

# The very large health impacts of very small particles in the air.

Ian Mudway

9<sup>th</sup> June 2022

MRC  
Centre for Environment & Health

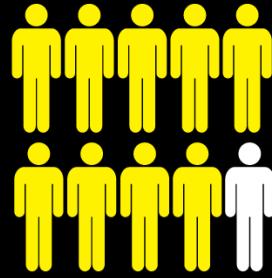


Medical  
Research  
Council

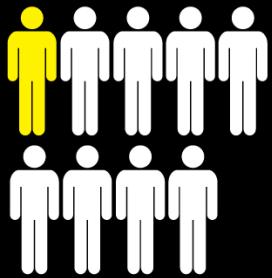
**Imperial College  
London**

# Air pollution - the facts

**9 in 10**  
people breathe  
polluted air  
worldwide



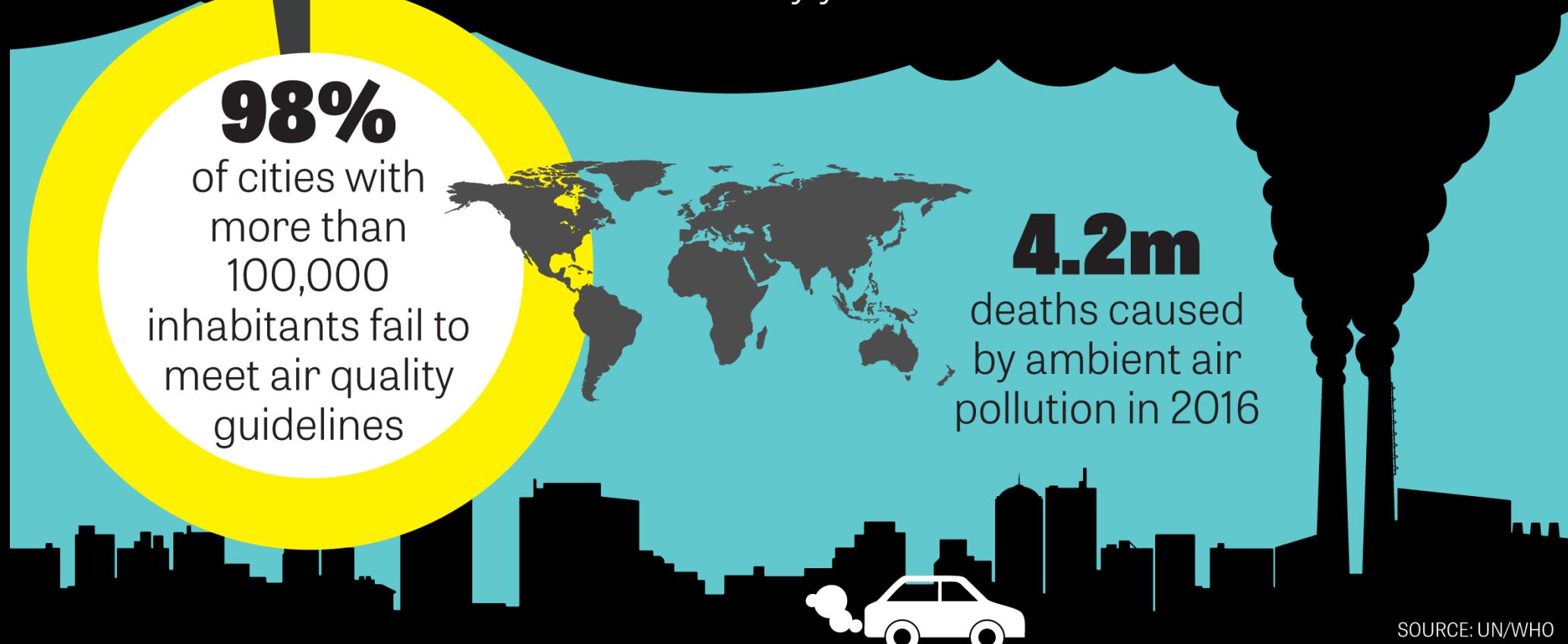
**1 in 9**  
deaths caused by  
air pollution - killing  
**7 million** people  
every year



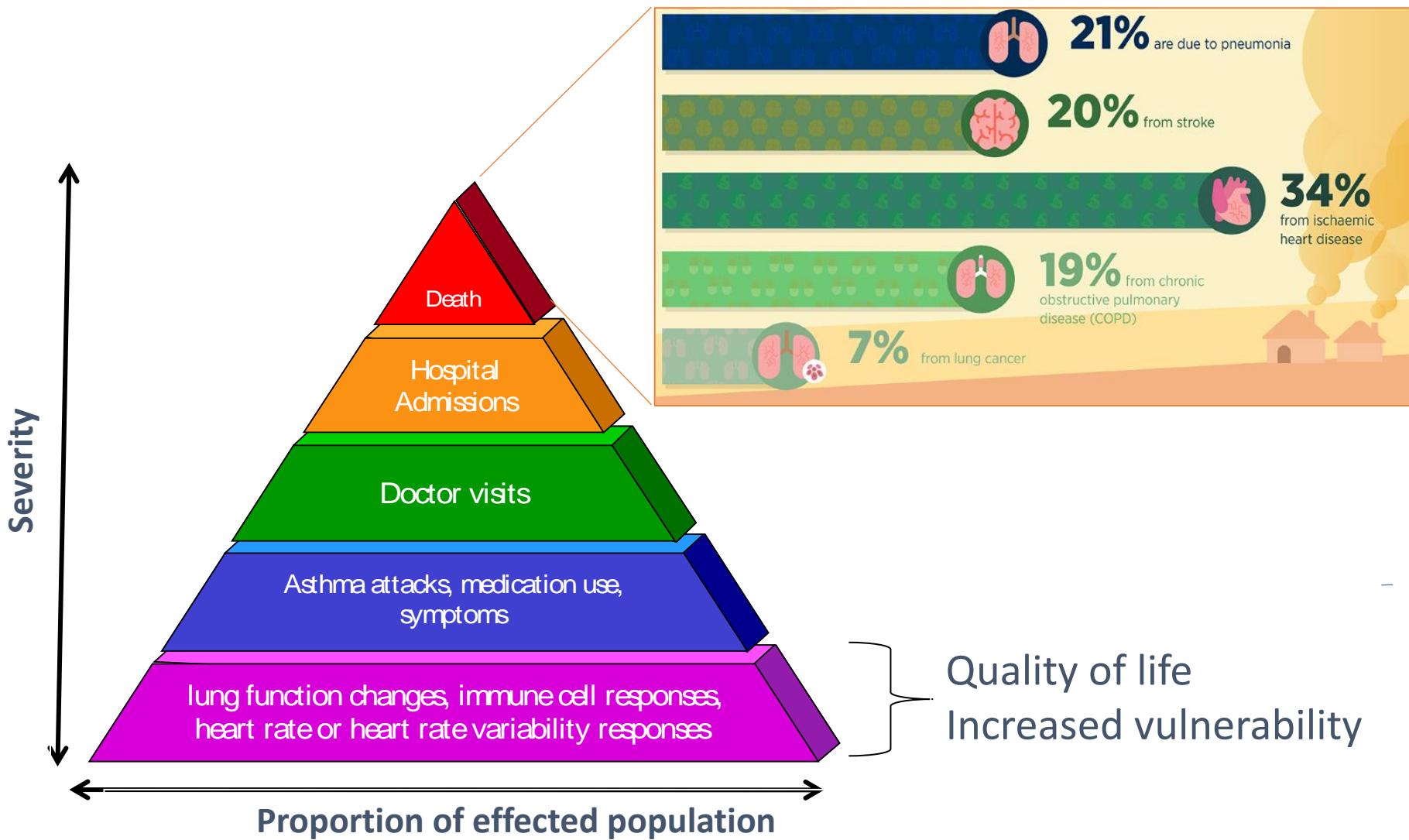
**3.8m**  
deaths caused  
by household  
air pollution  
in 2016

