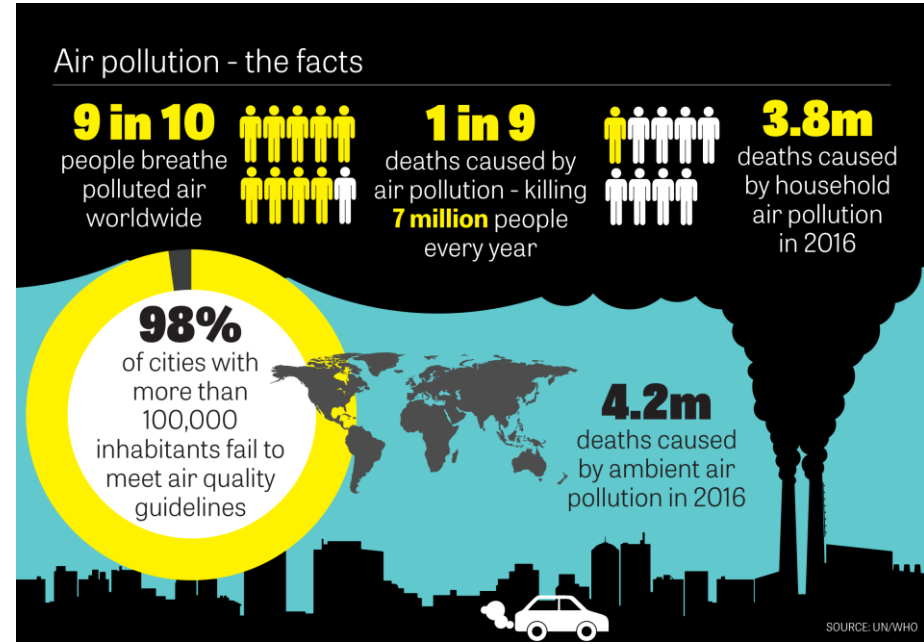


Impacts of Air Quality on Health

Ian Mudway



MRC
Centre for Environment & Health



Imperial College
London

Asthma UK Centre in Allergic Mechanisms of Asthma



Imperial College
London



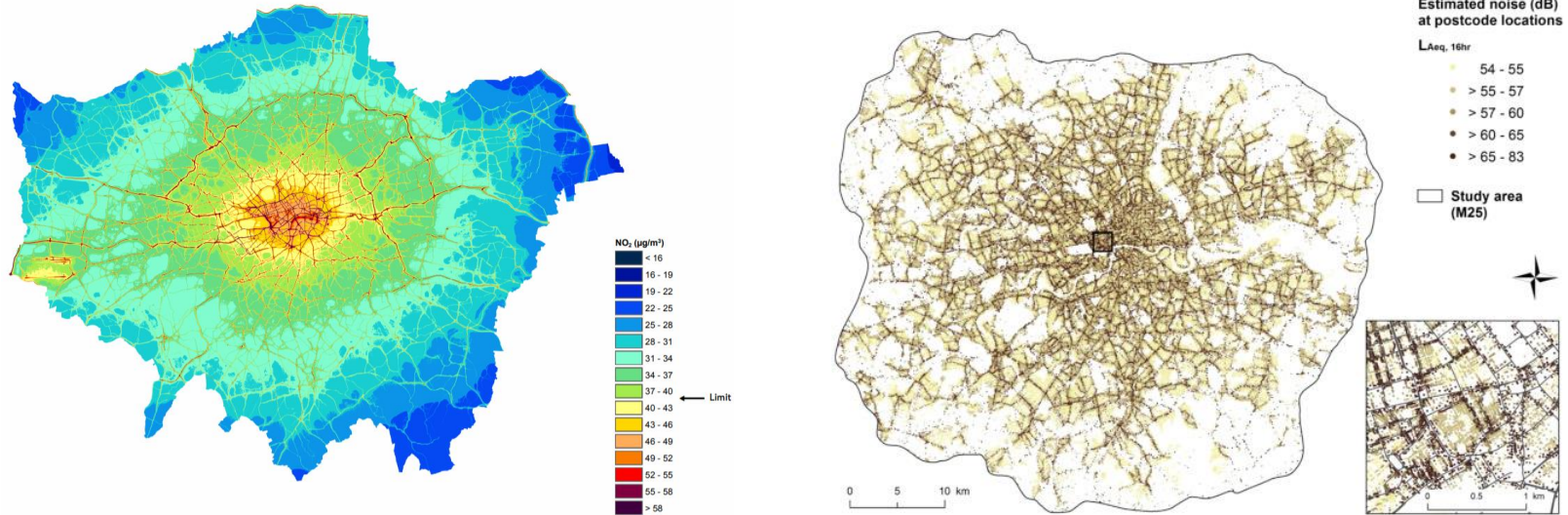
NIHR | Health Protection Research Unit in Chemical and Radiation Threats and Hazards at Imperial College London

