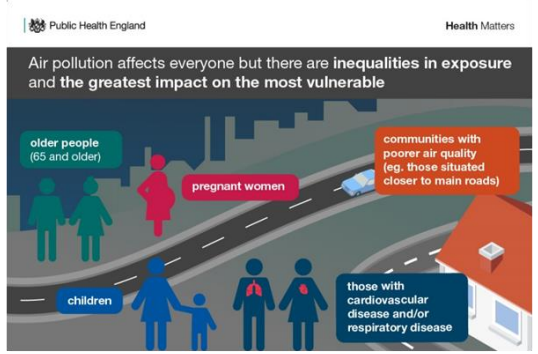
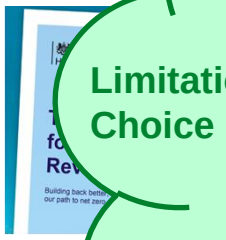
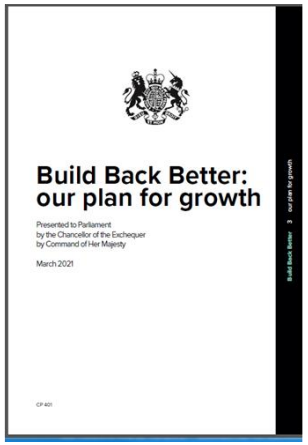
Understanding inequalities and vulnerabilities in air pollution exposure

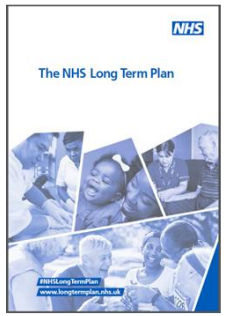
Joe Swift

CARFuG: 12th May 2022









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AQIP Recommendations

- **Engagement:** Make engagement accessible, intersectional and meaningful.
- **Forming a network:** Use of local community groups that already exist and can help with wider engagement and communications.
- **Communicating advice:** Make communications meaningful and practical.
- **Data collection and monitoring:** Make monitoring, data collection and data use meaningful and an ongoing activity.
- **Co-production of interventions:** Encourage co-produced and community led initiatives.
- **Responsibility:** Engage the widest range of stakeholders in the process.

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General understanding for inequalities research

How to embed inequalities into research?

Put the ‘Lived experience’ at the heart!

- What are the best methods to engage those most effected?
- Can we track air quality health groups and vulnerable groups? And form networks?
- What are the best methods of health communication for those most effected?
- Understanding our roles and responsibilities: How to mobilize all sections of society?
- How to enable informed choices? What information do those most effected need, and how to help enable action?

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Specific research areas

1. Indoor AQ: Link and relationship between indoor and outdoor AQ
2. Understanding peoples movement patterns and exposure
3. Quantifying human health: Cost to society of those living with air quality health inequalities
4. Relationship between air quality inequalities and climate change
5. Relationship between air quality inequalities and social equity
6. How to mitigate. What tools can we use? Social analysis and tech solutions / mitigations
7. FUTURE: Impact of population growth and movement over time

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Monitoring and target setting

Monitoring: Where to measure? What to measure (pollutant, averaging times)? How to measures?

- Monitoring averages v heterogeneity.
- Hotspot approach. Focus on worst effected.
- Personal exposure.
- Environment Act: Network expansion is a good chance to make these improvements and measure those nuances in populations.

What to do with the measurements?

- Use hotspots to express the added value. i.e. for health, planning of road etc
- APES Air Pollution Env Survey System
- Identify worst areas and assess interventions
- How to use, inform and enable
- Clear, transparent and trust worthy data

Setting Targets: Moving on from just achieving EU targets. What will have the biggest impact?

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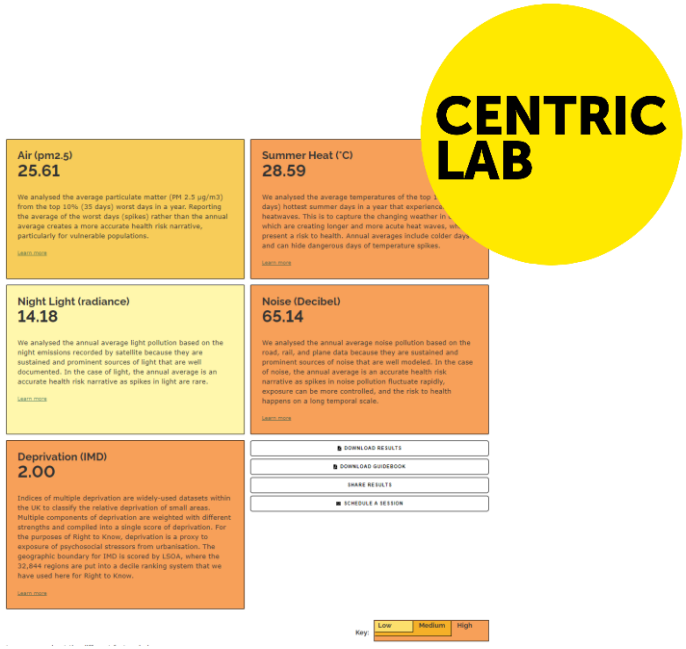
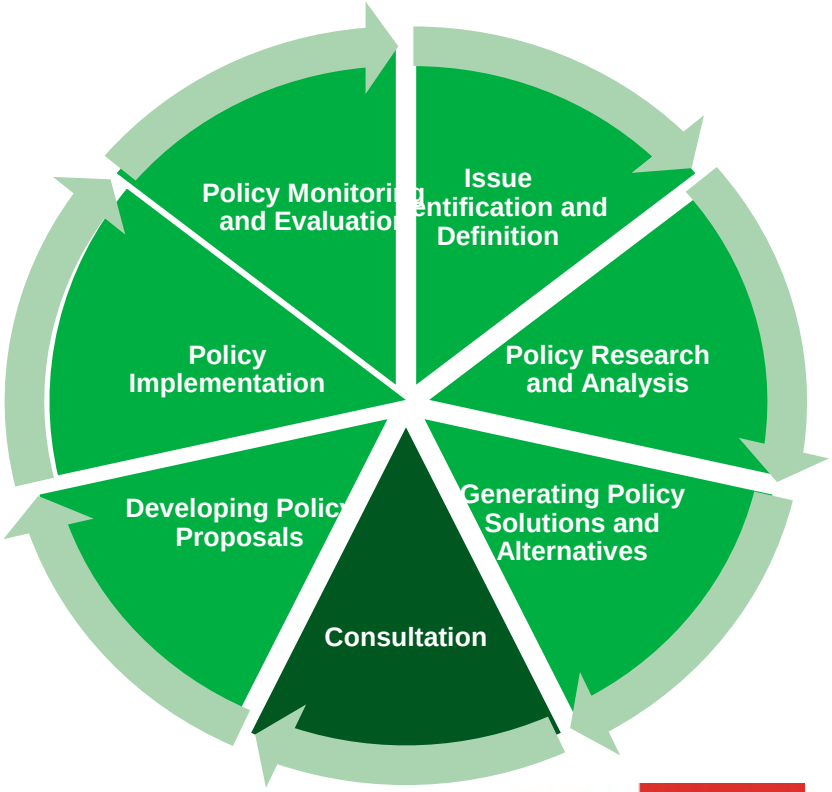
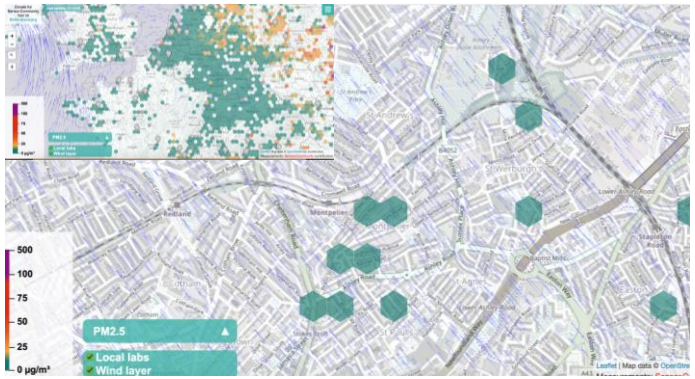
Concepts in Action

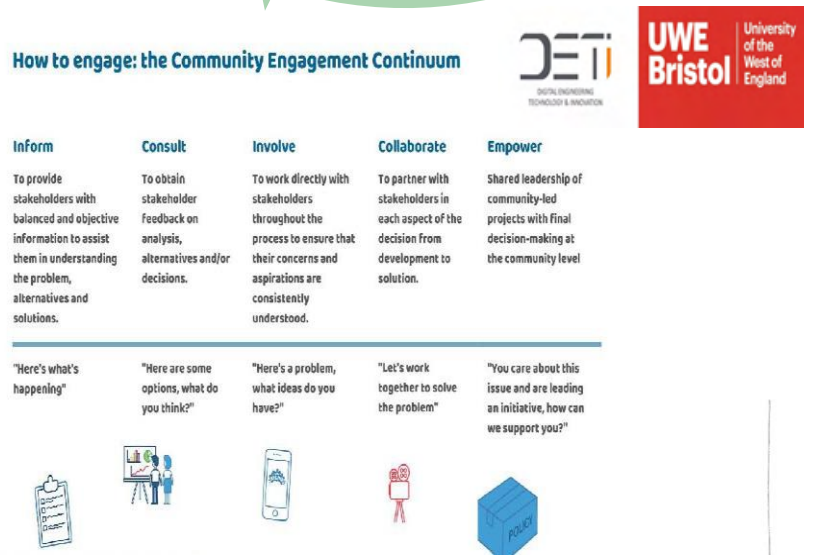


Deprivation
Easton
Bristol
2011
[Census]

NO2
Easton, Bristol
2017
[Earthsense]







UWE Bristol | University of the West of England

Presented by

Jo Barnes,
Associate Professor
Clean Air, Air Quality Management Resource Centre,
UWE Bristol

