmospheric Biogeochemistry
University of Birmingham

On behalf of the INHABIT Study Team

University of Birmingham

The University of Edinburgh

UCL

London School of Hygiene & Tropical Medicine

LSE – The London School of Economics and Political Science

King's College London

Cranfield University

University of Cambridge

UK Health Security Agency

University of Surrey

Oxford Brookes University

Award under embargo!

Net Zero Housing to Improve Health

The challenge

How do we ensure that retrofitting 29 million homes will deliver co-benefits for population health and equity?

Energy retrofit

- Health-centred
- Partner -orientated
- Real-world solutions

Our vision

To accelerate the creation of healthy, net zero homes where *everyone* enjoys clean air and comfort indoors

"*Our homes provide the living environment that dictates our future health*."

Sir Michael Marmot

Multi-Sector Team

Health and Social Sciences, Built and Natural Environment

42 Diverse Partners

10 Universities

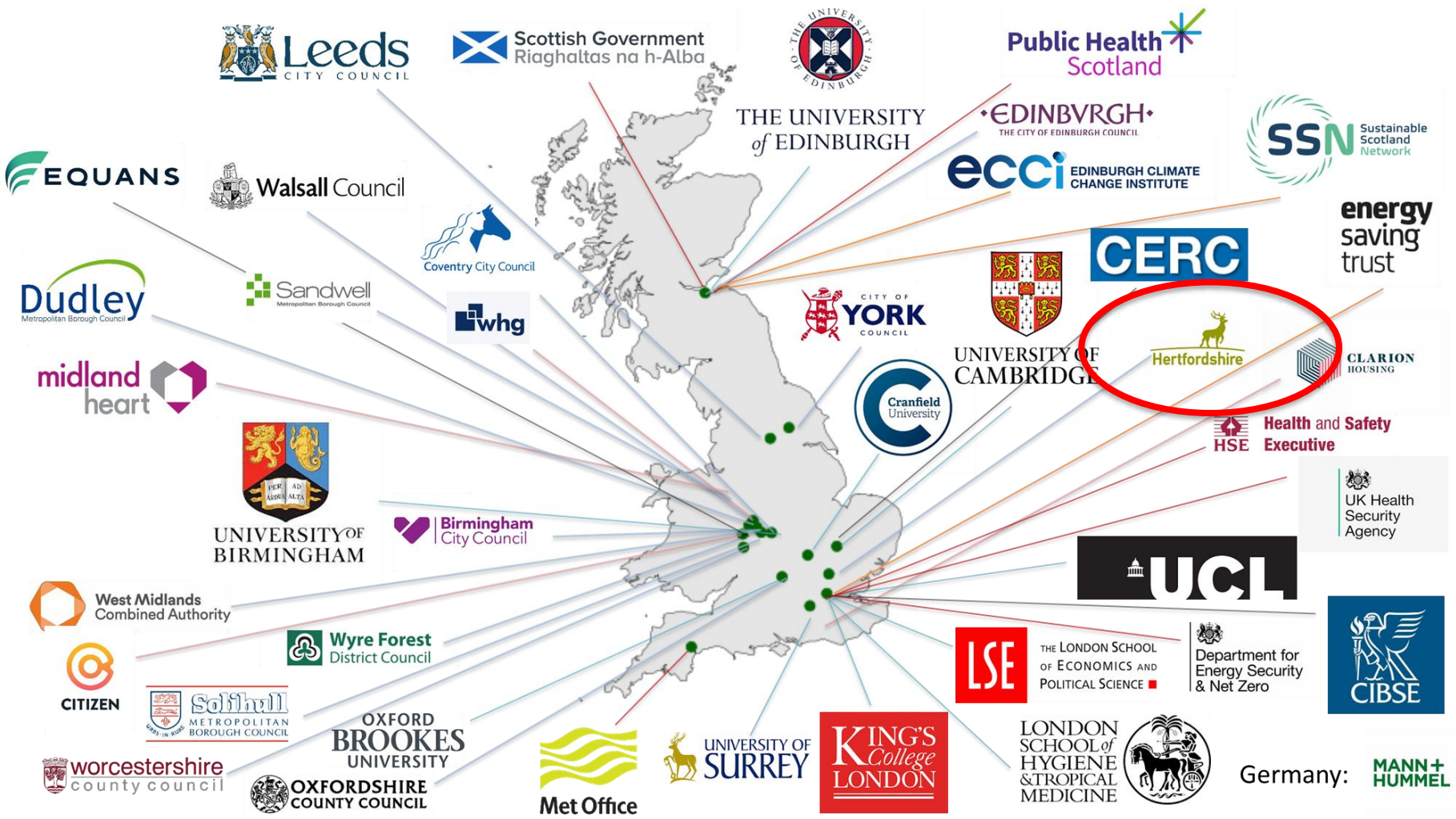
14 Local authorities

6 Government-related

4 Housing associations

4 Industrial partners

4 NGOs



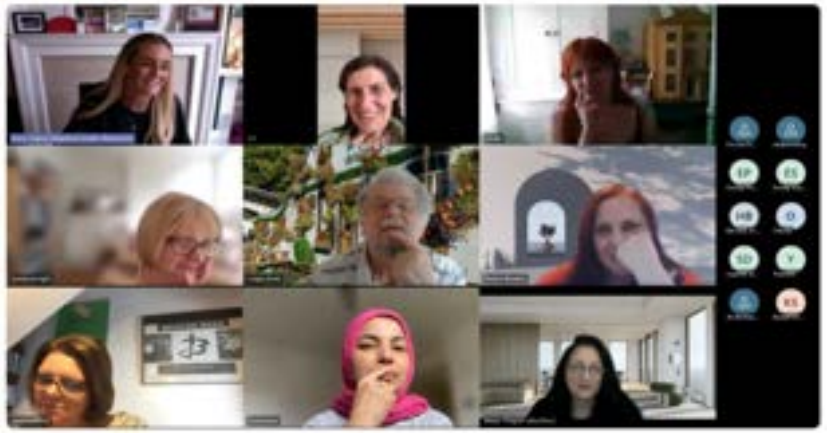
World-leading Expertise, Mature and New Partnerships

Our Approach

- **Co-creation** with key stakeholders:
  - Local authorities
  - Businesses
  - Community groups
- **Real-world measurements** inside homes:
  - Damp/mould
  - Indoor pollution
  - Temperature
- **Net zero housing** policies appraised:
  - Practical implications
  - Costs and benefits (NHS/social care)

Partnerships: Work Strand & Theme Co-leads

Co-creation Solutions



NHS action towards clean air, climate change and health

Interactive discussion and call to action

Session Chair: Dr Gary Fuller

UKRI Clean Air Champion | Imperial College London

Clean Air Programme

West Midlands Combined Authority

Met Office

UK Research and Innovation

Summary and Close

Dr Suzanne Bartington
UKRI Clean Air Champion | University of Birmingham

Dr Jackie Homan
Head of Environment, West Midlands Combined Authority

contact@ukcleanair.org
https://www.ukcleanair.org/
@UKCleanAir
@UKCleanAir

environment@wmca.org.uk
https://www.wmca.org.uk/
@WestMids_CA
@WestMidsCA

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West Midlands Combined Authority
Met Office
UK Research and Innovation