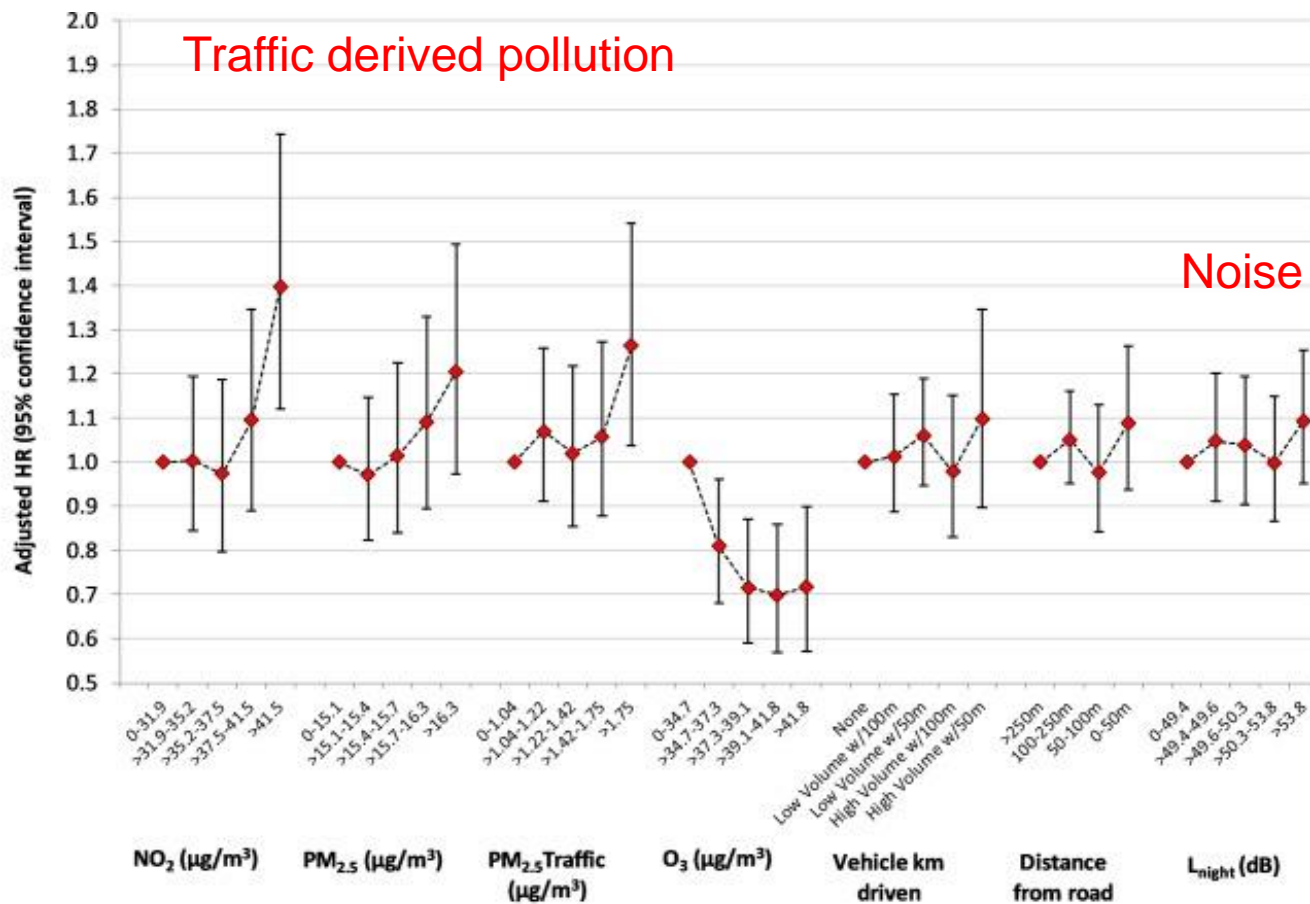
NIHR | Health Protection Research Unit in Environmental Exposures and Health at Imperial College London

Key studies (2016 - 2020)

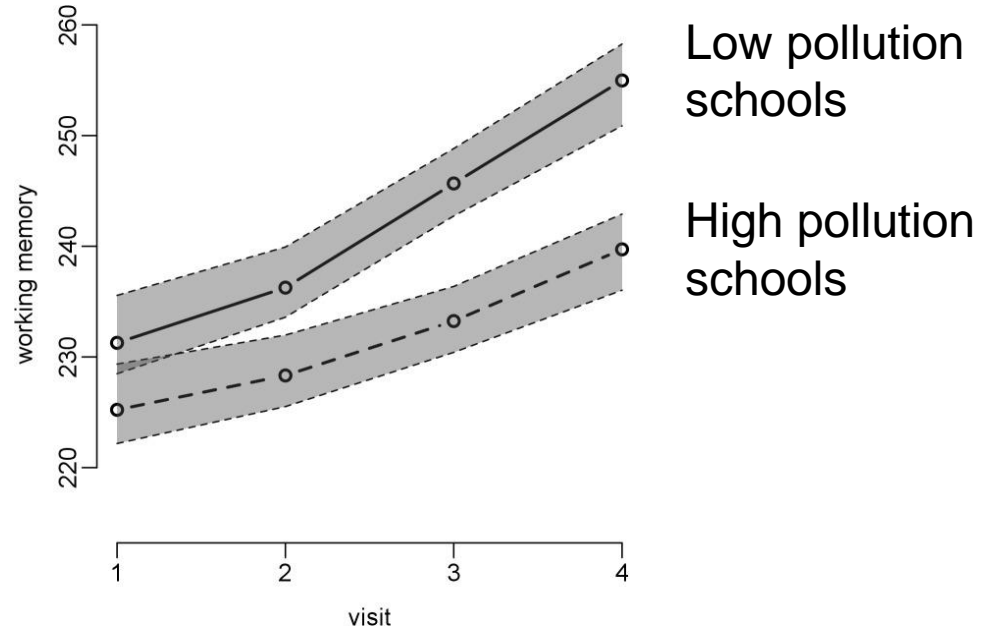
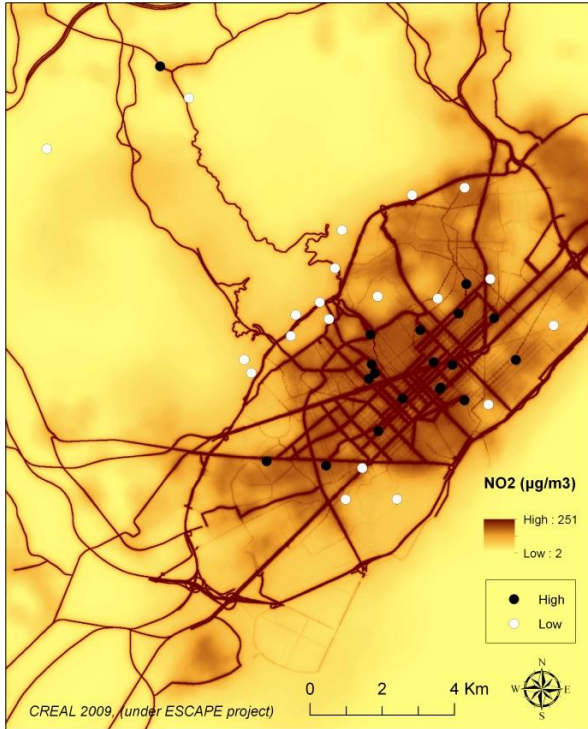
Carey I et al. BMJ Open. 2018; 8(9): e022404.

A first recorded diagnosis of dementia and, where specified, subgroups of Alzheimer's disease and vascular dementia during 2005–2013.