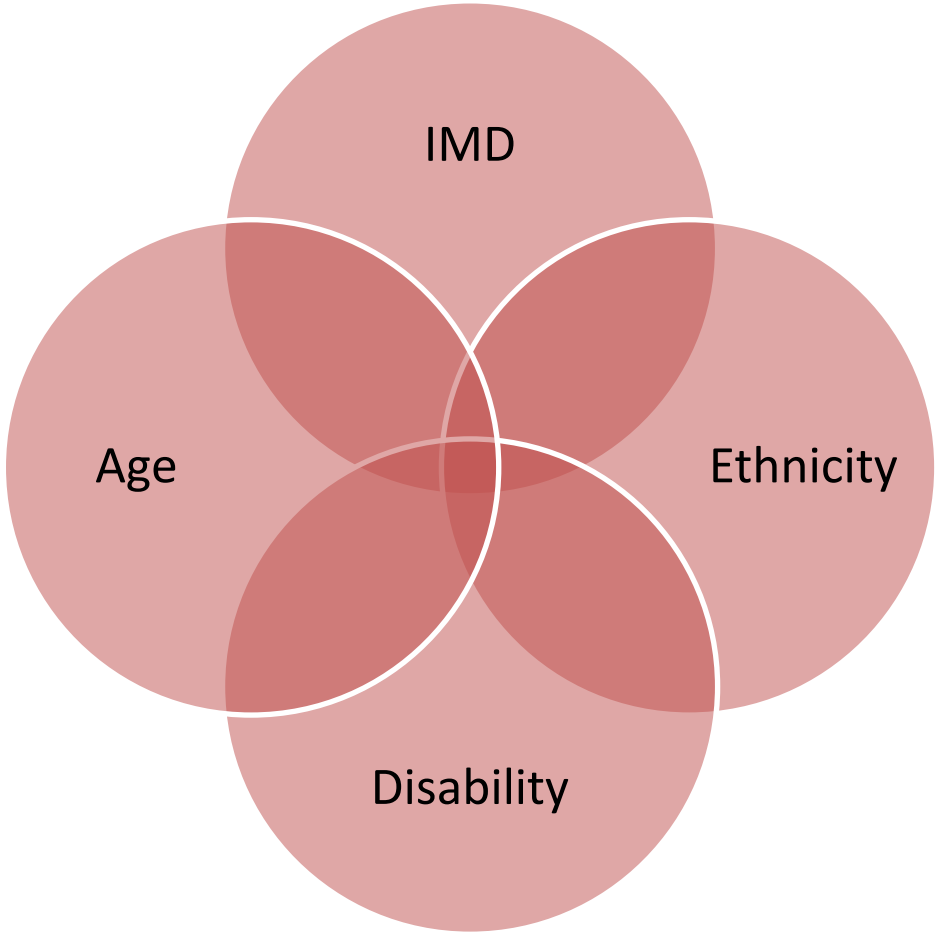
Distributive and procedural justices

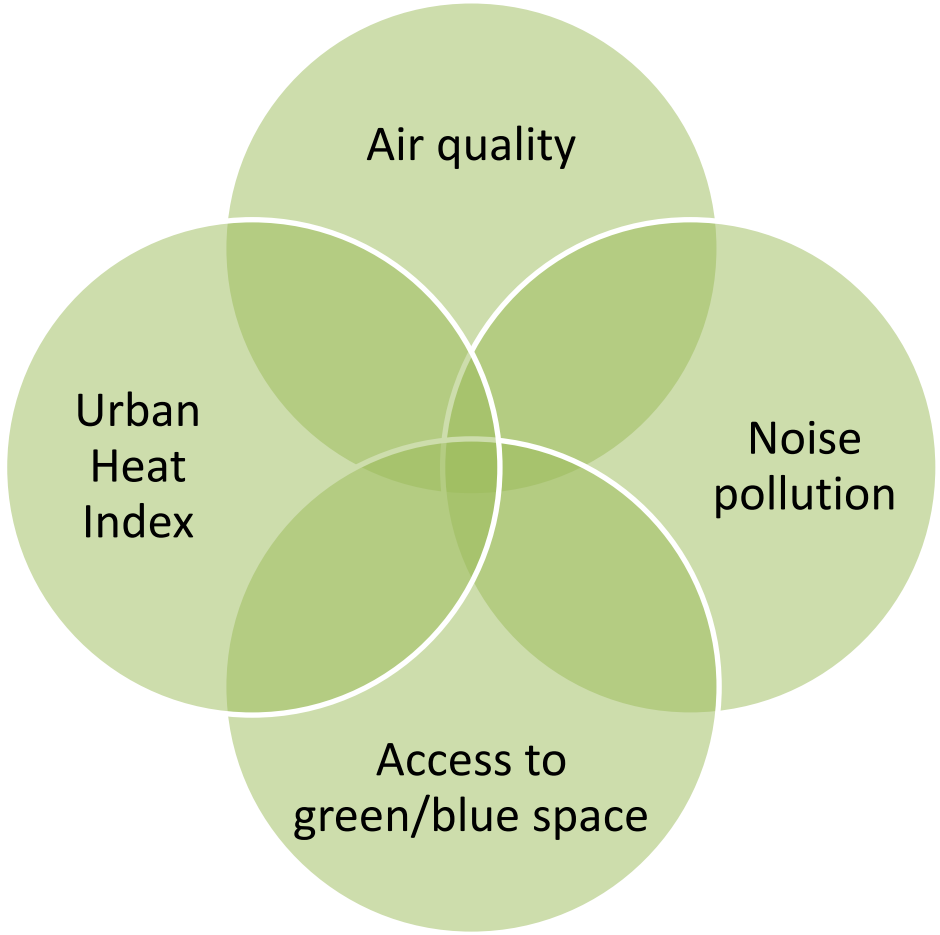
Clean Air Research Futures Group: Meeting 3

What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?

12 May 2022

Intersectionalities – social & environmental

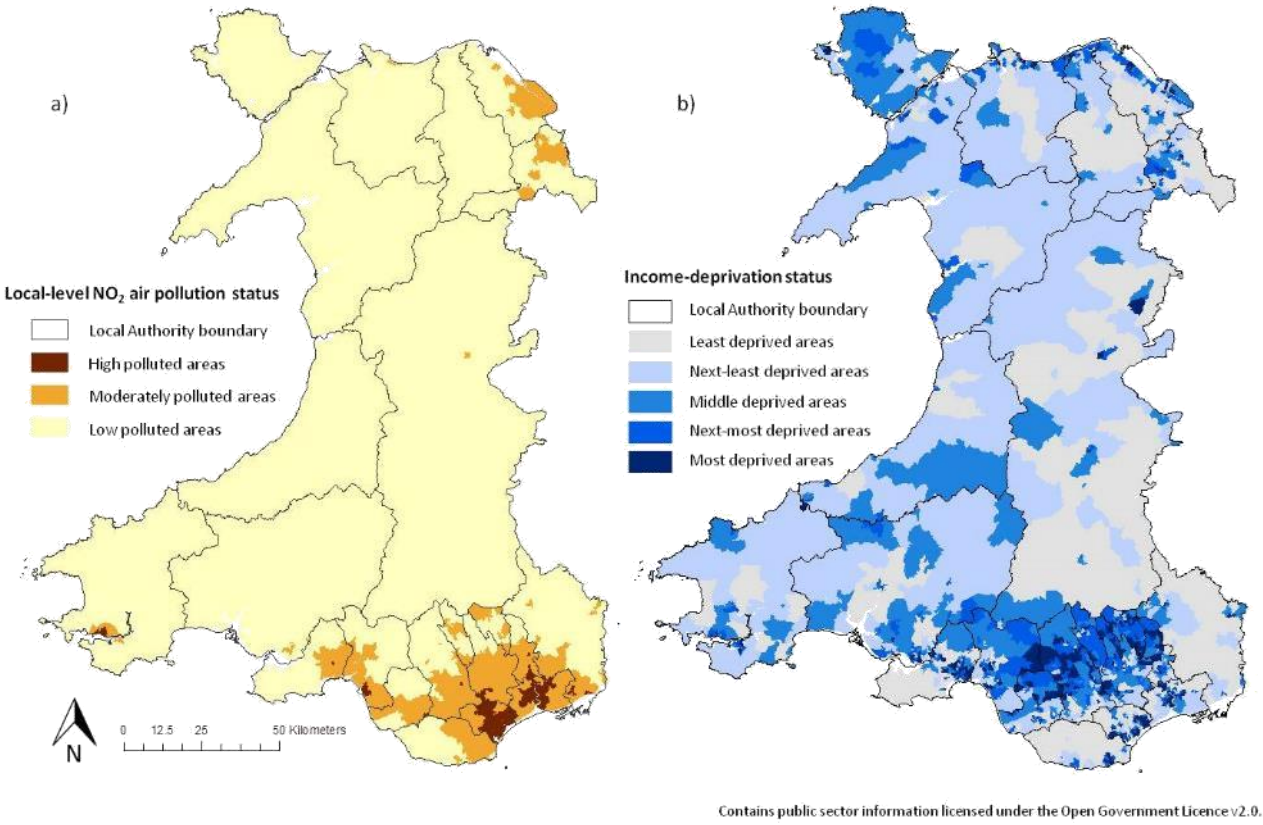




Trends – temporal and spatial

- Are inequalities in air pollution exposure increasing/decreasing over time?
  - Nationally – within DAs
  - Locally – within LAs

- Are inequalities in air pollution exposure changing spatially?
  - Nationally – within DAs
  - Locally – within LAs



Brunt, H., Barnes, J., Jones, S., Longhurst, J., Scally, G. and Hayes, E. T. (2017) Air pollution, deprivation and health: Understanding relationships to add value to local air quality management policy and practice in Wales, UK. *Journal of Public Health*, 39 (3). pp. 485-497. ISSN 1741-3842 Available from: http://eprints.uwe.ac.uk/30133

Policy analysis – e.g. land-use planning

- National Planning Policy Framework/Practice Guidance
- Spatial planning – spatial development strategies, local plans, neighbourhood plans
- Nationally Significant Infrastructure Projects
- Planning approvals – individual/cumulative

- What good practice is happening that can be adopted?
- What are the challenges/barriers to implementation?

Different sources/exposures

“What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?”

- Improving the spatial and temporal representation of air pollution
- Mapping the complex systems of drivers and impacts of air pollution in the context of inequalities, and understanding their relationships
- Connect socio-economic, physical and political dimensions of air pollution, its sources and mitigation options

"What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?"

Improving the spatial and temporal representation of air pollution

- Integrating air pollution mapping with spatial information on inequalities, e.g. deprivation indices and other socio-economic parameters
- Consideration of hotspots/high pollution locations in the context of e.g. commuting and time spent in those environments for different (vulnerable) groups
- Moving from single-pollutant views to overall multi-pollutant loads
- Requires long-term, resilient underpinning data services and infrastructures

"What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?"

Mapping the complex systems of drivers and impacts of air pollution in the context of inequalities, and understanding their relationships

- Inequalities and socio-economic dimensions can be both drivers and endpoints of varying air pollution exposures – requiring complex systems approaches to better understand the relationships and identify potential intervention points
- Identifying unintended consequences and highlighting co-benefits between policies not only focusing on air pollution (e.g. NetZero, biodiversity, …) needs analyses of socio-economic impacts alongside direct environmental and public health impacts

"What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?"

Connect socio-economic, physical and political dimensions of air pollution, its sources and mitigation options

- Mitigation approaches have to be grounded in political economy to be meaningful, feasible, realistic
- Path-dependencies of the socio-economic, physical and political dimensions of air pollution
- Multi-scalar challenges at different geographic/geopolitical dimensions
- Aspects of local community capacity are vital for implementation of interventions
- Requires open, cross-disciplinary research funding calls (and evaluation)

The University Of Sheffield.

What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?