**98%**  
of cities with  
more than  
100,000  
inhabitants fail to  
meet air quality  
guidelines

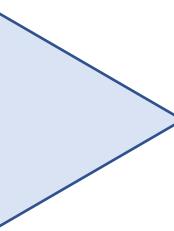
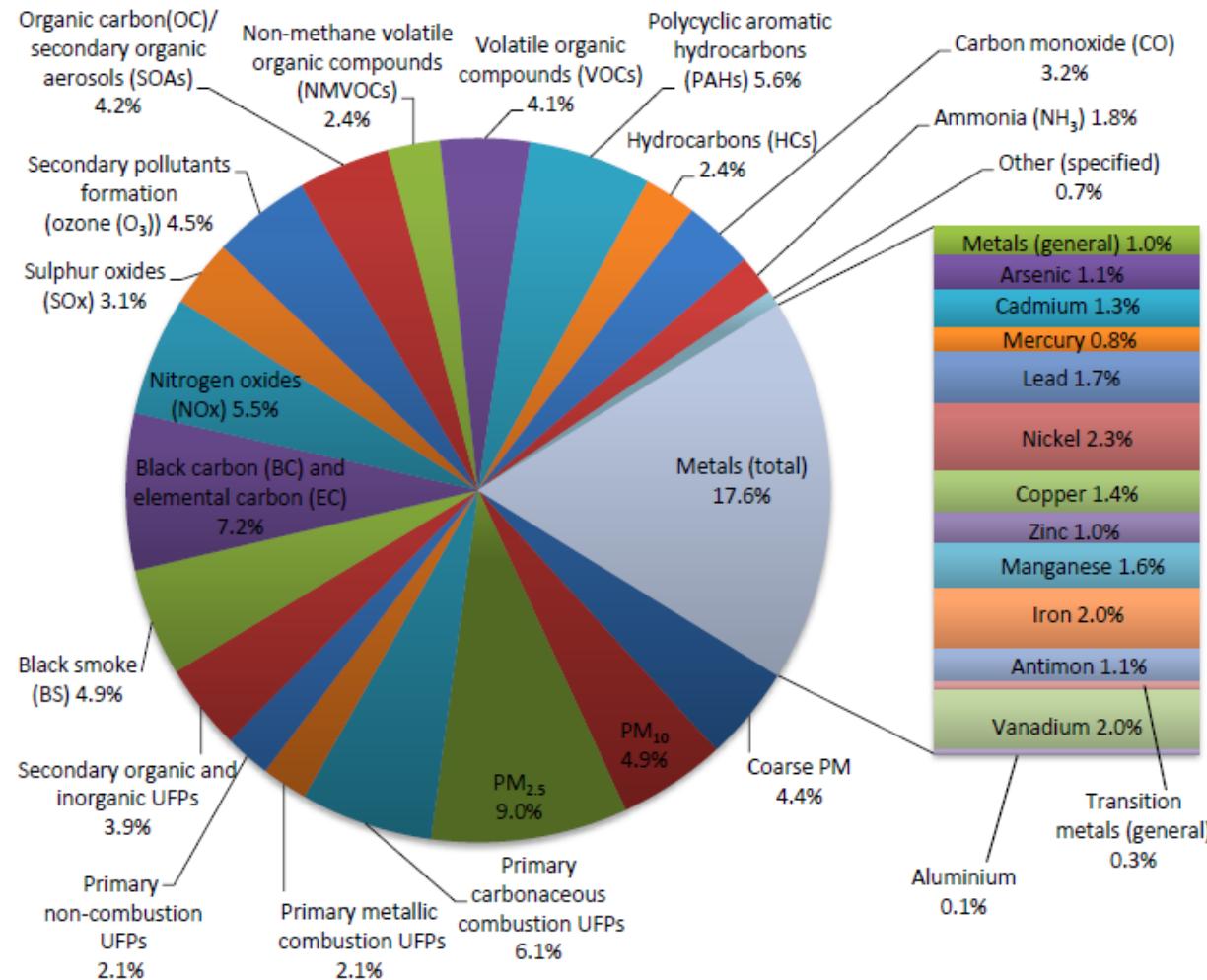
**4.2m**  
deaths caused  
by ambient air  
pollution in 2016



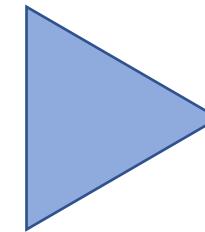
# Illness and quality of life



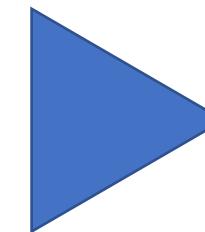
# What are the harmful components of PM2.5?