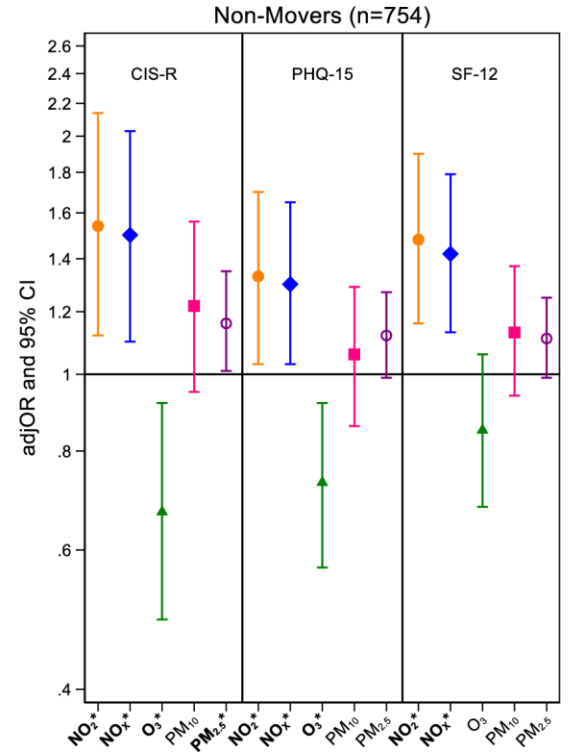
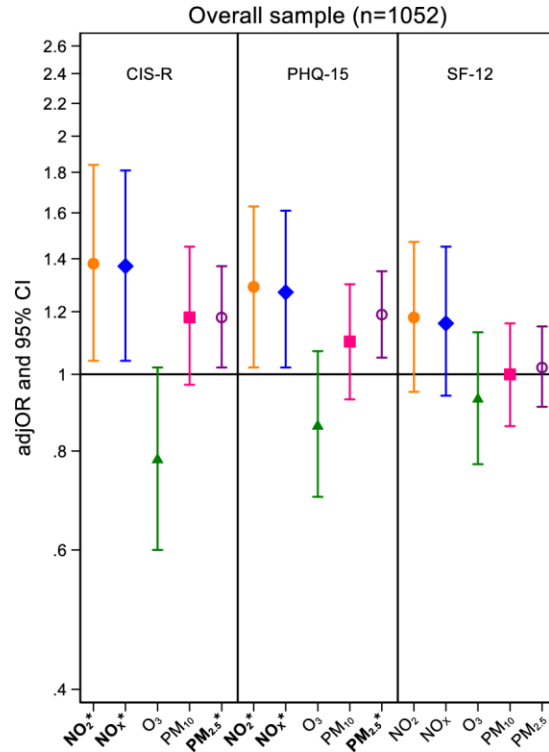
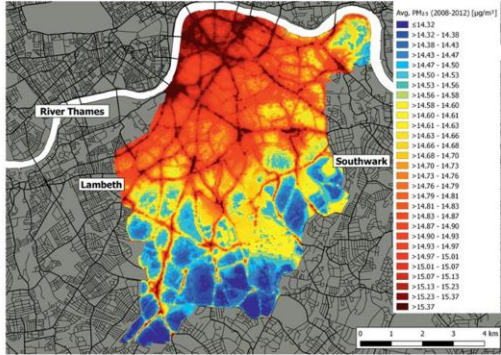
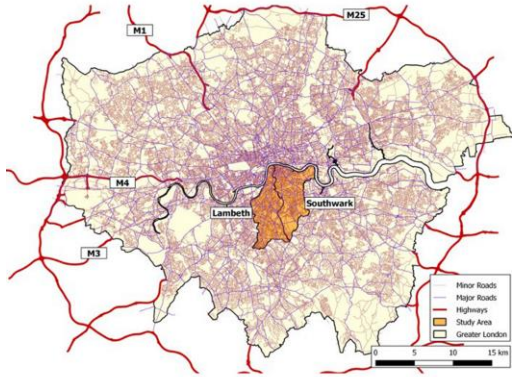


Sunyer J et al. PLoS Med . 2015 Mar 3;12(3):e1001792.



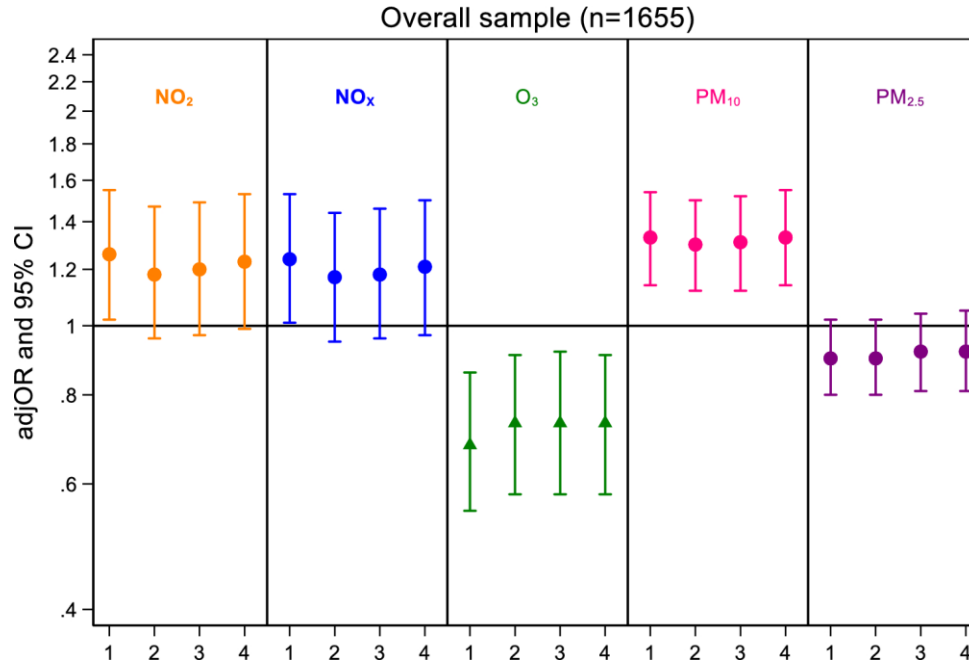
BREATHE study - the researchers assessed whether exposure of children aged 7–10 years to traffic-related air pollutants in schools in Barcelona,

Impacts on mental health



Impacts on mental health (psychosis)

Bakolis I et al. Soc Psychiatry Psychiatr Epidemiol. 2020:1-13.



Model 1: unadjusted

Model 2: Adjusted for age, sex, latent classes of SES, smoking status, ethnicity

Model 3: Adjusted for age, sex, latent classes of SES, smoking status, ethnicity, frequency of drinking, physical activity

Model 4: Adjusted for age, sex, latent classes of SES, smoking status, ethnicity, frequency of drinking, physical activity and Lden

Impacts of Air Pollution across the Life Course

Low birth weight



Smaller lungs
Cognitive ability?