^ mitigation of

Dr Chantelle Wood
University of Sheffield

A WORLD TOP 100 UNIVERSITY

Need research to understand diverse groups'…

Michie et al.'s (2011) COM-B Model

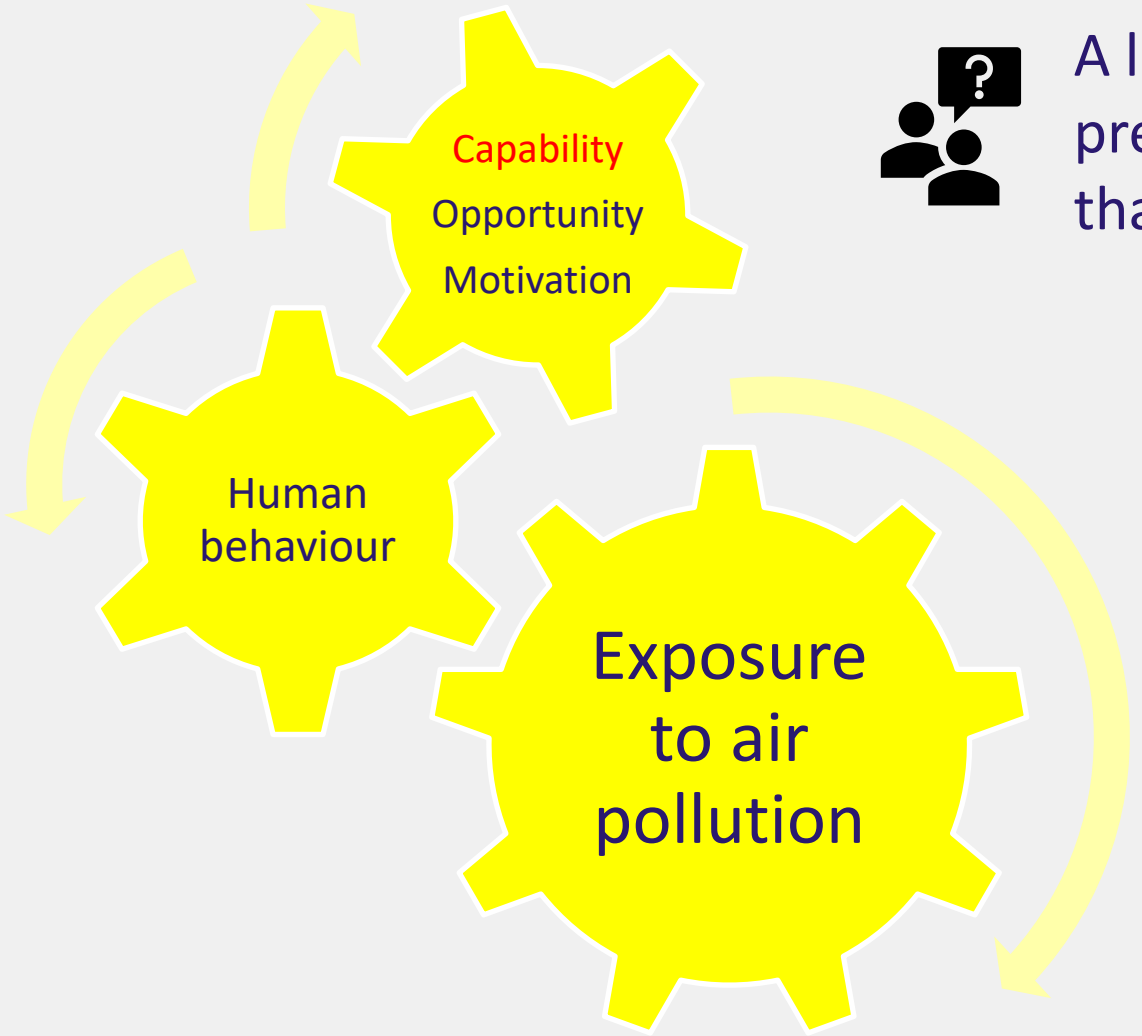
Psychological and physical capability to reduce air pollution exposure

Physical and social opportunity to reduce air pollution exposure

Automatic and reflective motivation to reduce air pollutant exposure

… and research to develop interventions to reduce exposure

If research identifies that…

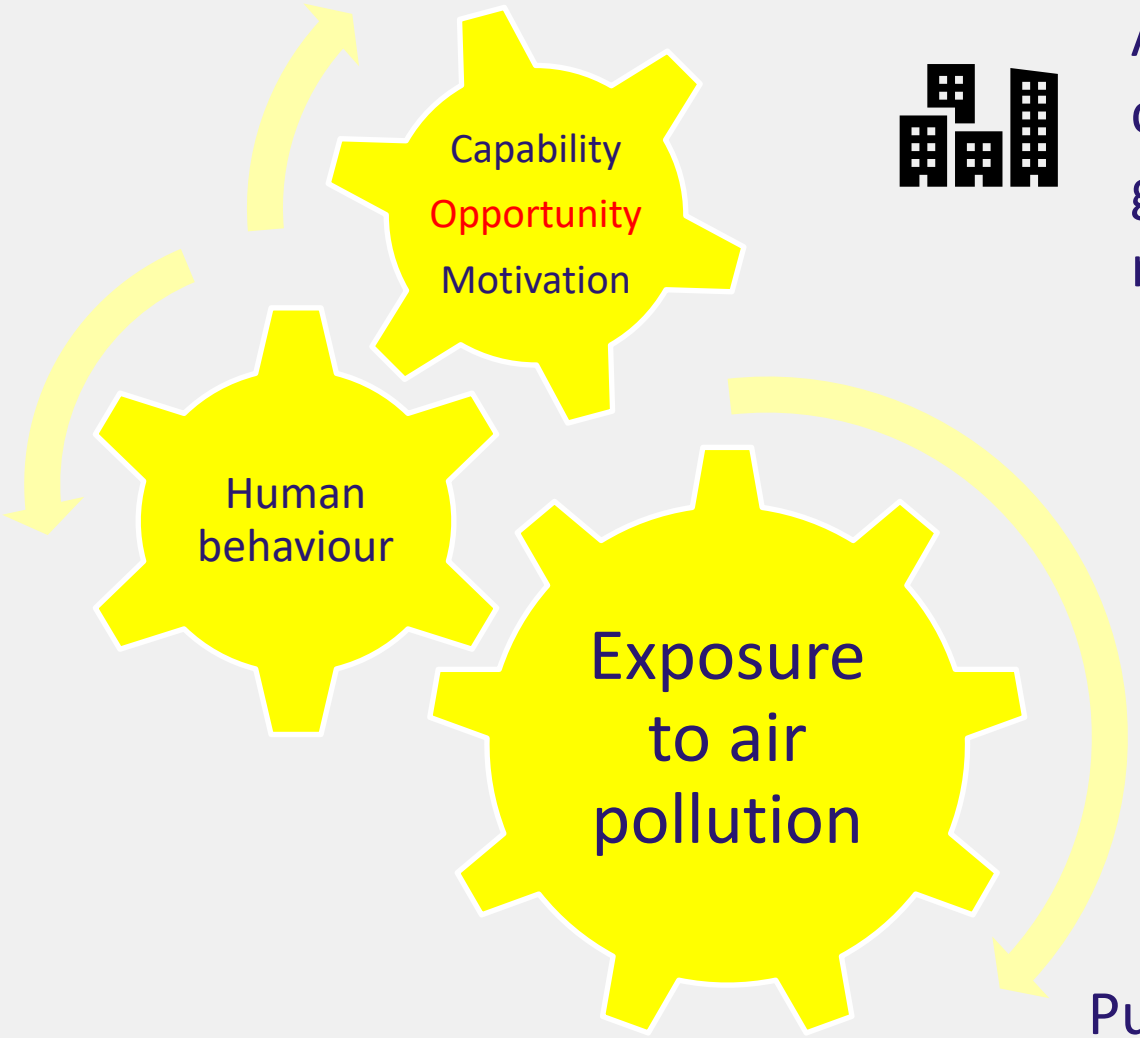


A lack of knowledge about indoor air pollution is preventing people making changes to behaviour that would reduce exposure

Then further research should…

Involve diverse groups of people in co-designing and evaluating behaviour change interventions that educate on air pollution sources, risks, and strategies to mitigate- in formats/languages that match their needs

If research identifies that…



A lack of control over rental/social housing conditions and infrastructure means that some groups of people don't have the opportunity to reduce exposure

Then further research should…

Understand the barriers to improving conditions in those in control over rentals/social housing

Or we could…

Push for policy-level solutions: e.g., better regulation of social housing

If research identifies that…

£

People in control of infrastructure/ conditions in rental/social housing may lack the motivation to reduce exposure because it requires a financial investment

Then further research should…

Involve these groups in co-designing and evaluating behaviour change interventions that incentivise change

Or we could…

Push for policy-level solutions

Imperial College London

May 12th 2022

What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure

Clean Air Programme

Clean Air Research Futures Group

Audrey de Nazelle

Centre for Environmental Policy

Imperial College London

Inequalities and vulnerabilities

- Air pollution exposures
- Health effects

DO ACTIVITY PATTERNS AND MICROENVIRONMENTS MATTER?

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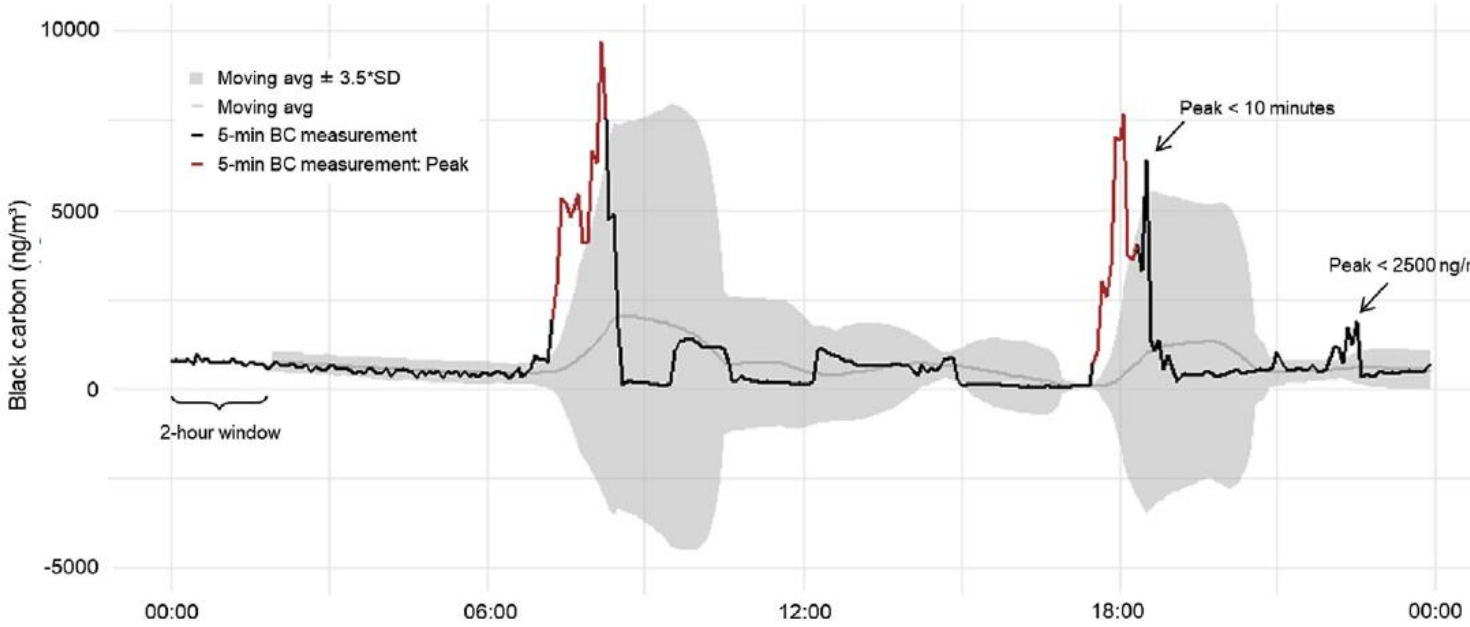
PASTA
PHYSICAL ACTIVITY THROUGH SUSTAINABLE TRANSPORT APPROACHES