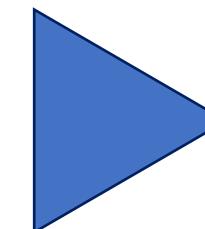
Sources



Primary/secondary



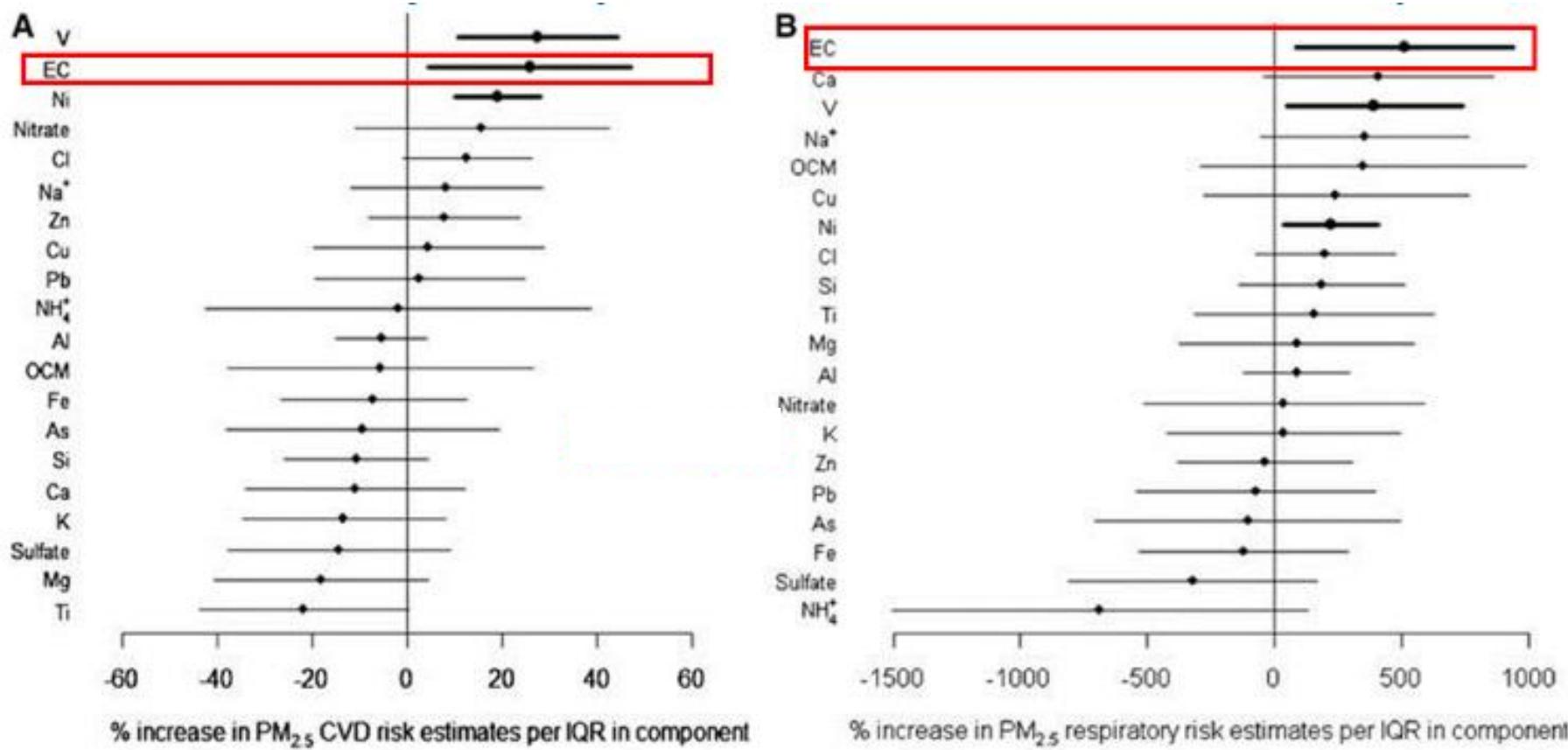
Gases / VOC



Ultrafines

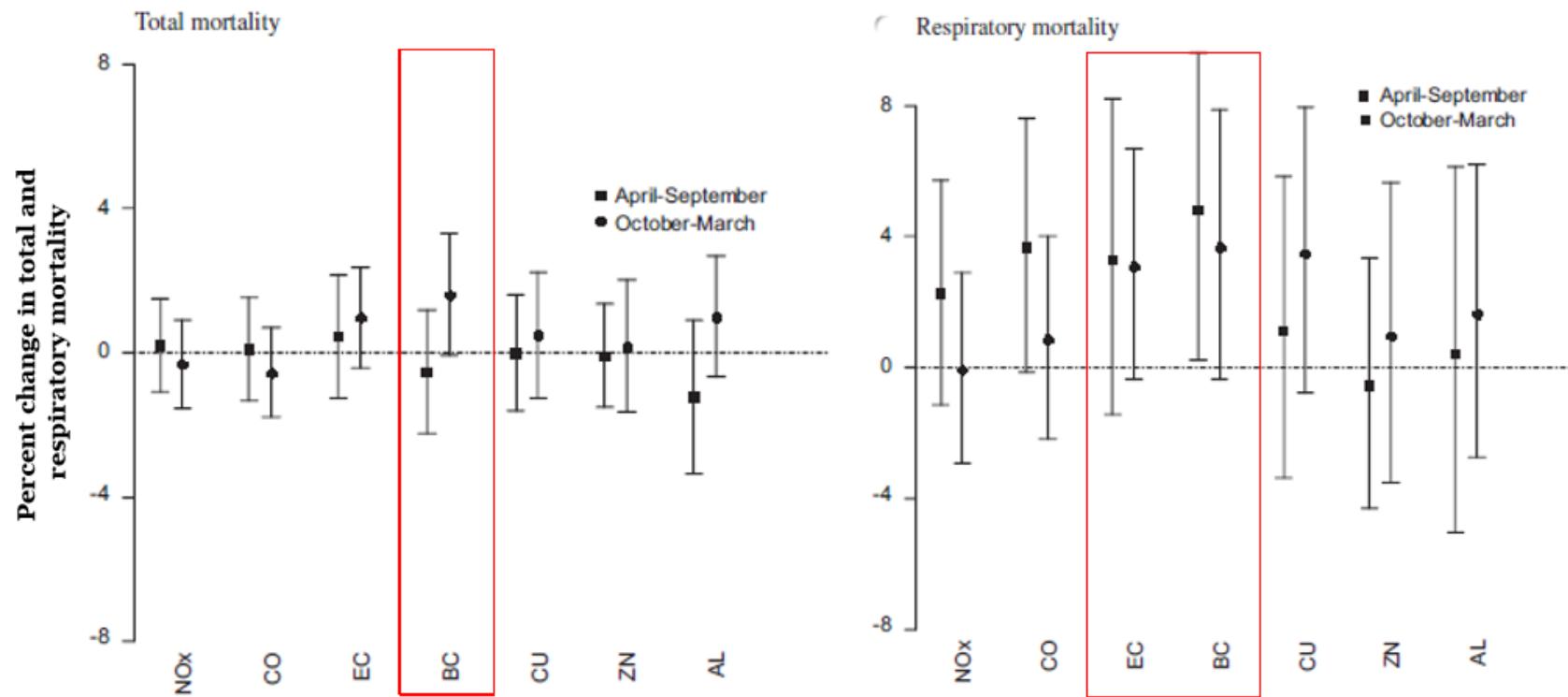
# Black Carbon – a better health indicator?

*Toxic component or source indicator?*



Estimated county- and season-specific relative risks (RR) of cardiovascular and respiratory hospitalization associated with PM<sub>2.5</sub> components in 106 U.S. counties for the years 1999 through 2005