Increased risk of chronic disease
Acute respiratory exacerbations

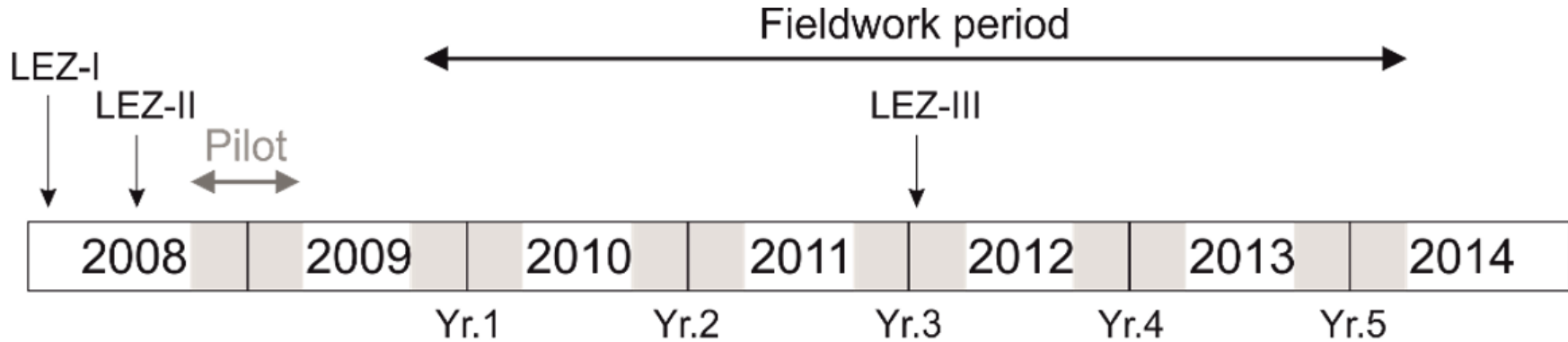


Acute and chronic
Premature death
Dementia



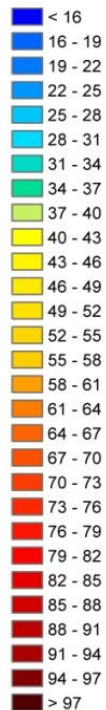
EXHALE study

Children's respiratory health in Hackney and Tower Hamlets



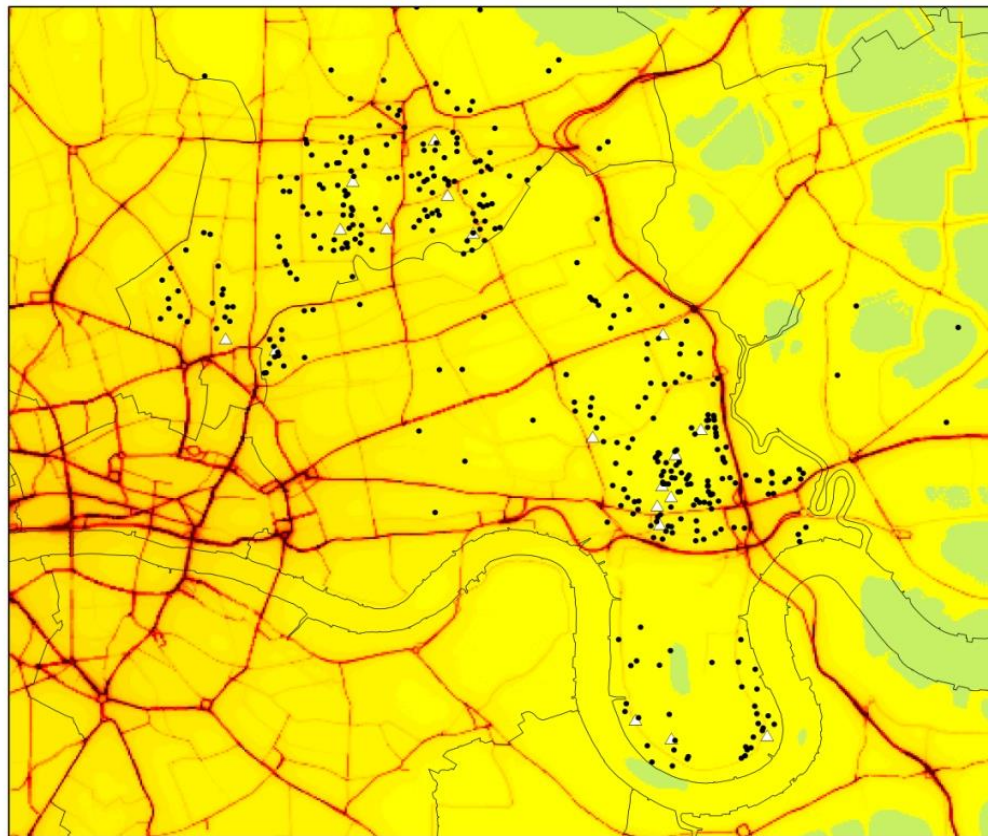
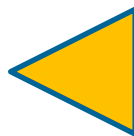
NO₂ in Tower Hamlets & Hackney