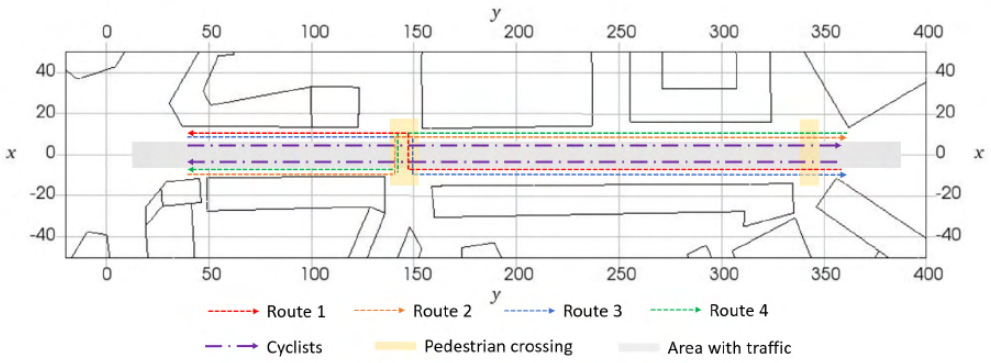
- **Who is exposed to these repeated?**

- **What are health implications of repeated peak exposures?**

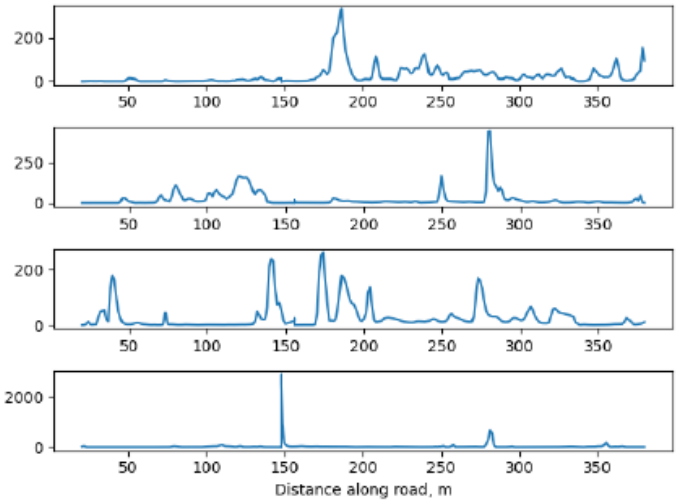
E. Dons, et al. *Dons et al. AE 2019*



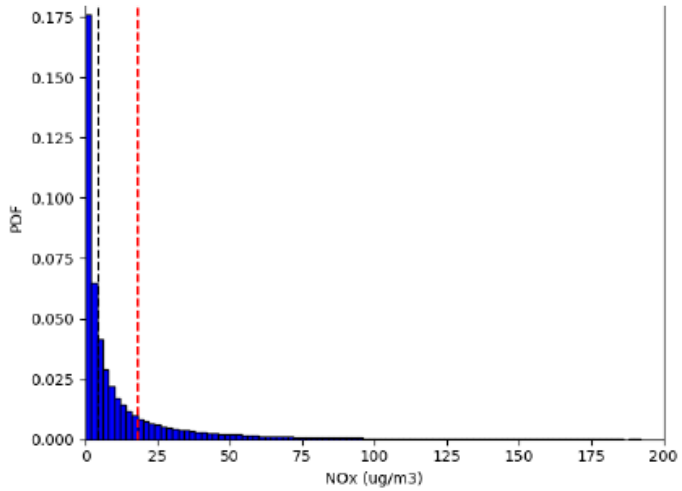
MAGIC
Envisaging a world with greener cities



(b) Routes taken by pedestrians along London Road.



(a) Time series of NO_x concentration exposure (ug/m3) for four pedestrians taking route 1, 2, 3 and 4 from top to bottom. Concentrations shown are for simulation run 1.

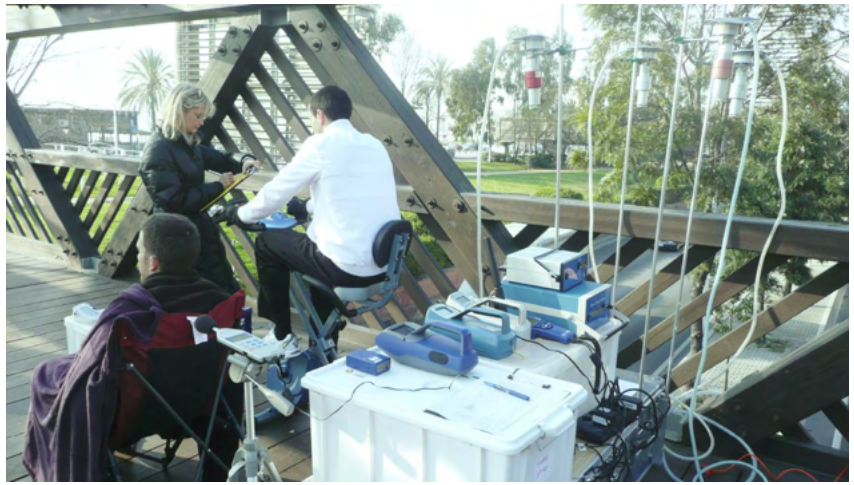


(b) Probability density function for all NO_x concentrations experienced by the simulated pedestrians for all routes and all simulation runs. The black dashed line indicates the median (4.4ug/m3) and the red dashed line indicates the mean (18.4ug/m3). The x axis has been limited to 200ug/m3, however concentrations go up to a maximum of 3456.0ug/m3.

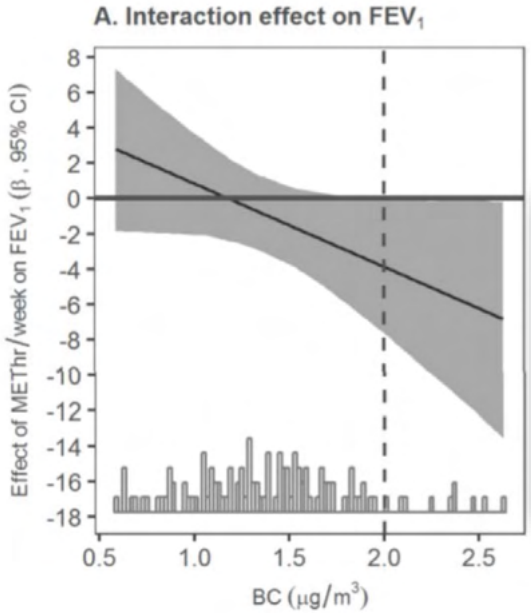
Source: Huw Woodward, CEP Imperial College

Are these micro-scale short-duration exposures relevant health-wise, especially combined with physical activity?

- Epi study acute effect: Onset of myocardial infarctions (Peters et al., 2013)
- Experimental studies sub-clinical effects (e.g. Adar et al., 2007; McCreanor et al., 2007; Strak et al., 2009; Weichenthal et al., 2011, Kubesch et al., 2014a,b; Synharay et al. 2017)
- **Lifestyle effects of repeated high exposures?**



Black carbon reduces de PA effect on Lung Function



115 healthy adults
3 European cities

PASTA
PHYSICAL ACTIVITY THROUGH SUSTAINABLE TRANSPORT APPROACHES

Laeremans et al, 2018

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Are we giving the best health advice, especially to vulnerable groups?

Department for Environment Food & Rural Affairs

Air pollution recommended actions and health advice

Air Pollution Banding	Value	Accompanying health messages for at-risk individuals*	Accompanying health messages for the general population
Low	1-3	**Enjoy** your usual outdoor activities.	**Enjoy** your usual outdoor activities.
Moderate	4-6	Adults and children with lung problems, and adults with heart problems, **who experience symptoms**, should **consider reducing** strenuous physical activity, particularly outdoors.	**Enjoy** your usual outdoor activities.
High	7-9	Adults and children with lung problems, and adults with heart problems, should **reduce** strenuous physical exertion, particularly outdoors, and particularly if they experience symptoms. People with asthma may find they need to use their reliever inhaler more often. Older people should also **reduce** physical exertion.	Anyone experiencing discomfort such as sore eyes, cough or sore throat should **consider reducing** activity, particularly outdoors.
Very High	10	Adults and children with lung problems, adults with heart problems, and older people, should **avoid** strenuous physical activity. People with asthma may find they need to use their reliever inhaler more often.	**Reduce** physical exertion, particularly outdoors, especially if you experience symptoms such as cough or sore throat.

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Environment International
Volume 140, July 2020, 105679

The long-term impact of restricting cycling and walking during high air pollution days on all-cause mortality: Health impact Assessment study

Giorgos Giallouros [a, b, 1], Panayiotis Kouis [c, 1], Stefania I. Papatheodorou [b, d], James Woodcock [e], Marko Tainio [e, f, g]

- All cause mortality risk increased by restricting active travel on high air pollution days in adult healthy populations.

  → How about vulnerable populations?

  → How about intermediary effects?

Journal of the American Heart Association

ORIGINAL RESEARCH

Combined Associations of Physical Activity and Particulate Matter With Subsequent Cardiovascular Disease Risk Among 5-Year Cancer Survivors

Daein Choi, MD, MSc*; Seulggie Choi, MD*; Kyae Hyung Kim, MD, PhD; Kyuwoong Kim, PhD; Jooyoung Chang, MD; Sung Min Kim, BSc; Seong Rae Kim, MD; Yoosun Cho, MD, PhD; Gyeongsil Lee, MD, MSc; Joung Sik Son, MD, PhD; Sang Min Park, MD, MPH, PhD

J Am Heart Assoc. 2022;11

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Research needs

- → Characterize activity patterns and microscale exposures by different population groups
- → Methods to integrate activity patterns and microscale exposures in epidemiologic analyses

Clean Air Research Futures Group Meeting

12 May 2022

Anomitro Chatterjee

Grantham Research Institute on Climate Change and the Environment

Centre for Climate Change Economics and Policy

E·S·R·C Economic & Social Research Council

The Grantham Foundation for the Protection of the Environment

University of Leeds

LSE The London School of Economics and Political Science

What do we know about vulnerabilities to air pollution?

- **Vulnerability refers to the extent to which an individual or group suffers greater adverse effects from air pollution than others.**
  - Vulnerability comprises factors relating to susceptibility, exposure and **adaptation**

- **Health (physiological) effects of air pollution are well known**
  - Effects of air pollution on cardiovascular and respiratory health (reports from WHO, 2018; PHE, 2019)
  - Evidence identifying relationships between air pollution and long-term health outcomes (Beelen et al., 2014)
  - Health impacts of indoor air pollution (IAP) has focused on developing country contexts due to use of biomass and coal.
    - Less research on IAP in developed countries, although a significant number of people use solid fuels for heating (Carvalho et al., 2016).