# Short-term exposure to traffic-related air pollution and daily mortality in London (2011–2012)



**NOx:** General traffic indicator

**CO:** Petrol vehicle exhaust

**EC:** Diesel vehicle exhaust

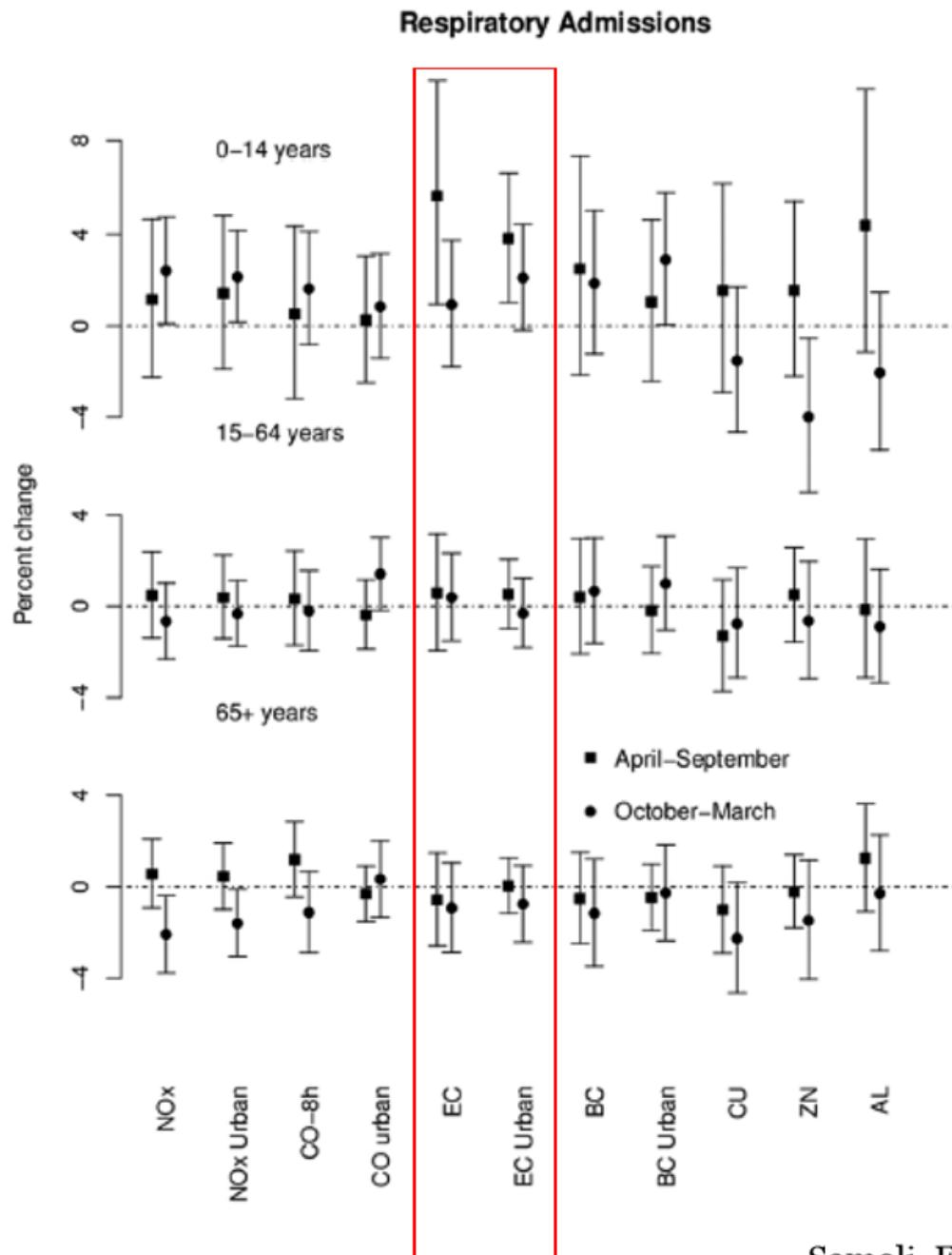
**BC:** Diesel vehicle exhaust

**Cu:** Brake wear

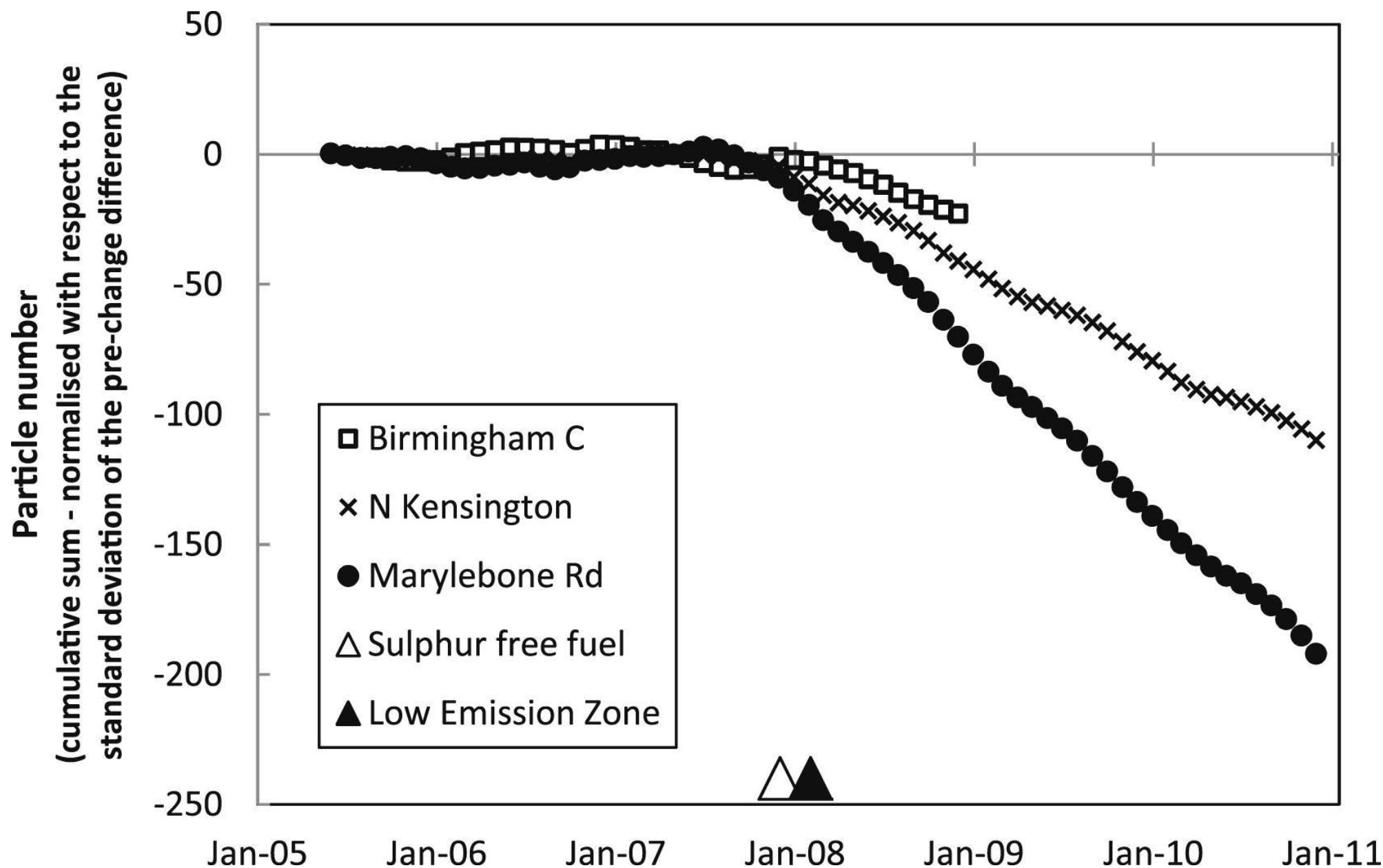
**Zn:** Tire wear

**Al:** Road dust resuspension

# Short-term exposure to traffic-related air pollution & respiratory hospital admissions in London



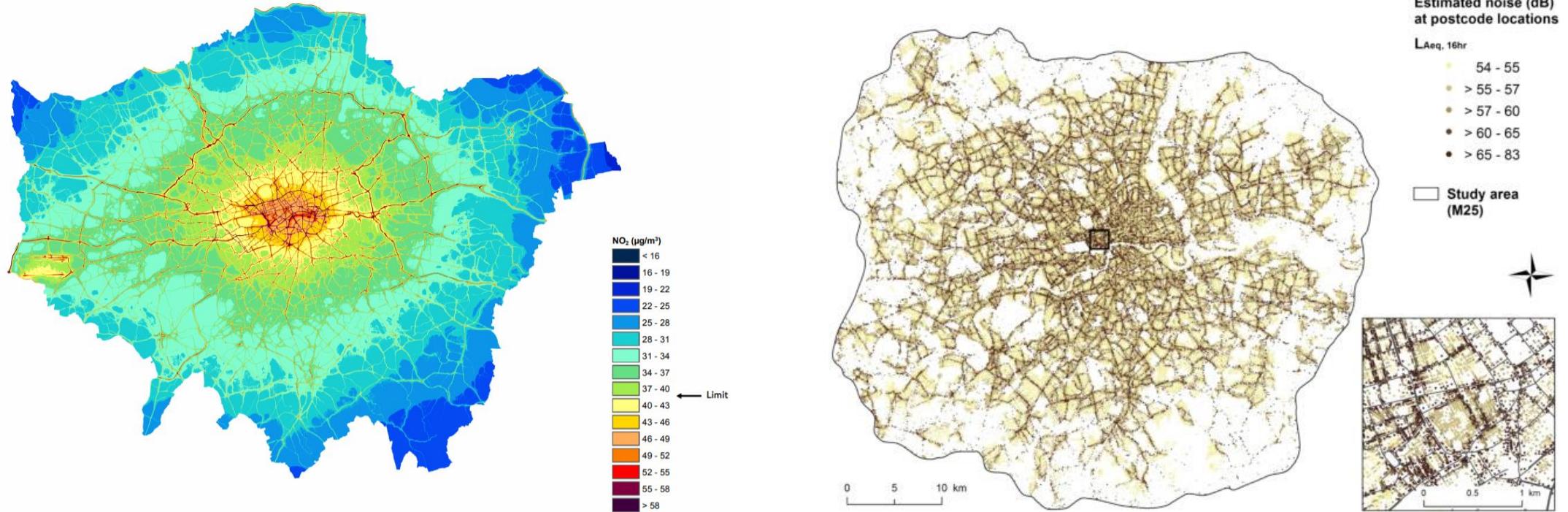
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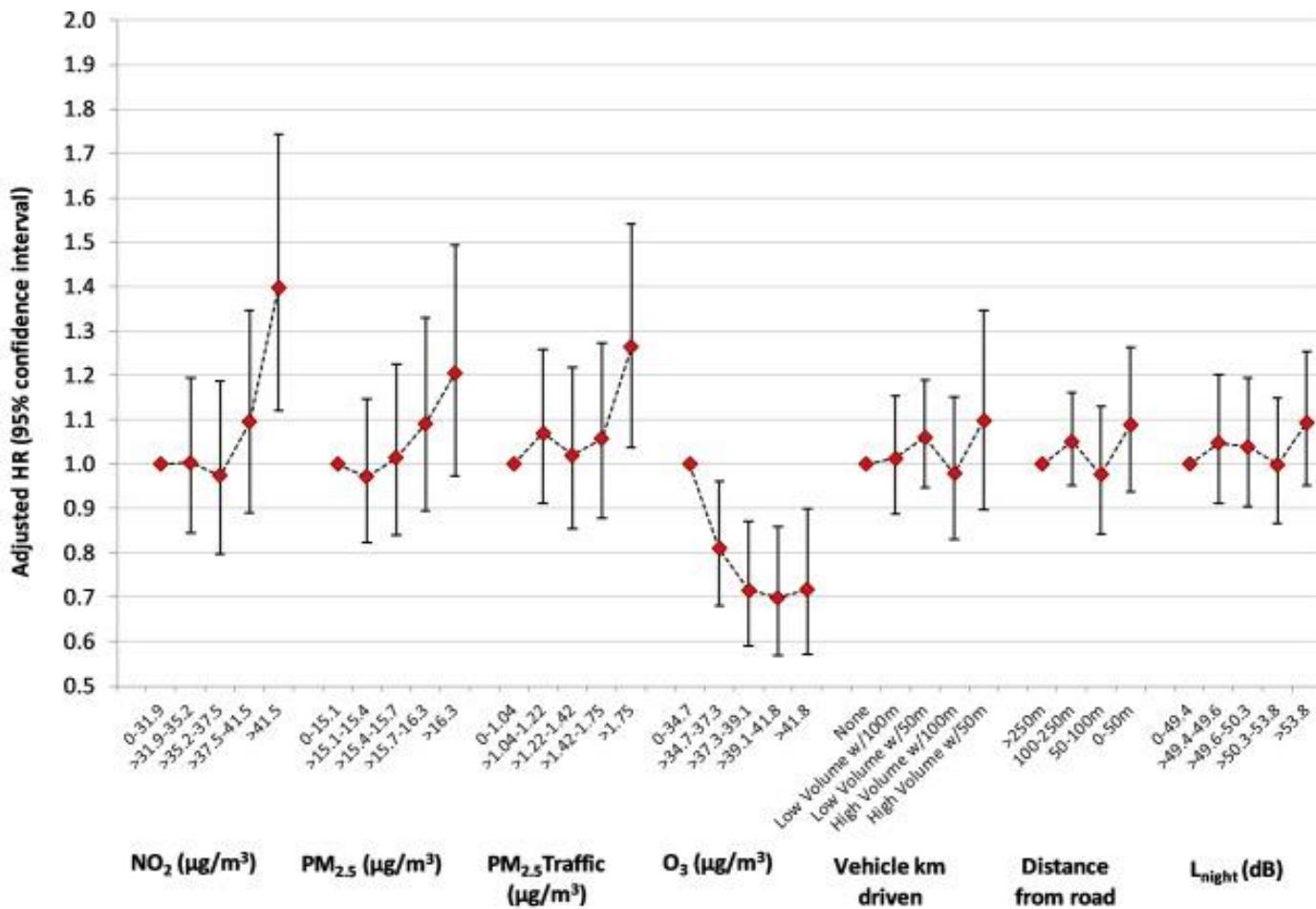
# Dementia Risk in London

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



## Traffic derived pollution

## Noise



the guardian

Air pollution linked to much greater risk of dementia

Risk in over-50s increases by 40% where highest nitrogen oxide levels exist, study shows