2009 NO₂ Annual Mean
($\mu\text{g m}^{-3}$)

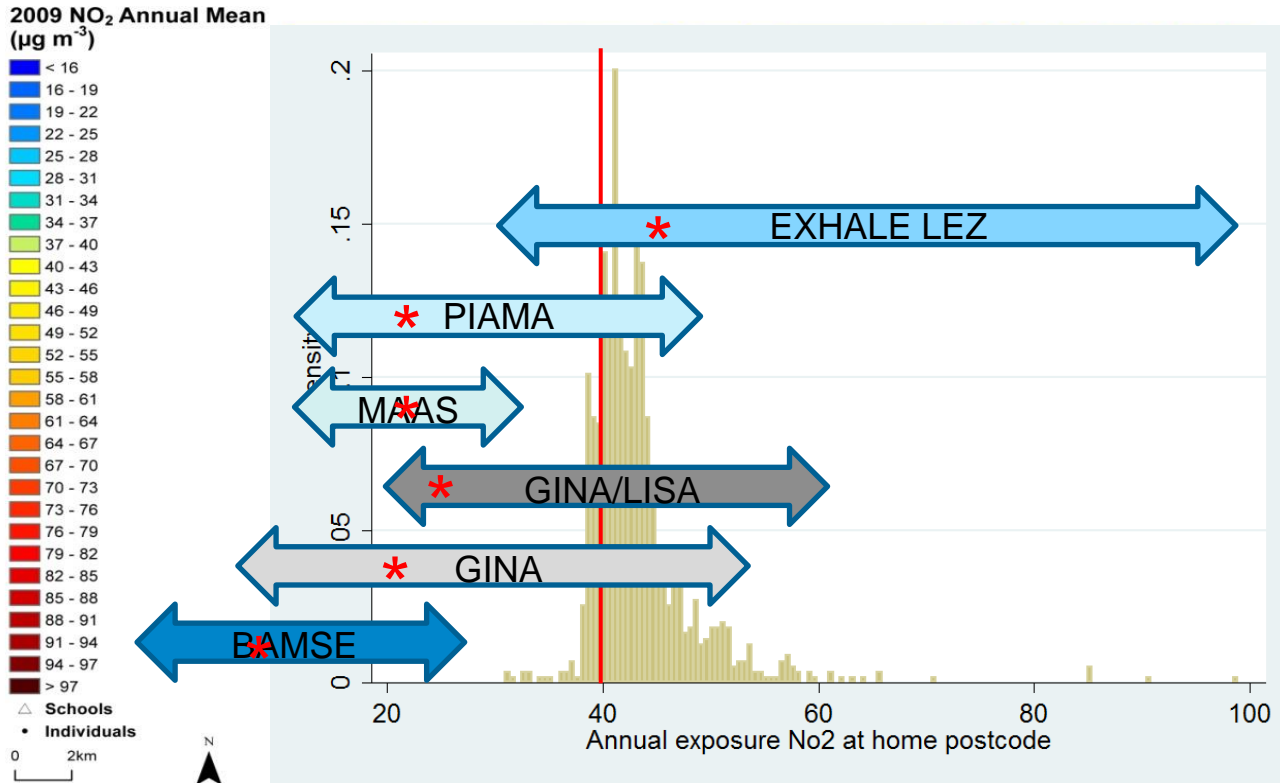


△ Schools
• Individuals

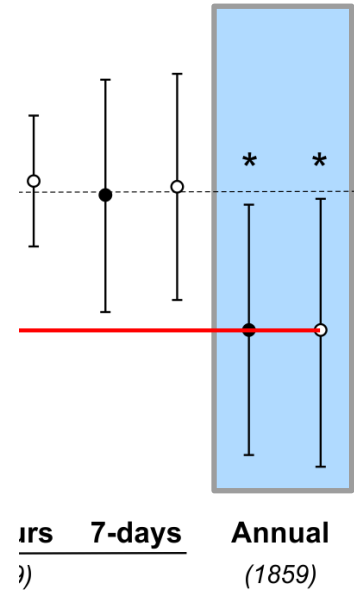
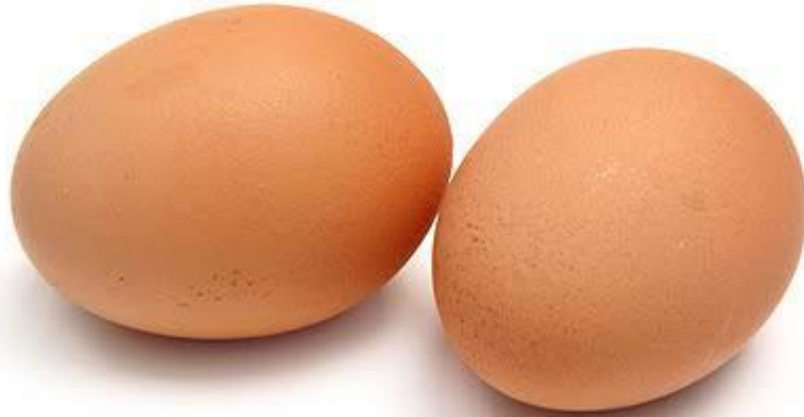
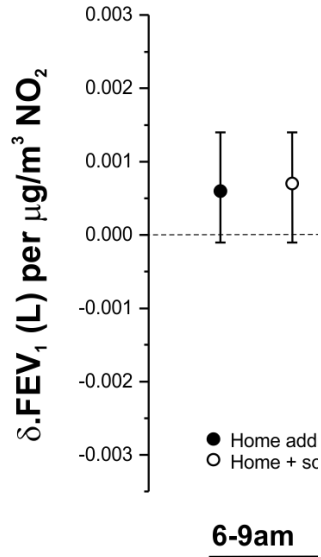
0 2km



Modelled annual NO₂ concentrations



NO₂ impact on lung function



DOOM

GLOOM



Improved Lung Growth as Pollution Decreases



Association of Improved Air Quality with Lung Development in Children

W. James Gauderman, Ph.D., Robert Urman, M.S., Edward Avol, M.S., Kiros Berhane, Ph.D., Rob McConnell, M.D., Edward Rappaport, M.S., Roger Chang, Ph.D., Fred Lurmann, M.S., and Frank Gilliland, M.D., Ph.D.

ABSTRACT

BACKGROUND

Air-pollution levels have been trending downward progressively over the past several decades in southern California, as a result of the implementation of air quality-control policies. We assessed whether long-term reductions in pollution were associated with improvements in respiratory health among children.

METHODS

As part of the Children's Health Study, we measured lung function annually in 2120 children from three separate cohorts corresponding to three separate calendar periods: 1994–1998, 1997–2001, and 2007–2011. Mean ages of the children within each cohort were 11 years at the beginning of the period and 15 years at the end. Linear-regression models were used to examine the relationship between declining pollution levels over time and lung-function development from 11 to 15 years of age, measured as the increases in forced expiratory volume in 1 second (FEV₁) and forced vital capacity (FVC) during that period (referred to as 4-year growth in FEV₁ and FVC).

RESULTS

Over the 13 years spanned by the three cohorts, improvements in 4-year growth of both FEV₁ and FVC were associated with declining levels of nitrogen dioxide (P<0.001 for FEV₁ and FVC) and of particulate matter with an aerodynamic diameter of less than 2.5 μm (P= 0.008 for FEV₁ and P<0.001 for FVC) and less than 10 μm (P<0.001 for FEV₁ and FVC). These associations persisted after adjustment for several potential confounders. Significant improvements in lung-function development were observed in both boys and girls and in children with asthma and children without asthma. The proportions of children with clinically low FEV₁ (defined as <80% of the predicted value) at 15 years of age declined significantly, from 7.9% to 3.6% across the three periods, as the air quality improved (P=0.001).