- **Research on adverse effects of air pollution on psychological conditions and subjective well-being**
  - Lu (2020) conducts a systematic review of the literature on this

What issues need more research?

- **How do people ADAPT to change their exposure to air pollution**
  - **Behavioural barriers** – perceptions of health risk, awareness, agency and how they link to avoidance behaviour
  - What sorts of behaviours are particularly **difficult to change** and for whom?
    - Insulation, travel mode, cooking/heating fuel choice may be more costly to change for people who are otherwise more vulnerable to air pollution

- **What are the domain-specificities in risks of pollution exposure**
  - Indoor air pollution and fuel choice in developed country contexts
  - Pollution exposure during travel (pollution in the underground rail networks)

- Methodologically, we need more a larger evidence base for causal effects of policies/interventions on behaviour through randomized controlled trials or quasi-experimental evaluations

What issues need more research?

- **What are the exposure levels (and consequent health risks) of pollution in different micro-environments?**
  - Indoor air pollution and fuel choice in developed country contexts
  - Pollution exposure during travel (pollution in the underground rail networks)

- **Person-level understanding of air pollution exposure instead of area-level exposure.**
  - Tracking how and where more vulnerable populations (elderly people, children, etc.) are exposed to pollution.

- **How can behavioural interventions like information campaigns be better targeted to vulnerable people?**
  - Are area-level pollution alerts sufficiently salient to change behaviour for vulnerable people?
  - Even if people are aware of the problem, why would they be unable to take effective actions to mitigate their exposure
    - Mobility constraints, high costs of avoidance technology, limited attention, etc.

Tracking inequalities and vulnerabilities in air pollution exposure

ASTHMA+ LUNG UK

Joined up: least first

- In order to have the largest impact on those who are most vulnerable, and to understand how we can combat inequalities at the same time, we need amore joined-up approach to tackling air pollution. We need to combine environmental, health, economic and social research to tackle the intersectional nature of the problem.
- Research and policy design must seek to protect the most vulnerable first and work back from there.

Annual asthma survey

- Our annual asthma survey help us to build up a picture of
  - how those living with lung conditions are being affected by their conditions
  - what sort of treatment they are receiving.
- We have increasingly begun to gather other information in our work to better understand how other issues may be affecting their conditions.
- Our 2022 Annual Asthma Survey found that
  - 54% of households earning below £20,000/year have uncontrolled asthma symptoms.
  - 40% of households earning over £70,000/year have uncontrolled asthma symptoms.
- In cities, more deprived households are more likely to be exposed to high air pollution

Air Pollution vulnerability and exposure

- In 2019
    - 96% of all hospitals across the UK were located in areas above new WHO guidelines (22% over 2005 WHO)
    - 98% of all care homes across the UK were located in areas above new WHO guidelines (23% over 2005 WHO)
    - 98% of all schools and colleges across the UK were located in areas above new WHO guidelines (27% over 2005 WHO)
- 77.4% of our beneficiaries say that air pollution impacts their health and wellbeing

Gaps in understanding

- Whether people being exposed to high levels of air pollution understand its impact on their health.
- Whether people who are clinically vulnerable are aware of the impact of air pollution on their condition.
- Which interventions will
  - Protect public health whilst allowing those that are vulnerable to live full lives.
  - Help change people's behaviour over the long-term.

Future work

Vulnerability and exposure mapping

- A comprehension mapping exercise to better understand how different vulnerable groups are interacting with air pollution information. This includes:
  - Clinically vulnerable groups
  - Those vulnerable due to long-term exposure to high levels of air pollution.
- We will also seek to cross-reference this to understand intersecting issues that may affect the second group.

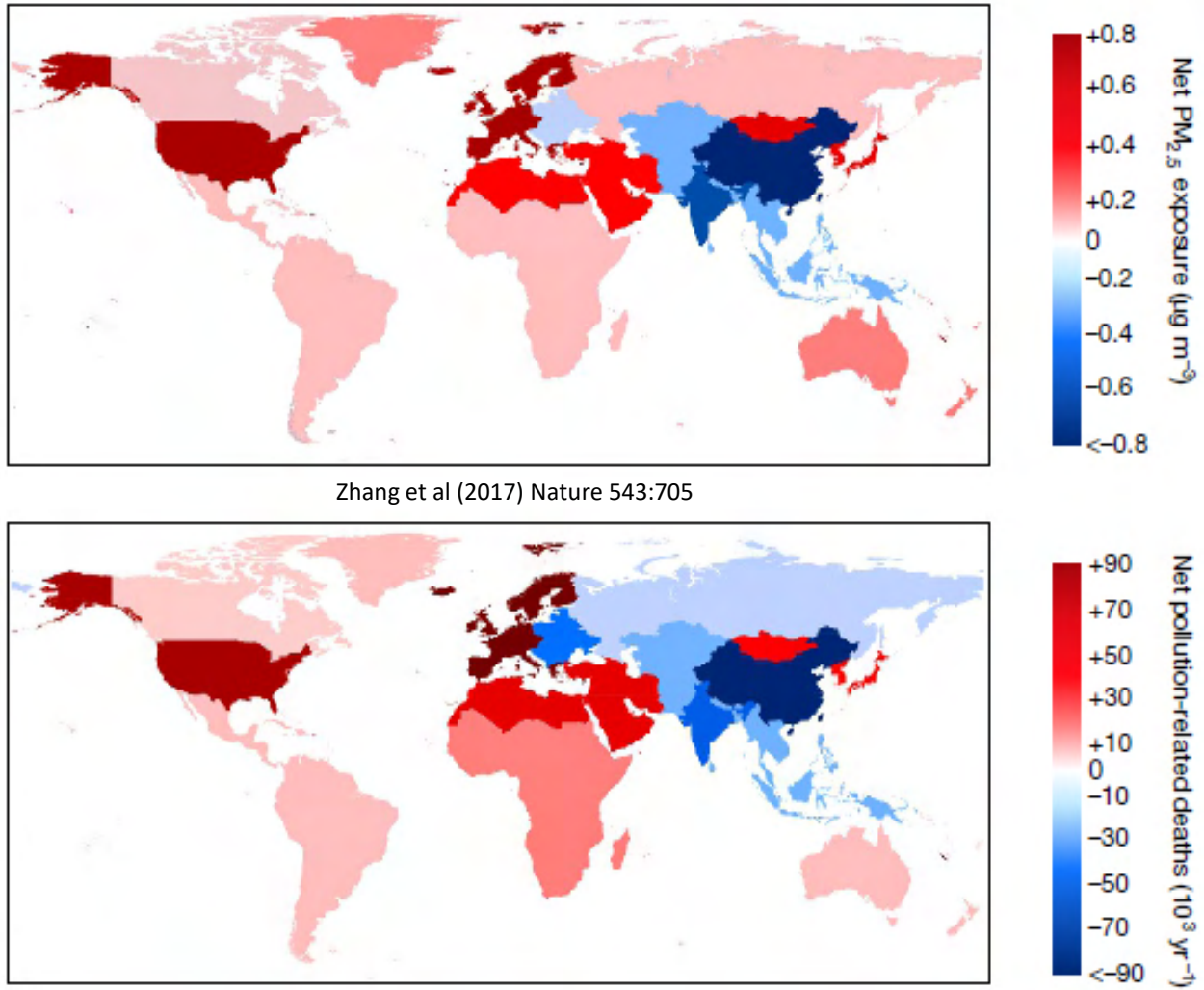
THANK YOU

“What research is needed to understand and track inequalities and vulnerabilities in air pollution exposure?”

Dr Matt Loxham

Faculty of Medicine, University of Southampton

International Inequality



Zhang et al (2017) Nature 543:705

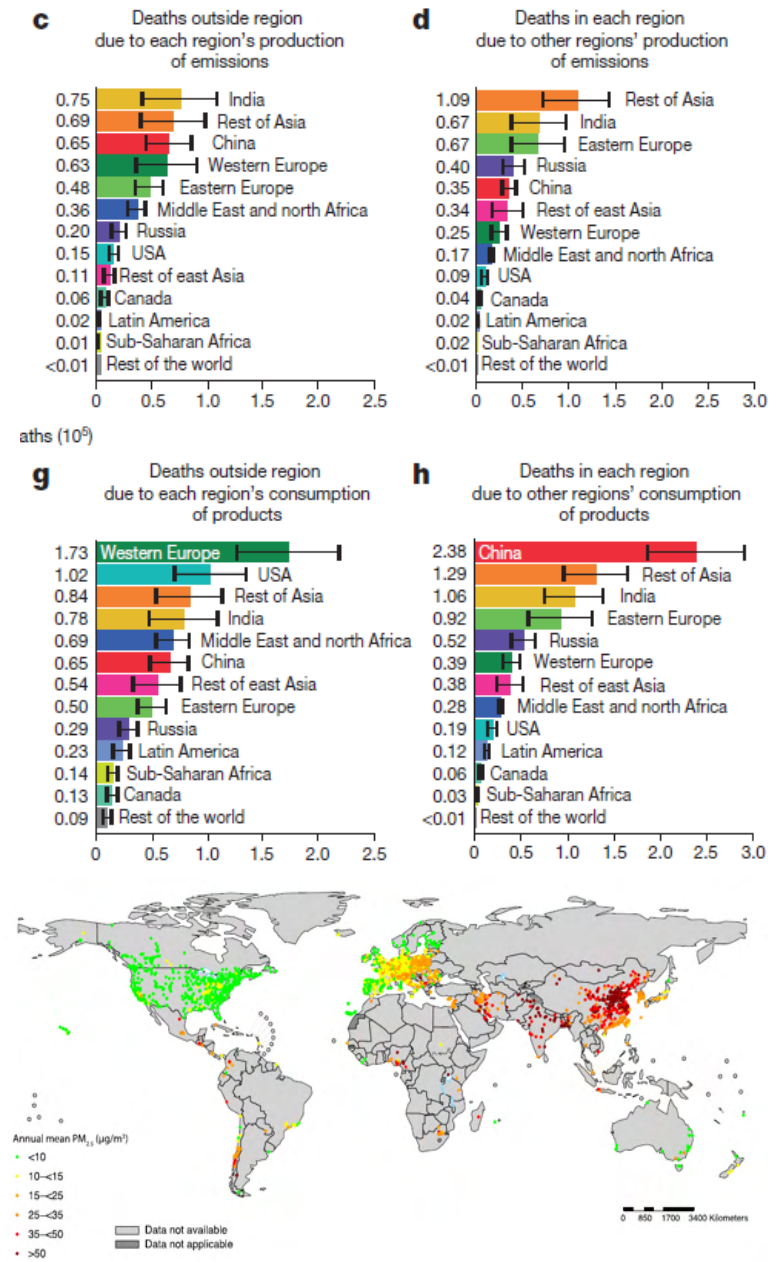
Air pollution can travel "directly" or "indirectly", but based on E:R functions, with less understanding of personal exposures.