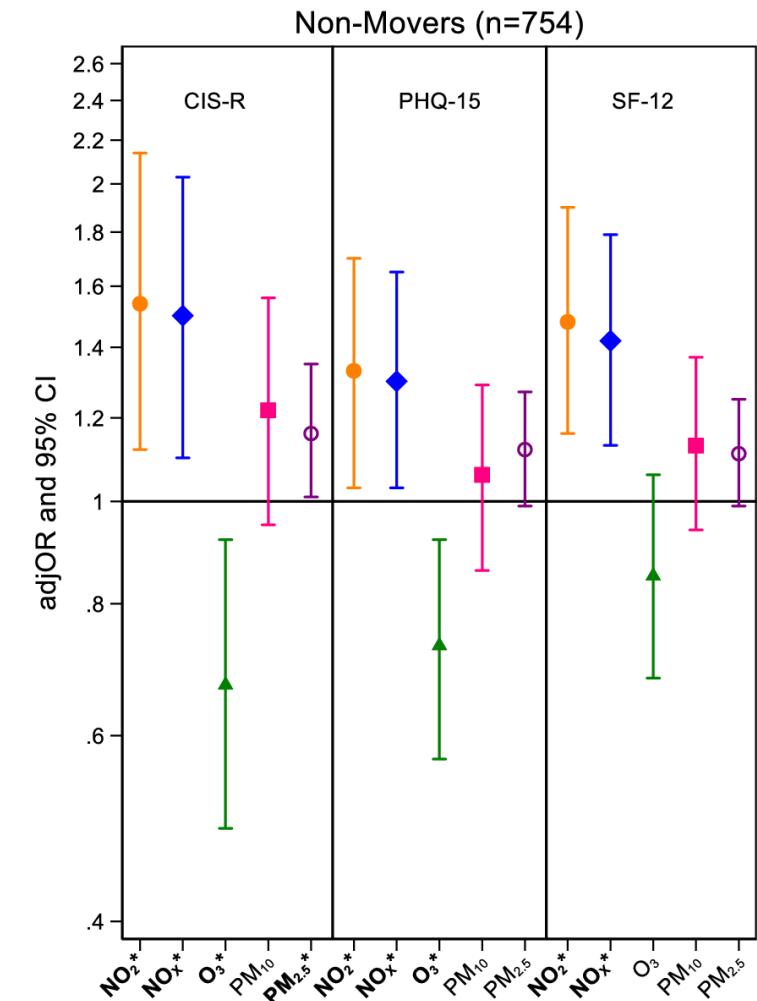
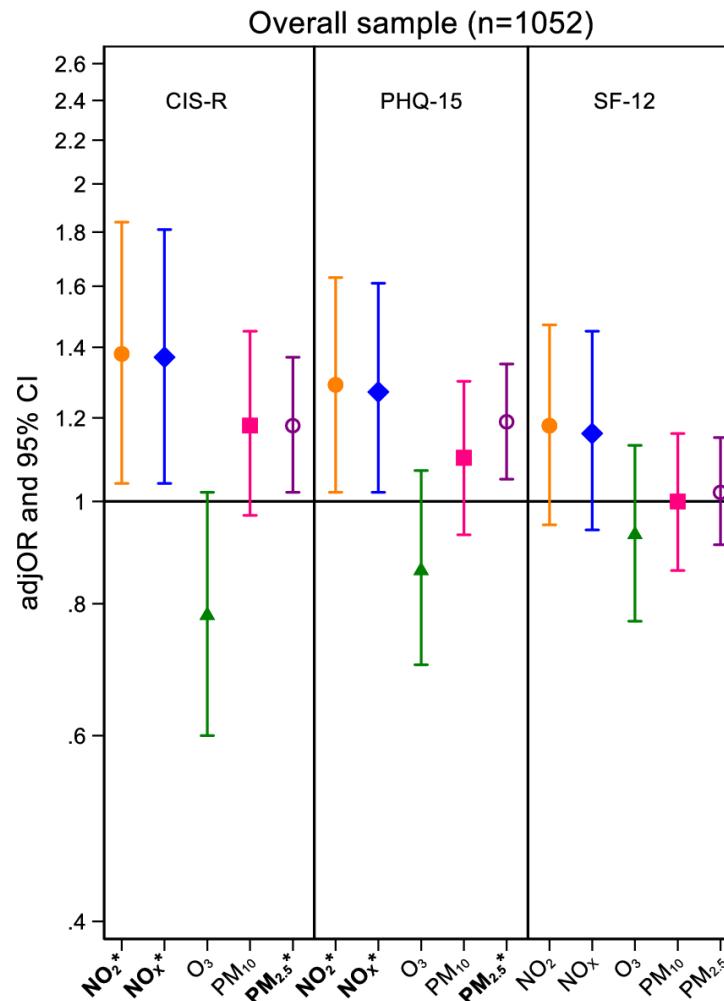
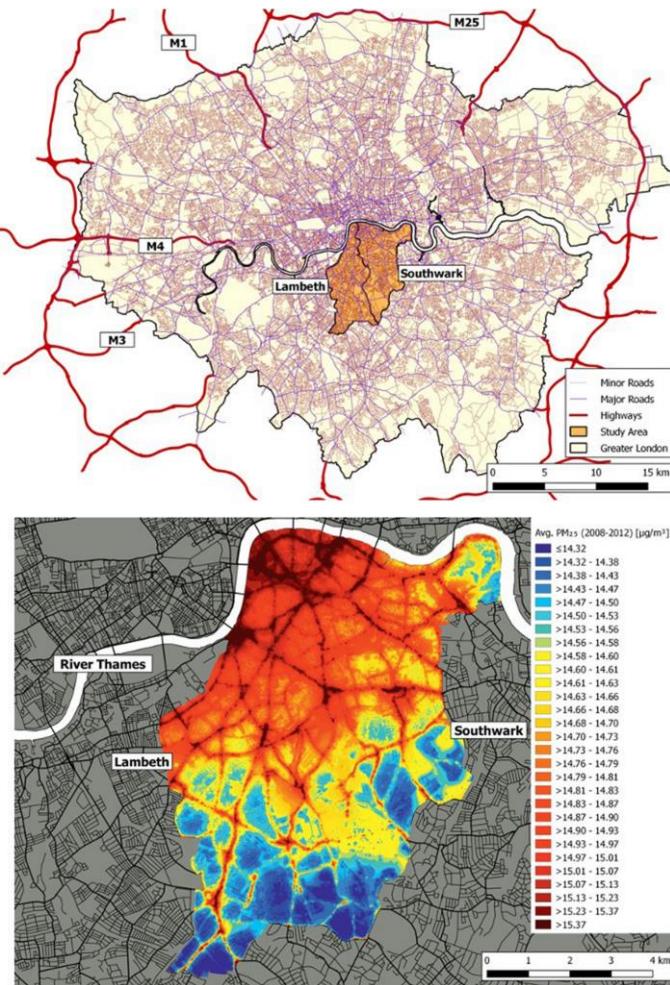


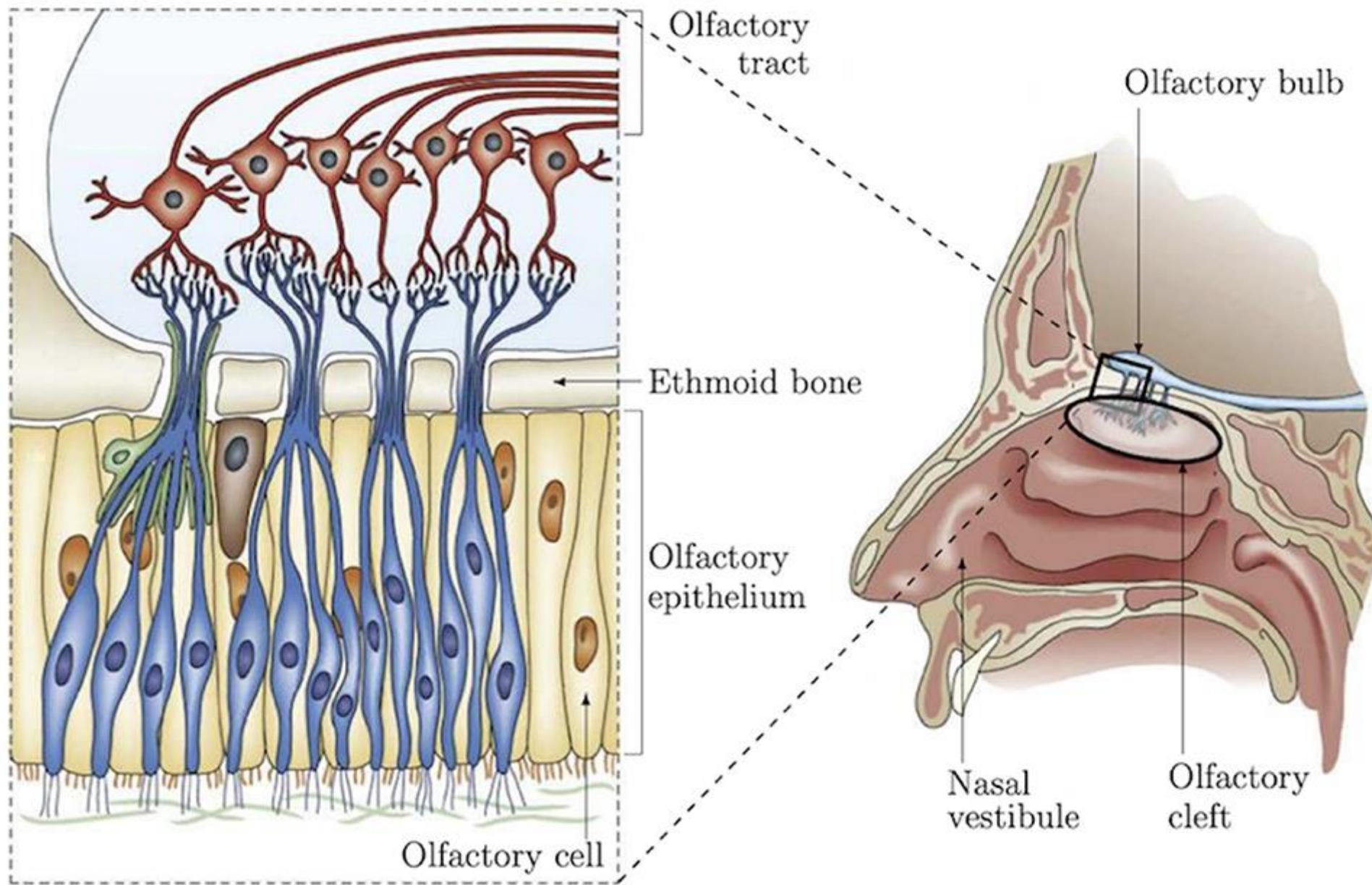
▲ King's College London study could not find factors other than pollution to explain higher incidence of dementia.  
Photograph: Adrian Dennis/AFP/Getty Images