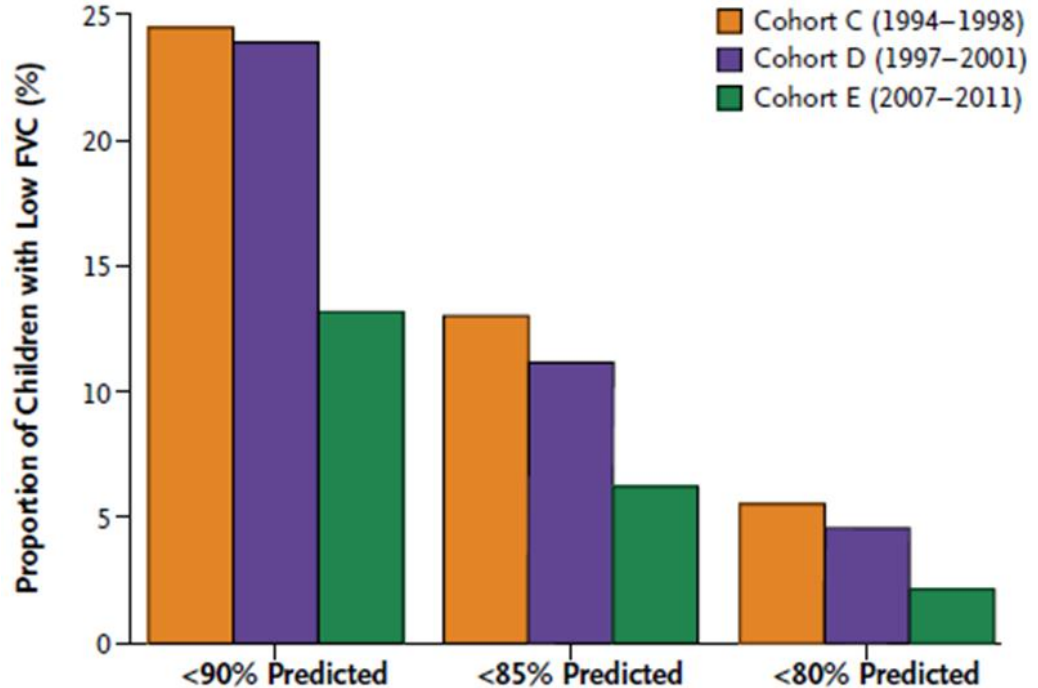
CONCLUSIONS

We found that long-term improvements in air quality were associated with statistically and clinically significant positive effects on lung-function growth in children. (Funded by the Health Effects Institute and others.)

From the Department of Preventive Medicine, University of Southern California, Los Angeles (W.J.G., R.U., E.A., E.B., R.M., E.R., R.C., F.G.) and Sonoma Technologies, Petaluma (F.L.)—both in California. Address reprint requests to Dr. Gauderman at the Department of Preventive Medicine, University of Southern California, 2001 Soto St, 202 K, Los Angeles, CA 90032, or wjg@usc.edu.

N Engl J Med 2015;372:905-13.
DOI: 10.1056/NEJMoa1414212

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Ultra low
emission



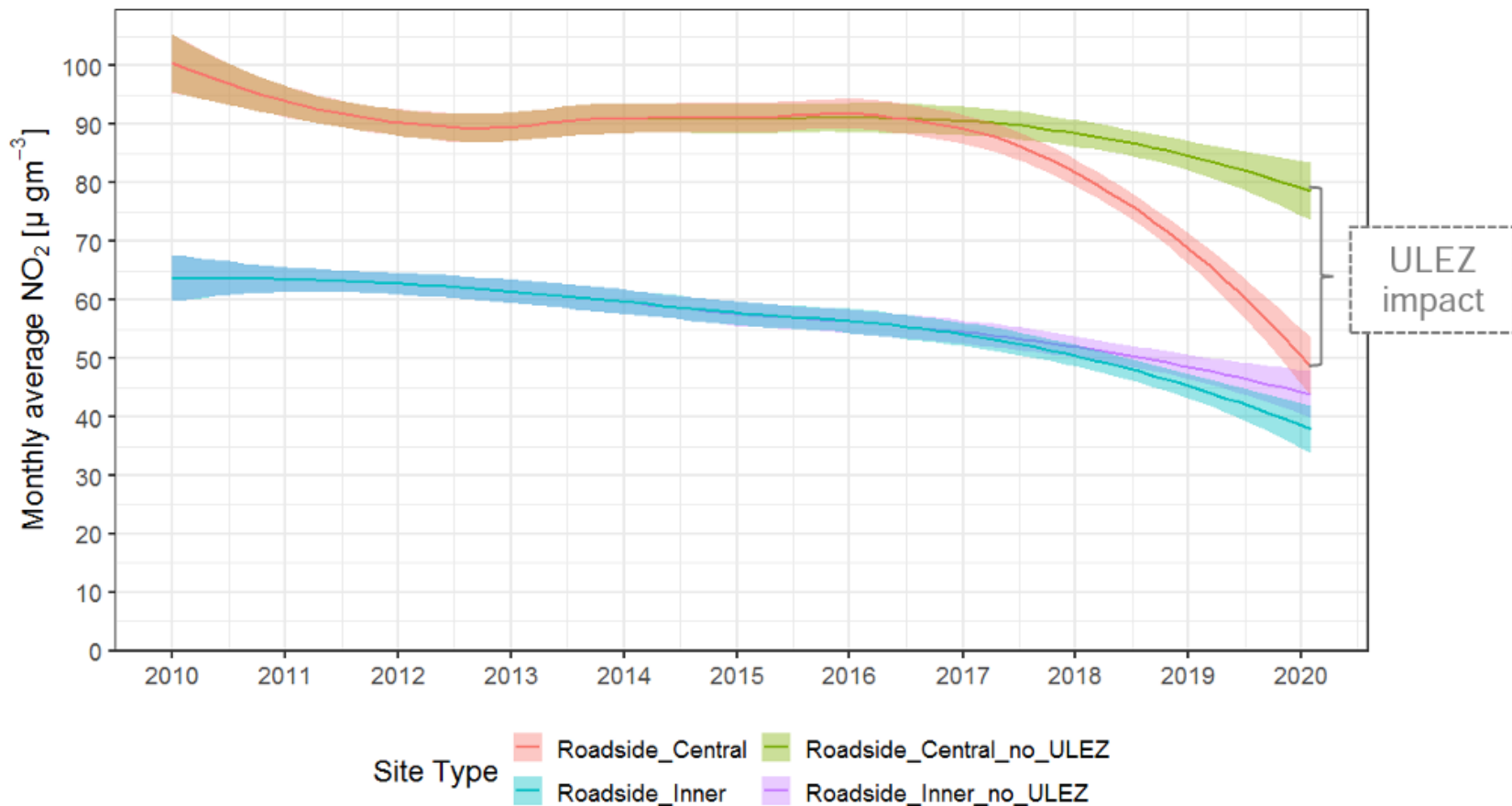
ZONE

At all times

10 pm



Trends in NO₂ in London vs. no ULEZ scenario



CHILL school locations

London



Luton







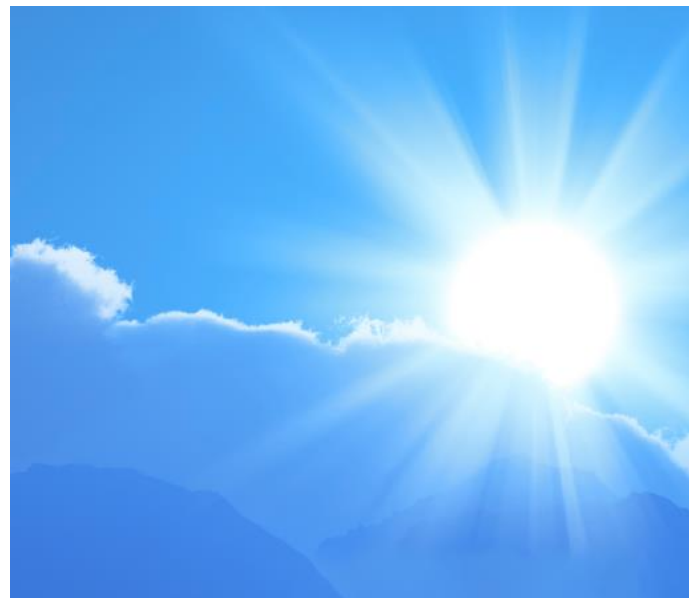
EUROPE

Air Quality Guidelines

Global Update
2005

$PM_{2.5}$: 10 $\mu g/m^3$

NO_2 : 40 $\mu g/m^3$



$PM_{2.5}$: 5 $\mu g/m^3$

...