IN→OUT

OUT→IN

TRANSPORTED

TRADE-BASED

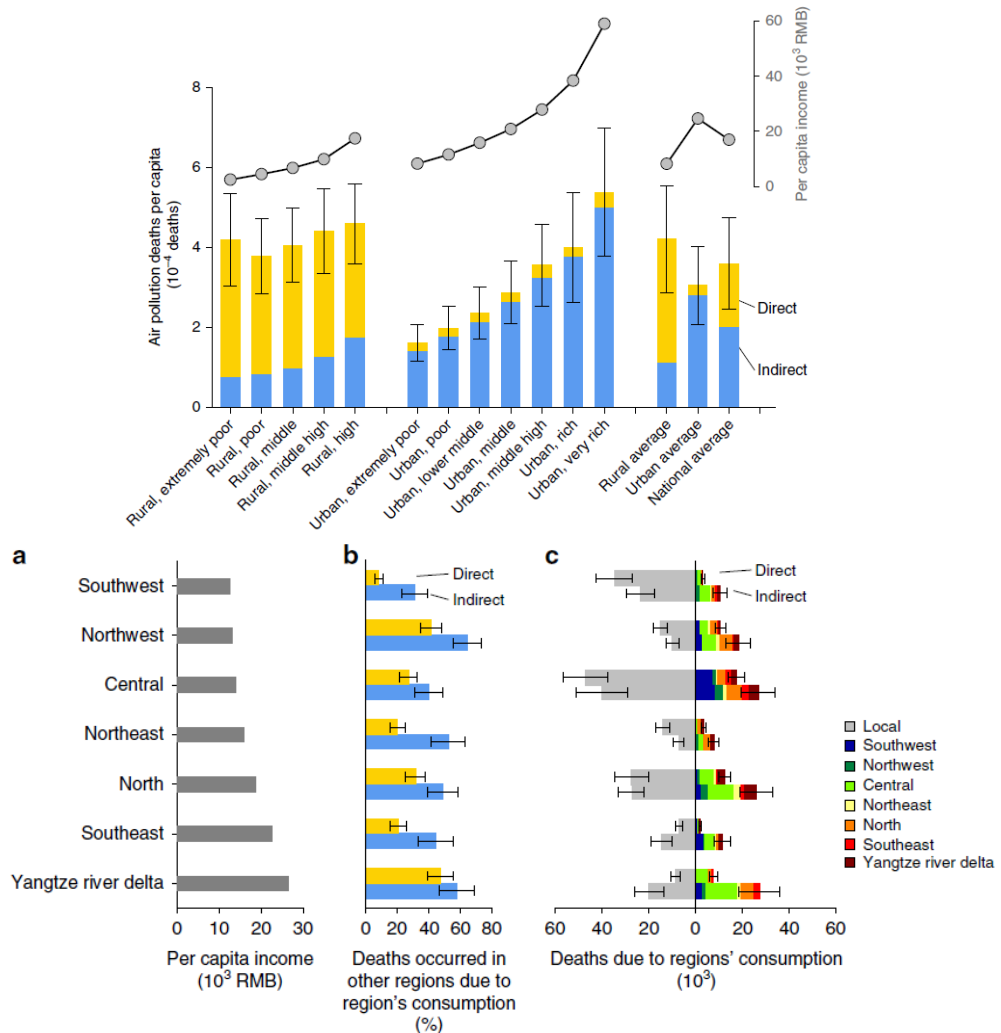


National Inequality

https://doi.org/10.1038/s41467-019-12254-x OPEN

Inequality of household consumption and air pollution-related deaths in China

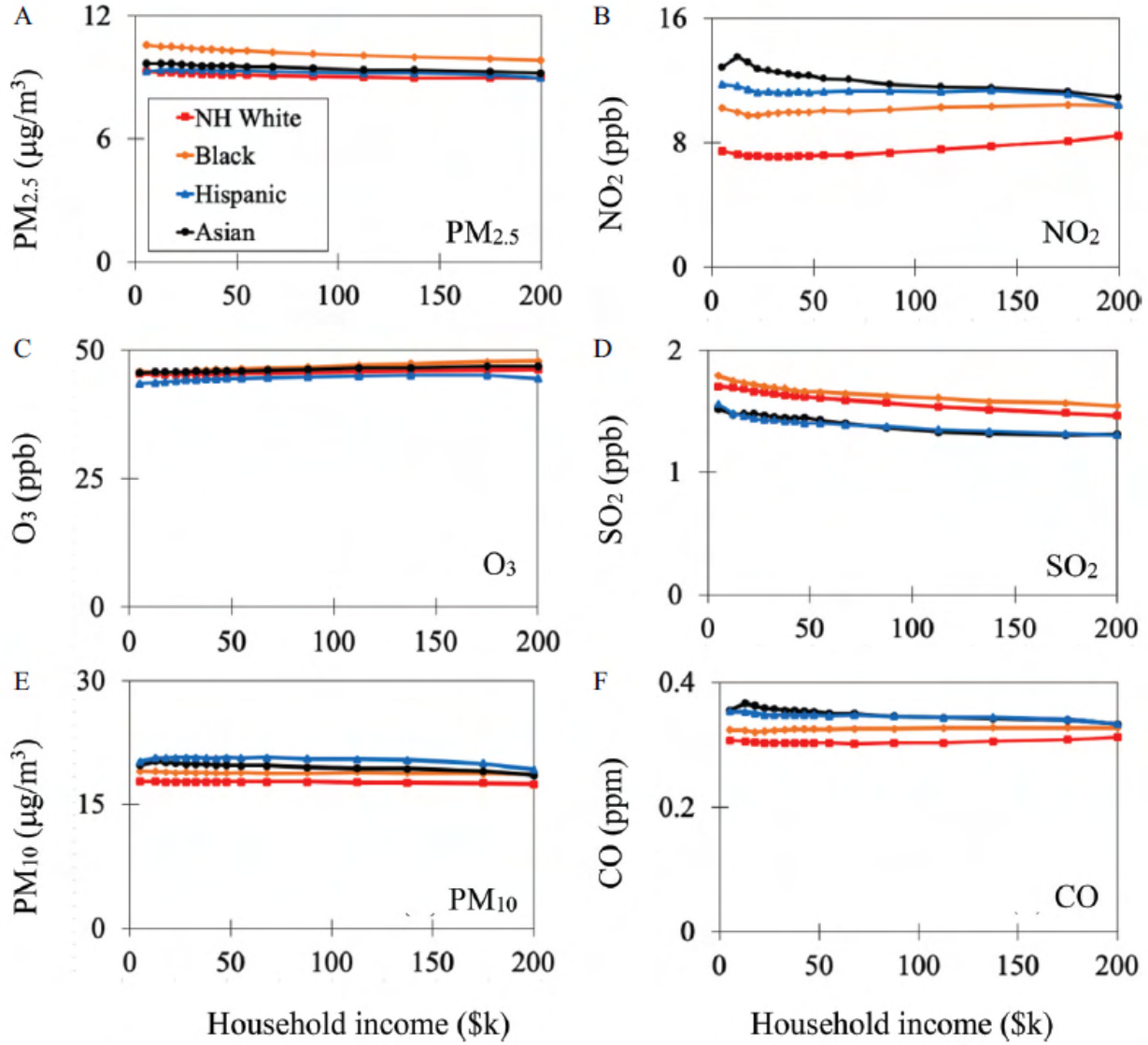
Hongyan Zhao[1,2,10], Guannan Geng[2,10], Qiang Zhang[1], Steven J. Davis[1,3,4], Xin Li[5], Yang Liu[1], Liqun Peng[2], Meng Li[1], Bo Zheng[2], Hong Huo[6], Lin Zhang[7], Daven K. Henze[8], Zhifu Mi[9], Zhu Liu[1], Dabo Guan[1] & Kebin He[2]



Disparities in Air Pollution Exposure in the United States by Race/Ethnicity and Income, 1990–2010

Jiawen Liu,[1] Lara P. Clark,[1] Matthew J. Bechle,[1] Anjum Hajat,[2] Sun-Young Kim,[3] Allen L. Robinson,[4] Lianne Sheppard,[5,6] Adam A. Szpiro,[5] and Julian D. Marshall[1]

[1]Department of Civil & Environmental Engineering, University of Washington, Seattle, Washington, USA
[2]Department of Epidemiology, University of Washington, Seattle, Washington, USA
[3]Department of Cancer Control and Population Health, Graduate School of Cancer Science and Policy, National Cancer Center, Goyang-si, Gyeonggi-do, Korea
[4]Department of Mechanical Engineering & Department of Engineering and Public Policy, Carnegie Mellon University, Pittsburgh, Pennsylvania, USA
[5]Department of Biostatistics, University of Washington, Seattle, Washington, USA
[6]Department of Environmental and Occupational Health Sciences, University of Washington, Seattle, Washington, USA



Intraurban Inequality


Environmental Pollution

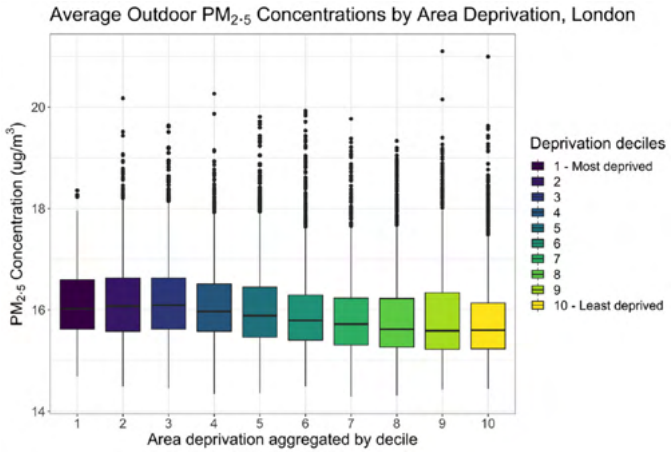
Spatial variability in air pollution exposure in relation to socioeconomic indicators in nine European metropolitan areas: A study on environmental inequality*

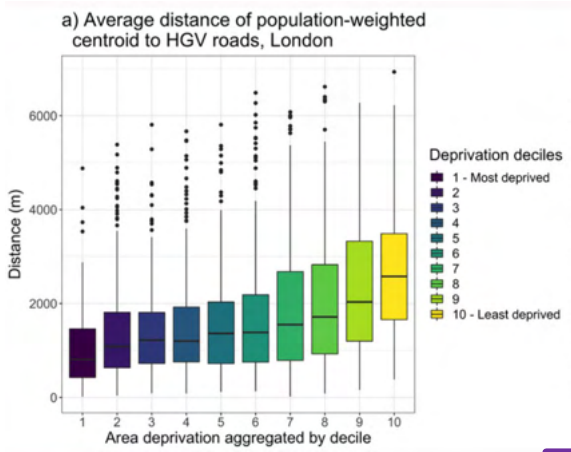
E. Samoli [a,*], A. Stergiopoulou [a], P. Santana [b], S. Rodopoulou [a], C. Mitsakou [c], C. Dimitroulopoulou [c], M. Bauwelinck [d], K. de Hoogh [e,f], C. Costa [b], M. Mari-Dell'Olmo [g,h], D. Corman [i], S. Vardoulakis [c,k], K. Katsouyanni [a,l], on behalf of the EURO-HEALTHY Consortium

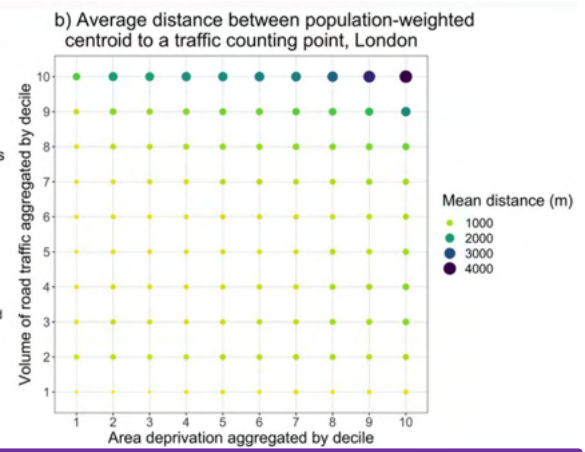
Table 3
Spearman Correlation coefficients between NO_2 and socio-economic indicators per metropolitan area.