Air pollution may increase the chance of developing dementia, a study has suggested, in fresh evidence that the health of people of all ages is at risk from breathing dirty air.

Tue 18 Sep 2018

# Impacts on mental health





# Magnetite pollution nanoparticles in the human brain

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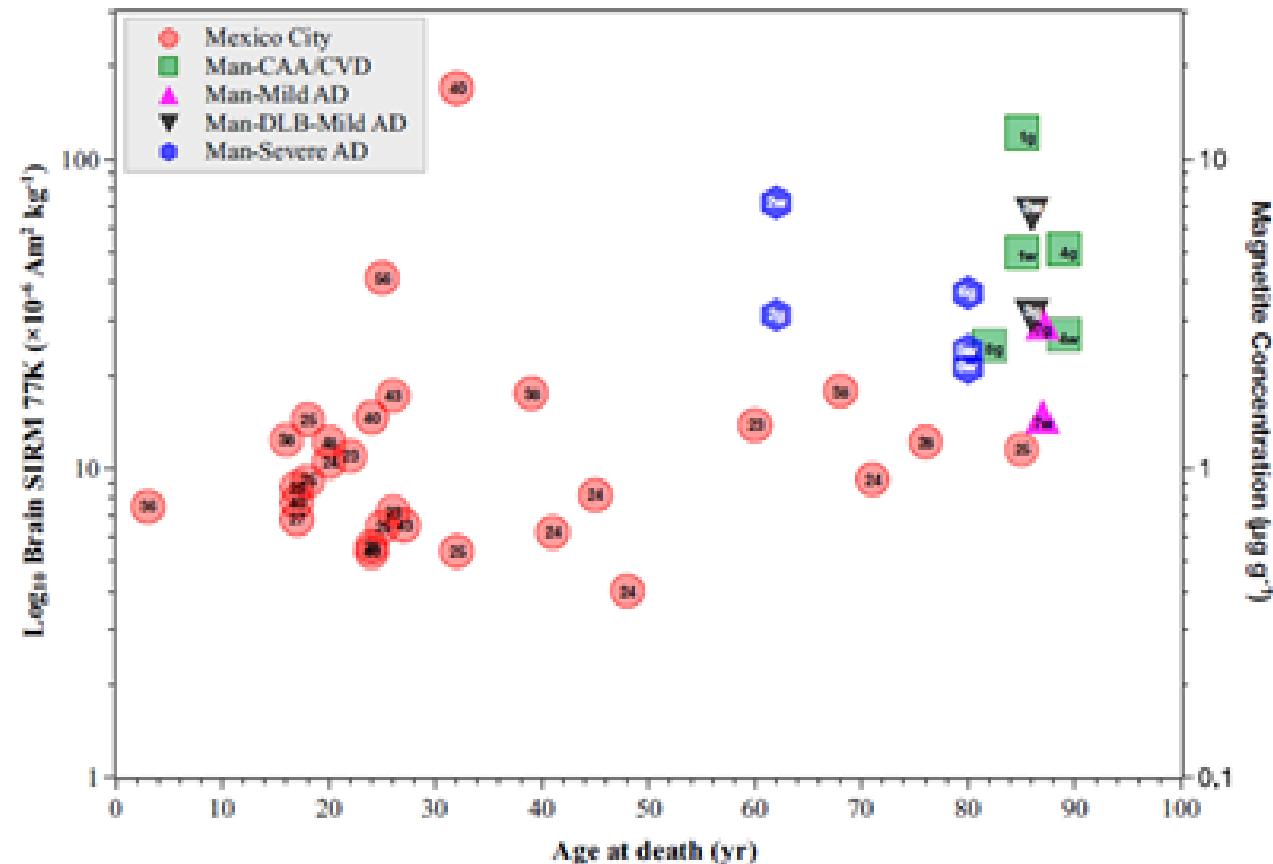
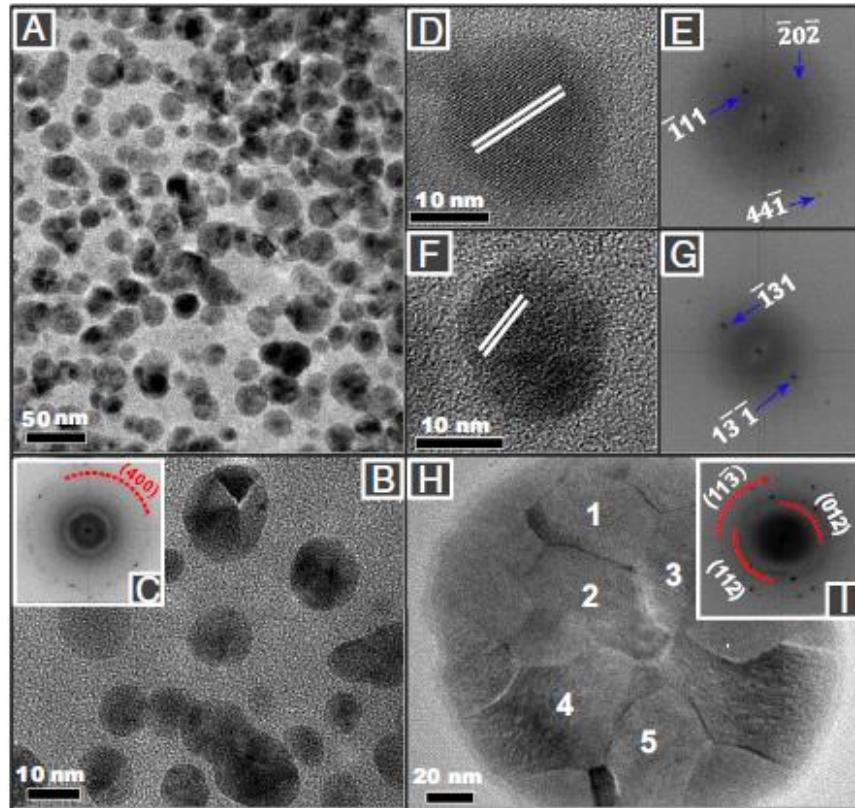
Astronomy, University of Glasgow, Glasgow G12 8QQ, United Kingdom; <sup>d</sup>Division of Biomedical and Life Sciences, Faculty of Health and Medicine,

University of Lancaster, Lancaster LA1 4YQ, United Kingdom; <sup>e</sup>Division of Neuroscience & Experimental Psychology, School of Biological Sciences, University