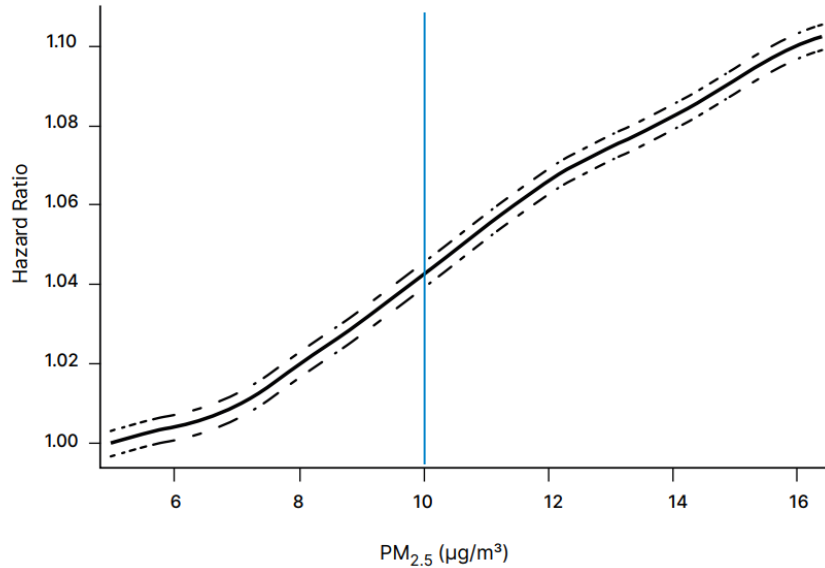
NO_2 : 10 $\mu g/m^3$

Executive summary



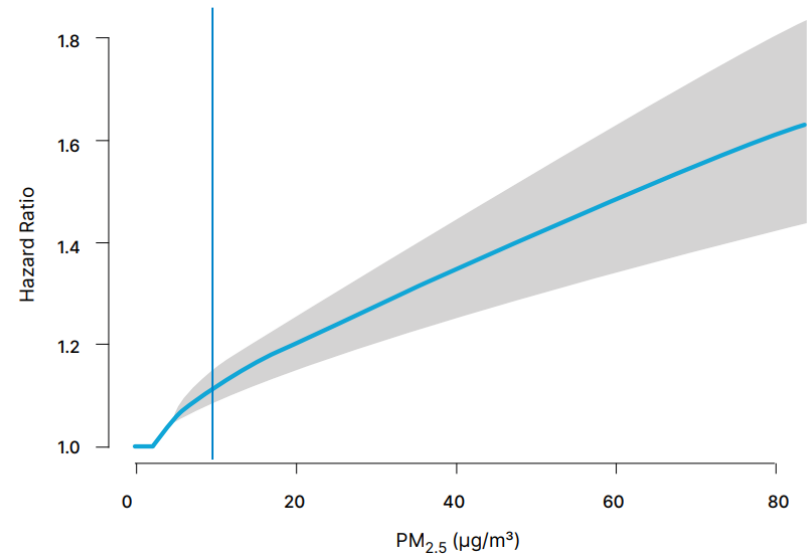
Evidence of health effects below the former WHO guideline value for PM_{2.5}

Relationship between long-term PM_{2.5} exposures and all cause mortality in the USA Medicare pop: 60 million +



Di et al. N Engl J Med. 2017;376(26):2513-2522.

Association between long-term PM_{2.5} exposure and mortality from NCDs and lower respiratory illness. Data from 41 different cohort studies



Burnett et al. Proc Natl Acad Sci U S A. 2018;115(38):9592-9597.

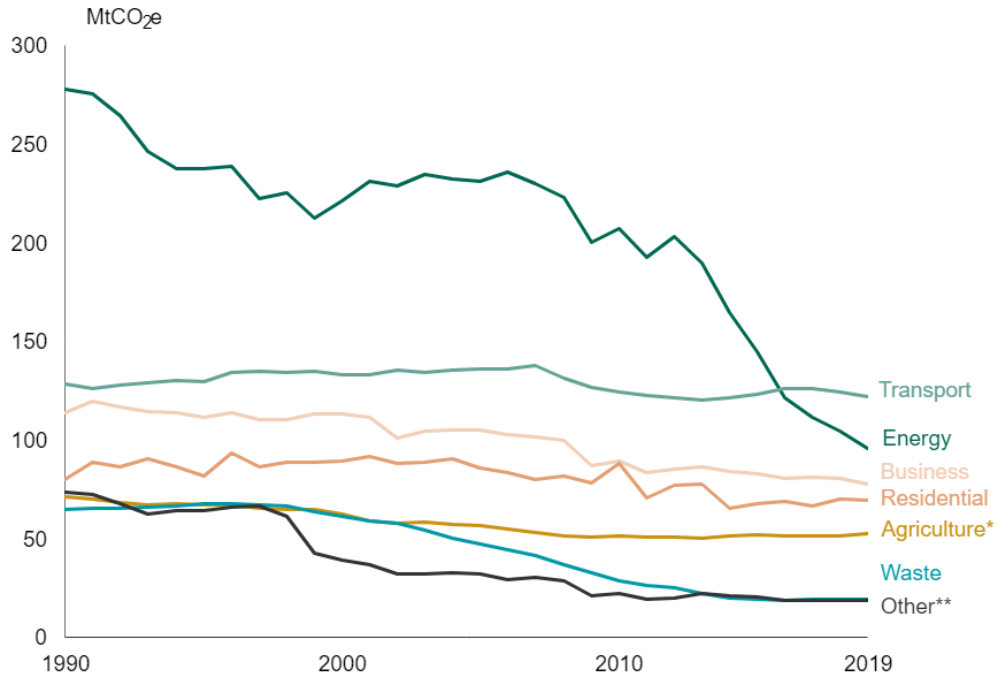
Recommended AQG – with interim targets

Pollutant	Averaging time	Interim target				AQG level
		1	2	3	4	
PM _{2.5} , µg/m ³	Annual	35	25	15	10	5
	24-hour ^a	75	50	37.5	25	15
PM ₁₀ , µg/m ³	Annual	70	50	30	20	15
	24-hour ^a	150	100	75	50	45
O ₃ , µg/m ³	Peak season ^b	100	70	–	–	60
	8-hour ^a	160	120	–	–	100
NO ₂ , µg/m ³	Annual	40	30	20	–	10
	24-hour ^a	120	50	–	–	25
SO ₂ , µg/m ³	24-hour ^a	125	50	–	–	40
CO, mg/m ³	24-hour ^a	7	–	–	–	4

^a 99th percentile (i.e. 3–4 exceedance days per year).