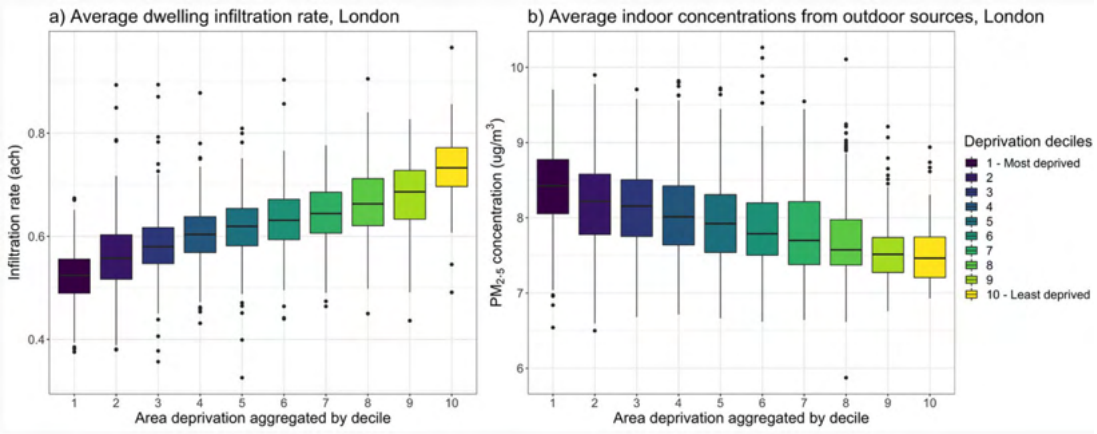
Metropolitan area	Unemployment rate	Youth unemployment rate	Household Income	Crimes per 100,000 inhabitants	Population 25–64yrs with upper education	Early education leavers	Born in non EU-28	Ageing index	Smokers >15yrs	Population Density
Athens	0.287[b]	0.005	–	–	−0.119	0.257	0.490[a]	0.309[b]	0.063	0.740[a]
Barcelona	0.502[a]	0.556[a]	−0.191	–	0.167	–	0.423[a]	0.482[a]	−0.129	0.765[a]
Berlin-Brandenbourg	0.647[a]	0.866[a]	−0.687[a]	0.841[a]	−0.683[a]	0.866[a]	0.734[a]	−0.374[b]	0.359[b]	0.963[a]
Brussels	0.375[a]	0.295[a]	−0.263[a]	0.659[a]	−0.157	0.351[a]	0.733[a]	−0.244[b]	−0.399[a]	0.923[a]
Lisbon	0.063	0.075	–	−0.088	0.197	−0.027	0.651[a]	0.746[a]	–	0.932[a]
London	0.381[a]	−0.013	0.243	0.850[a]	0.507[a]	0.254	0.642[a]	−0.339[b]	0.435[a]	0.769[a]
Paris	0.236[a]	0.224[a]	0.126	0.335[a]	0.346[a]	−0.251[a]	–	0.133	–	0.824[a]
Stockholm	0.045	−0.240	0.316	0.265	0.478[a]	−0.324	0.503[a]	0.030	−0.319	0.939[a]
Turin	0.421[a]	0.258[b]	–	–	0.010	0.182	0.251[b]	0.249[b]	−0.245[b]	0.697[a]

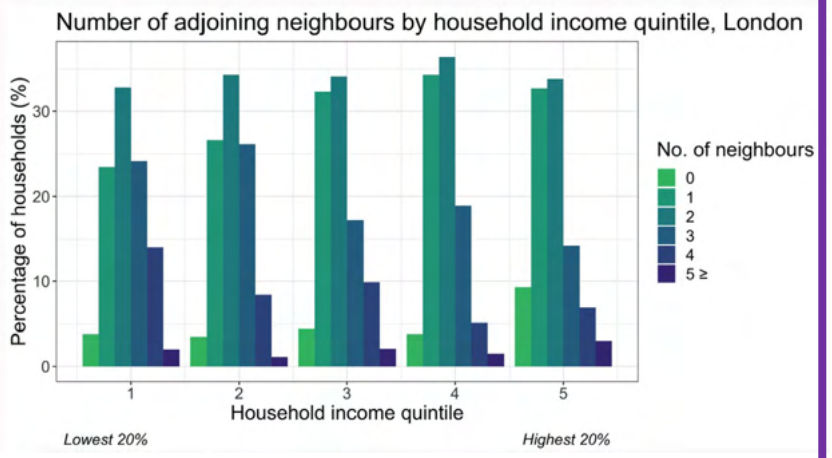
[A]$p<0.05$, [b]$p<0.1$.











Q1
HOW CAN INCREASED EXPOSURE BE IDENTIFIED AND ADDRESSED?

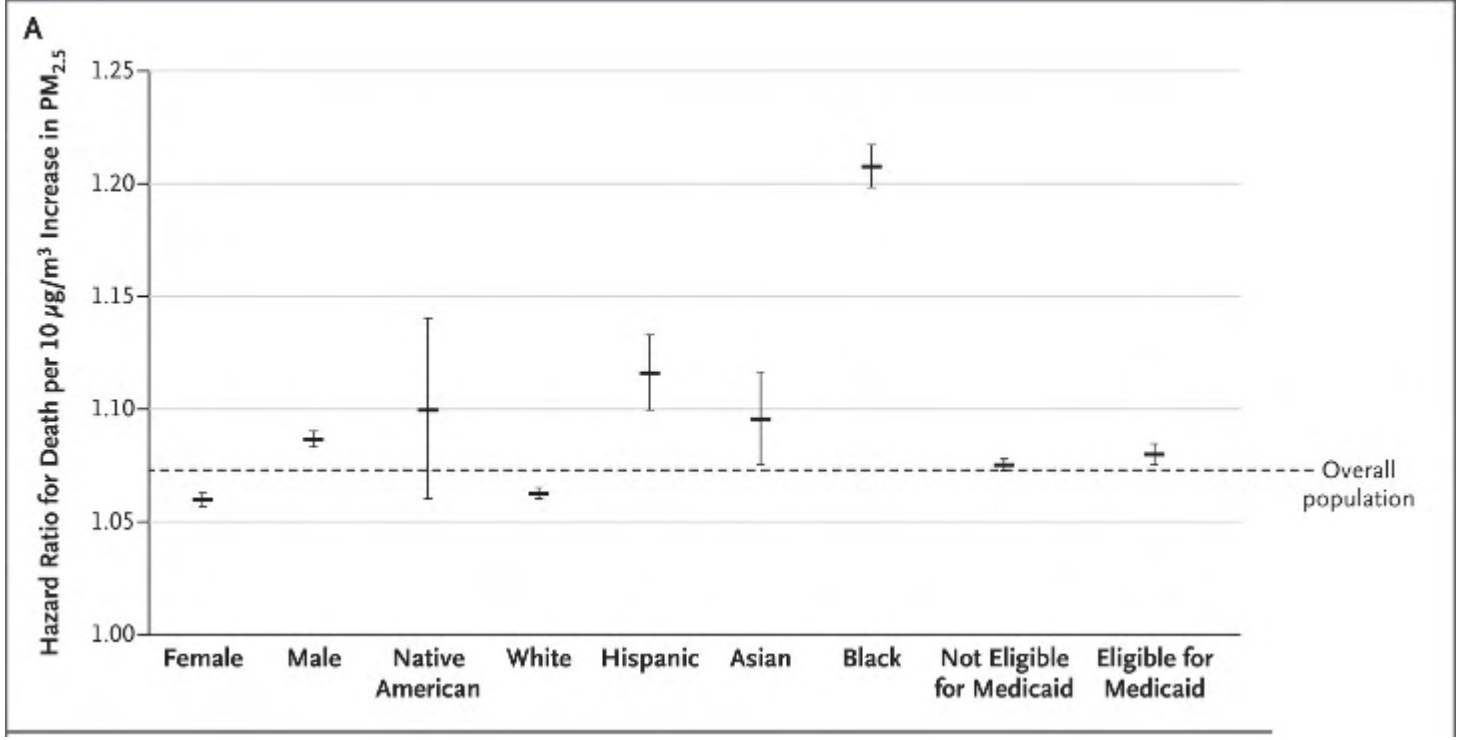
Risk Modification

The NEW ENGLAND JOURNAL of MEDICINE

ESTABLISHED IN 1812 JUNE 29, 2017 VOL. 376 NO. 26

Air Pollution and Mortality in the Medicare Population

Qian Di, M.S., Yan Wang, M.S., Antonella Zanobetti, Ph.D., Yun Wang, Ph.D., Petros Koutrakis, Ph.D., Christine Choirat, Ph.D., Francesca Dominici, Ph.D., and Joel D. Schwartz, Ph.D.