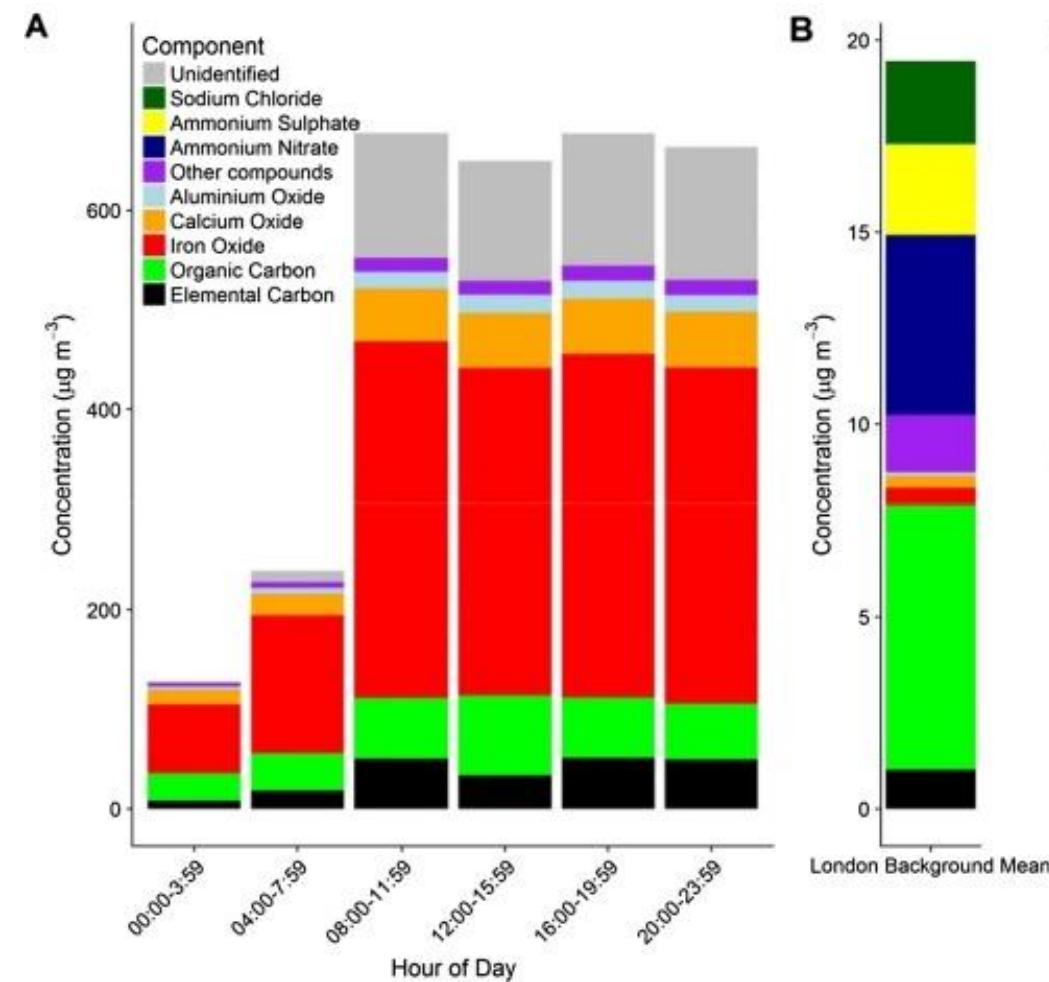
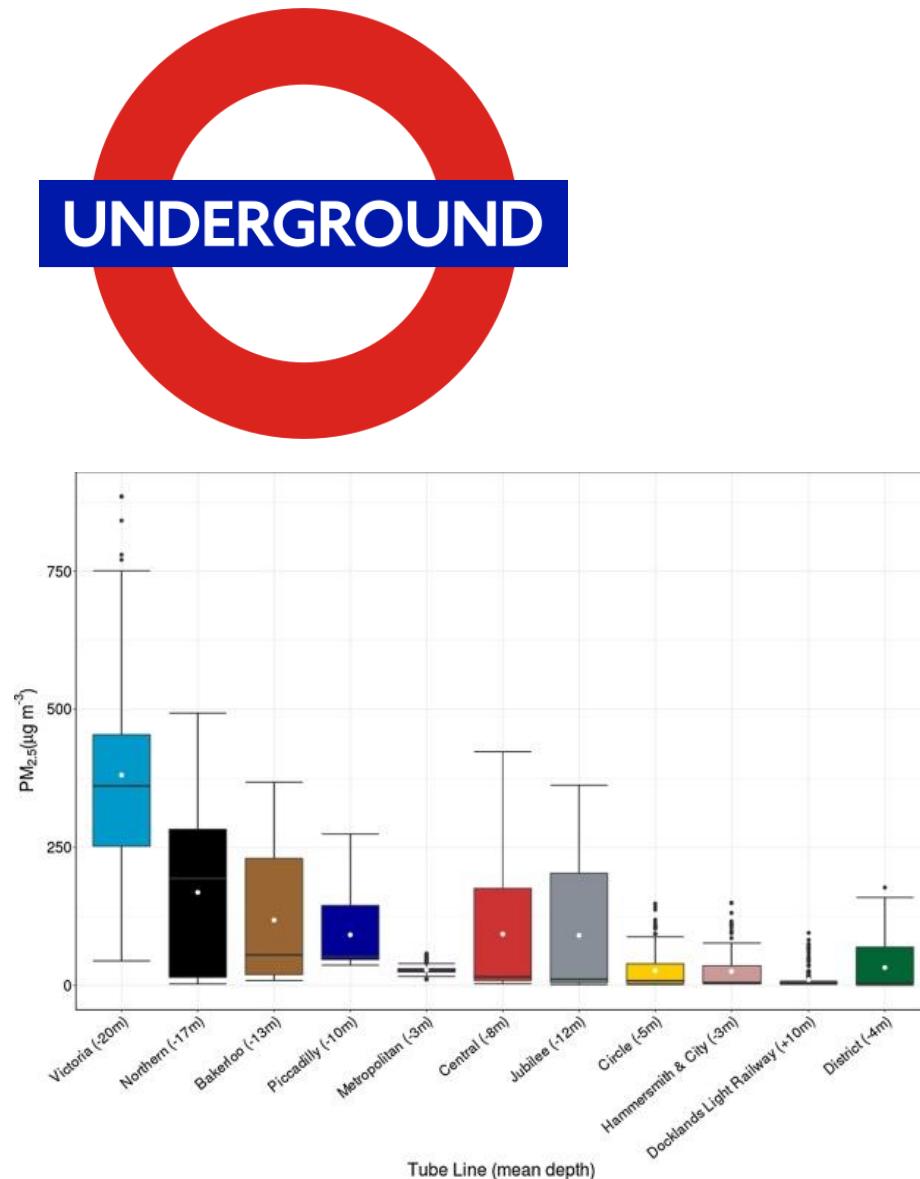
of Manchester, Manchester M6 8HD, United Kingdom; <sup>f</sup>Centro de Ciencias de la Atmósfera, Universidad Nacional Autónoma de México, Mexico City 04310,

Mexico; <sup>g</sup>Neurotoxicology Laboratory, The University of Montana, Missoula, MT 59812; and <sup>h</sup>Universidad del Valle de México, Mexico City, 04850, Mexico

Edited by Yinon Rudich, Weizmann Institute of Science, Rehovot, Israel, and accepted by Editorial Board Member A. R. Ravishankara July 25, 2016 (received for review April 13, 2016)