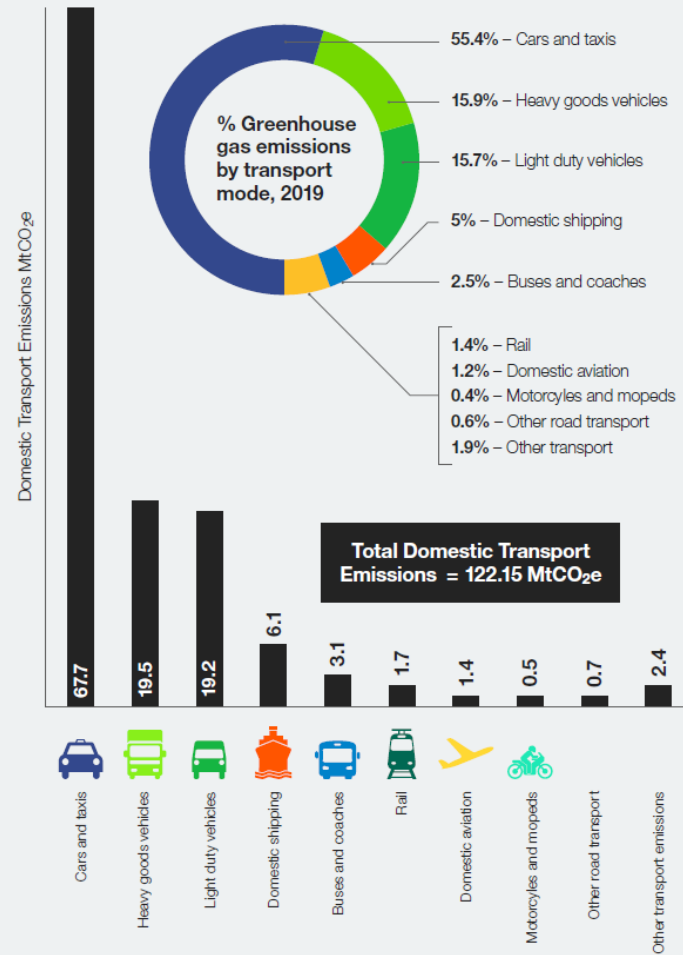
^b Average of daily maximum 8-hour mean O₃ concentration in the six consecutive months with the highest six-month running-average O₃ concentration.

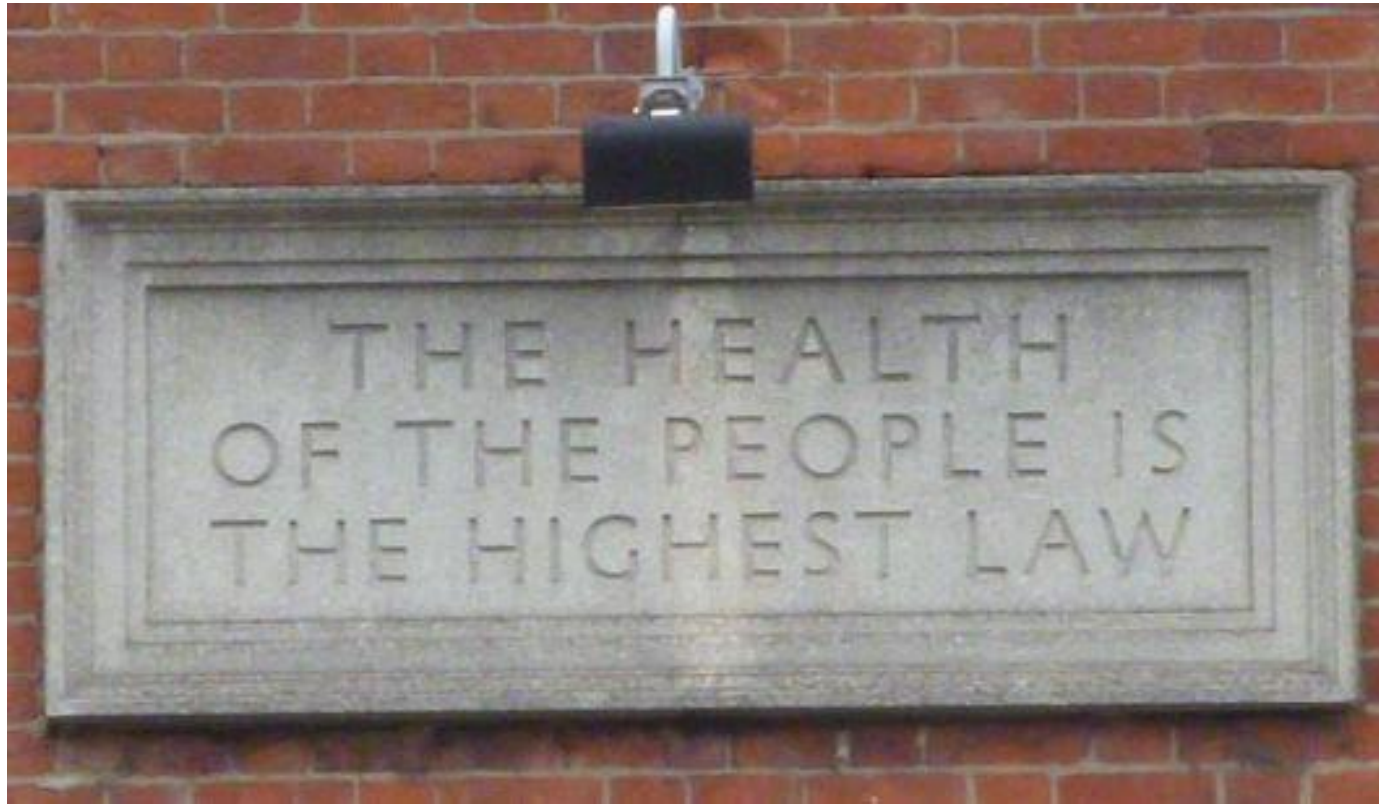
Intersection with NetZero



* LULUCF – Land Use, Land Use Change and Forestry
 ** Includes emissions from Public and Industrial Processes

UK domestic transport emissions 2019⁶





‘Salus populi suprema est lex’. Cicero