Individual and Neighborhood Socioeconomic Status and the Association between Air Pollution and Cardiovascular Disease

Gloria C. Chi,[1] Anjum Hajat,[2] Chloe E. Bird,[3] Mark R. Cullen,[4] Beth Ann Griffin,[5] Kristin A. Miller,[1] Regina A. Shih,[5] Marcia L. Stefanick,[6] Sverre Vedal,[2] Eric A. Whitsel,[7,8] and Joel D. Kaufman[1,2]

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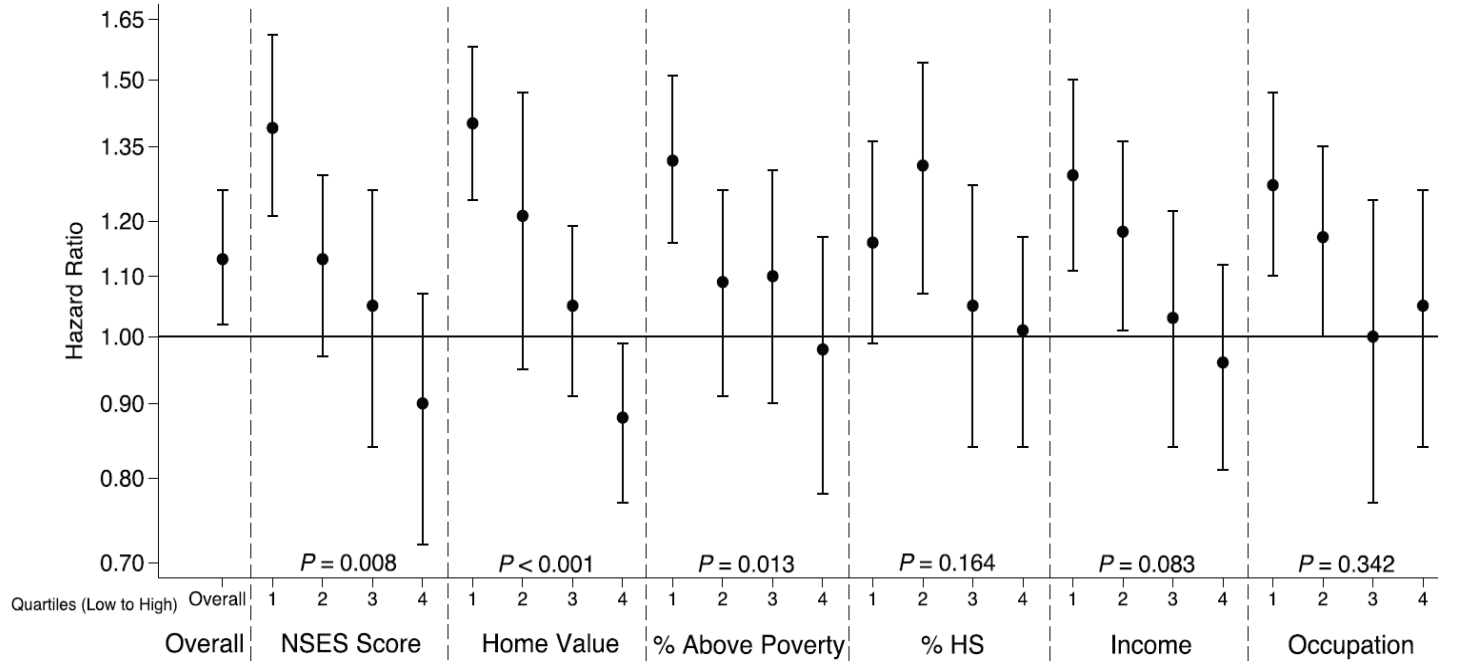


Q2

WHY ARE MARKERS OF SOCIOECONOMIC DEPRIVATION ASSOCIATED WITH POORER EXPOSURE OUTCOMES?

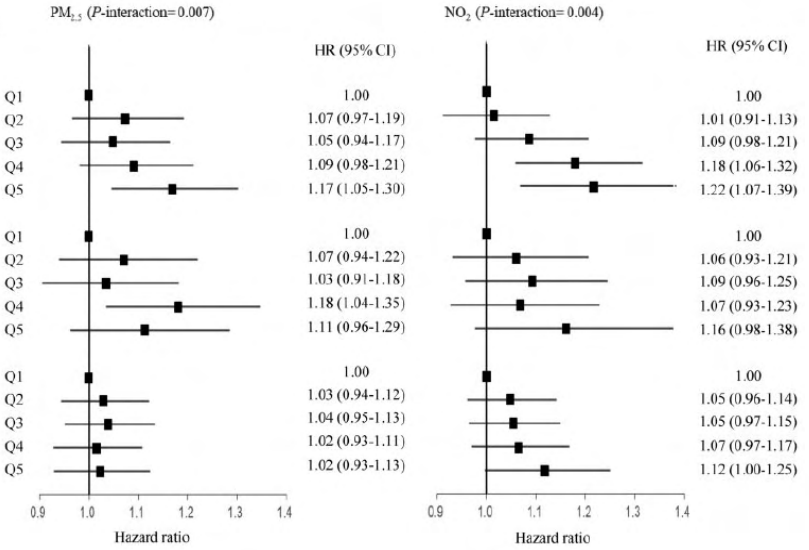
Diet

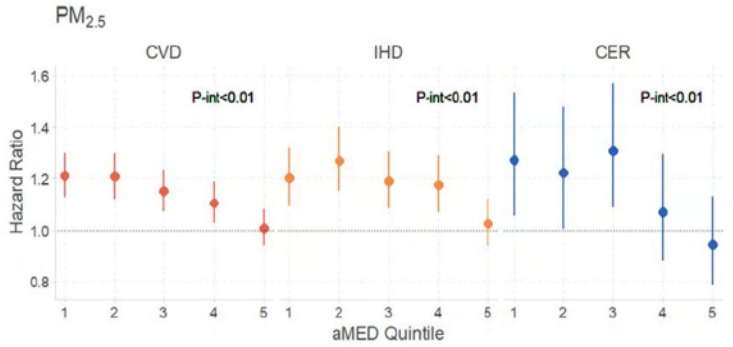
International Journal of Epidemiology, 2022, 1–11
https://doi.org/10.1093/ije/dyac022
Original article

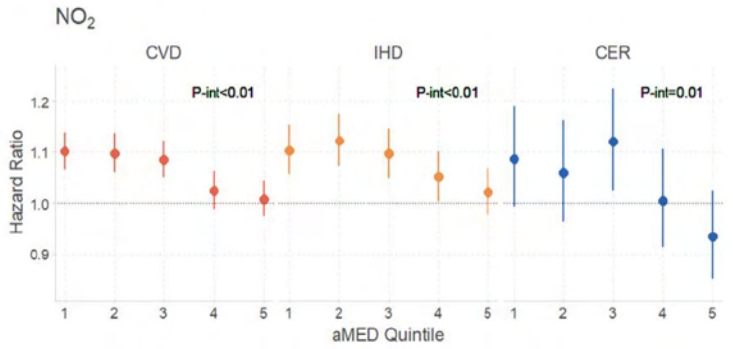
Original article

Ambient air pollution, healthy diet and vegetable intakes, and mortality: a prospective UK Biobank study

Mengying Wang,[1,2] Tao Zhou,[2] Qiying Song,[2,3] Hao Ma,[2] Yonghua Hu,[1] Yoriko Heianza[2] and Lu Qi [2,4,5]*







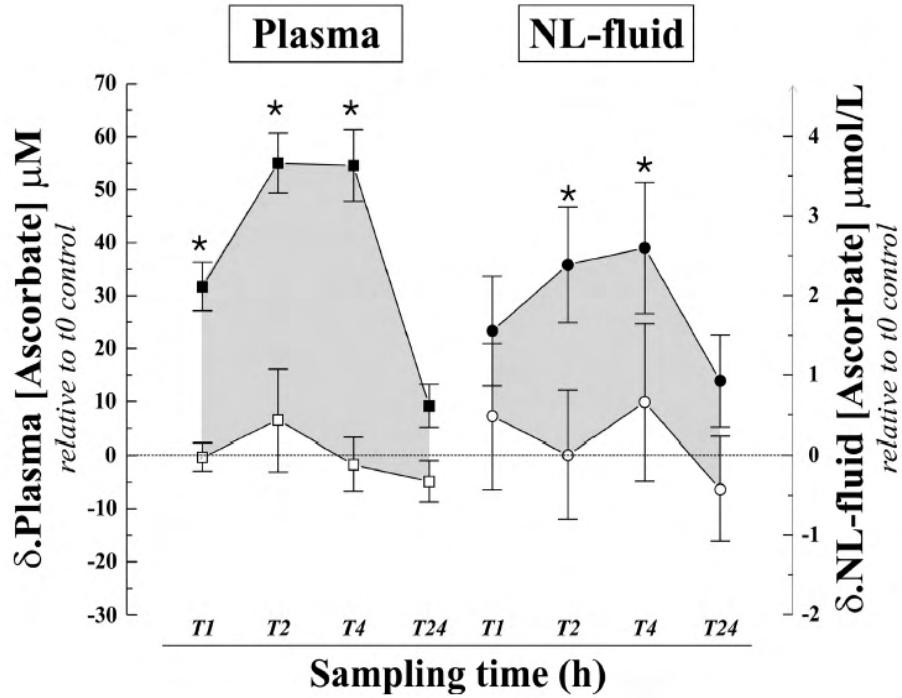
Circulation

ORIGINAL RESEARCH ARTICLE

Mediterranean Diet and the Association Between Air Pollution and Cardiovascular Disease Mortality Risk

Augmentation of Respiratory Tract Lining Fluid Ascorbate Concentrations Through Supplementation with Vitamin C

Annelie F. Behndig, Anders Blomberg, Ragnberth Helleday, Frank J. Kelly & Ian S. Mudway



Q3

HOW CAN WE BETTER UNDERSTAND EFFECTS OF DIET ON RESPONSE TO EXPOSURE?

Understanding and tracking inequalities and vulnerabilities in air pollution exposure?

Brian Castellani

Director, Research Methods Centre

Co-Director, Wolfson Research Institute of Health and Wellbeing

Durham University

Adopt a complex systems approach

- First, change the question!
- GET RID OF:
  - ~~How do we help vulnerable populations and mitigate their inequalities?~~
- REPLACE WITH:
  - How do the systems in which people live create the inequalities and vulnerability they experience?

Adopt a complex systems approach

- Second, focus on the places in which people live
- GET RID OF:
  - ~~Thinking about social determinants in the abstract~~
    - ~~What is the correlation between income and air quality~~
- REPLACE WITH:
  - Understanding social determinants as a function of place.
    - Poor urban areas are not all the same.
    - What makes some thrive in the face of air pollution over others?

Adopt a complex systems approach

- Third, thinking of configurations of factors
- GET RID OF:
  - ~~Which variable is the most important?~~
- REPLACE WITH:
  - What configuration of factors account for differences.
    - Poor urban area versus middle class
    - Housing congestion versus low
    - High versus low green space
    - Strong versus weak public transportation

Adopt a complex systems approach

- Fourth, think of vulnerability as situated in places
- GET RID OF:
  - ~~It's only vulnerable areas that need help~~
- REPLACE WITH:
  - Vulnerable populations live in clean air places such that even low levels of air quality can impact them.
    - Those with pre-existing cardiopulmonary issues
    - Those with pre-existing neurodegenerative issues
    - Making communities air friendly to vulnerable groups

Adopt a complex systems approach

- Fifth, think of systems and places as nested
- GET RID OF:
  - ~~We need to only improve poor communities to solve the issue~~
- REPLACE WITH:
  - Poor communities with high air pollution often do not generate the air quality from which they suffer; it is a function of the wider systems in which they are nested.

Adopt a complex systems approach

- Finally, realise all policy interventions, no matter how small, take place in complex systems.
- GET RID OF:
  - ~~If we keep our interventions simple, we can manage them~~
  - ~~Or, we need a whole-systems intervention to fix the problem~~
  - REPLACE WITH:
  - Most interventions take place along multiple trajectories and have differential impacts for different populations and places.
  - People, the public sector, private sector and third-sector all will react differently to any intervention.
  - Interventions take place at cross-purposes, creating barriers to change.
  - There is also the potential for co-benefits by working across policies and practices.