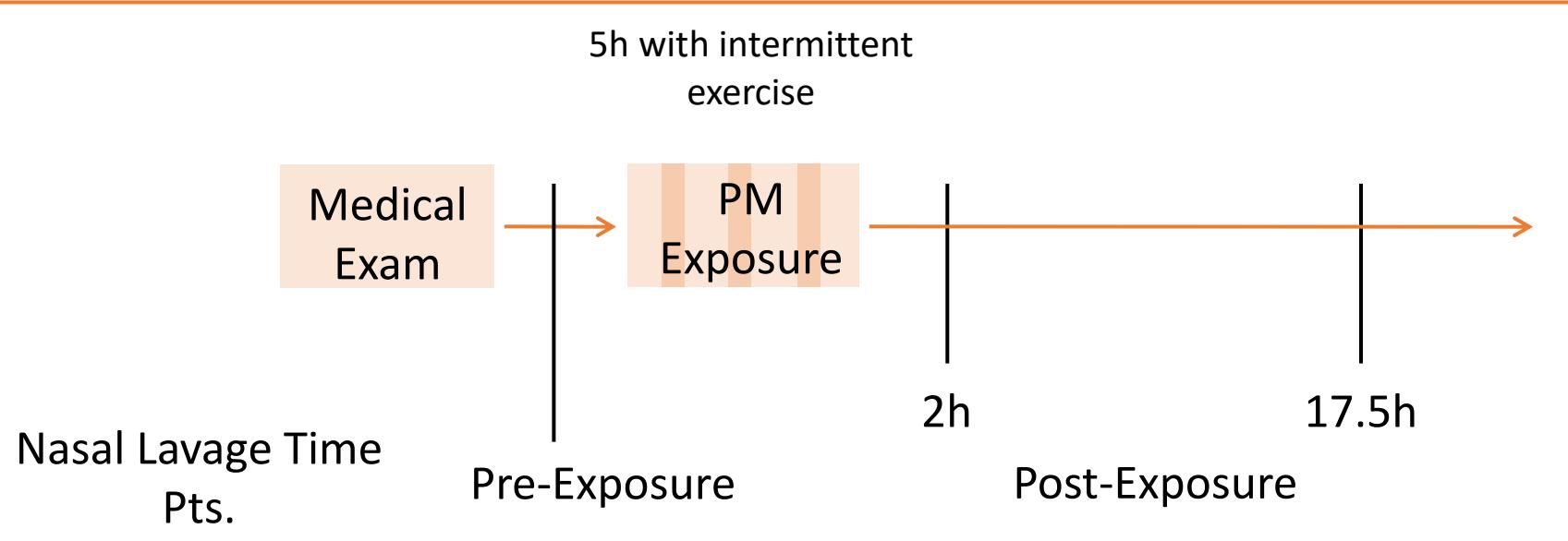
# Other important microenvironments



# RAPTES study

36 healthy subjects: 11 male, 25 female

Mean age: 22 years



Underground platform



Intersection

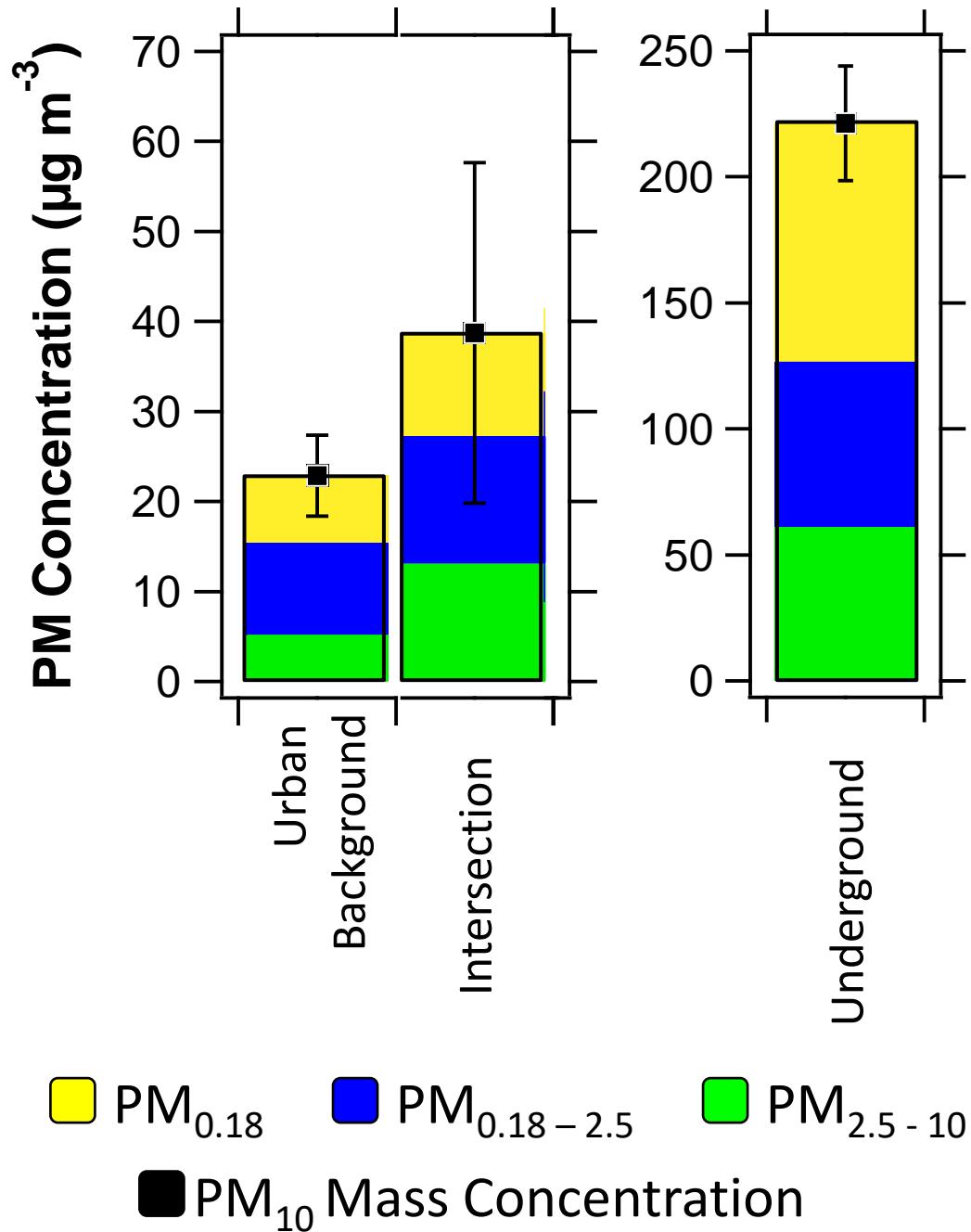
Urban Background

## Nasal Lavage (NAL) Measurements:

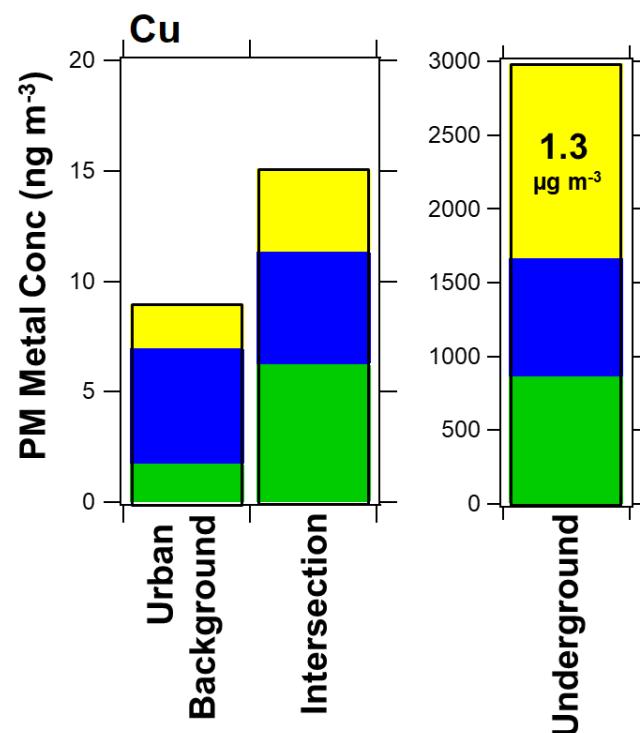
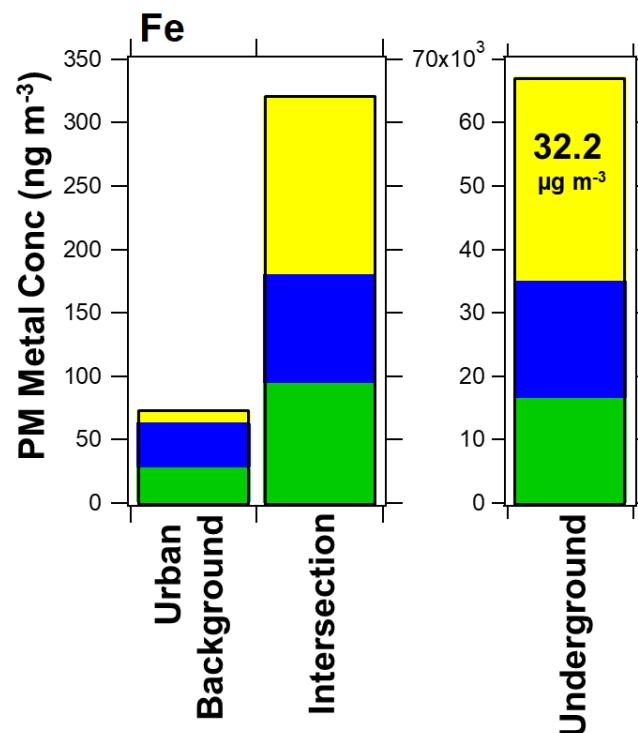
**Trace Metals** – *Fe, Cu, Zn, Pb, Ni, Cr, Al, V (endogenous/dietary and ambient PM sources)*  
*Ba, Sb (no endogenous form but ambient PM sources)*  
*Cl, Br, Ca (endogenous forms and weak ambient PM source)*

## Metal Handling Protein – Transferrin

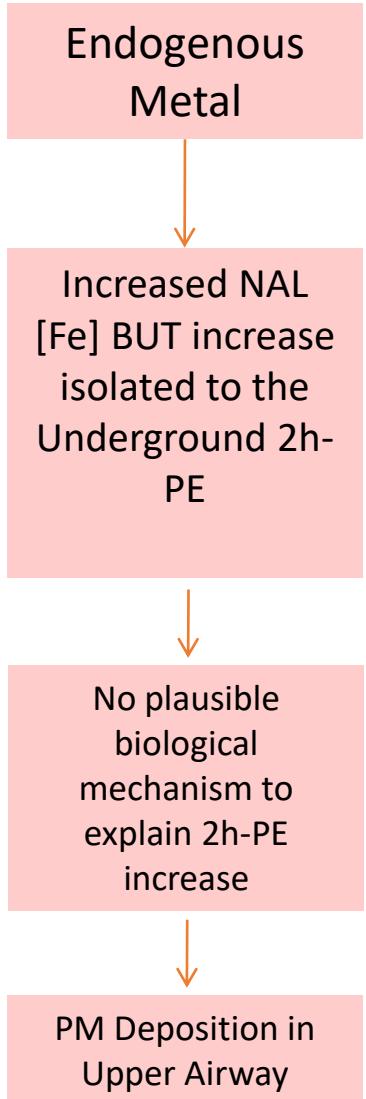
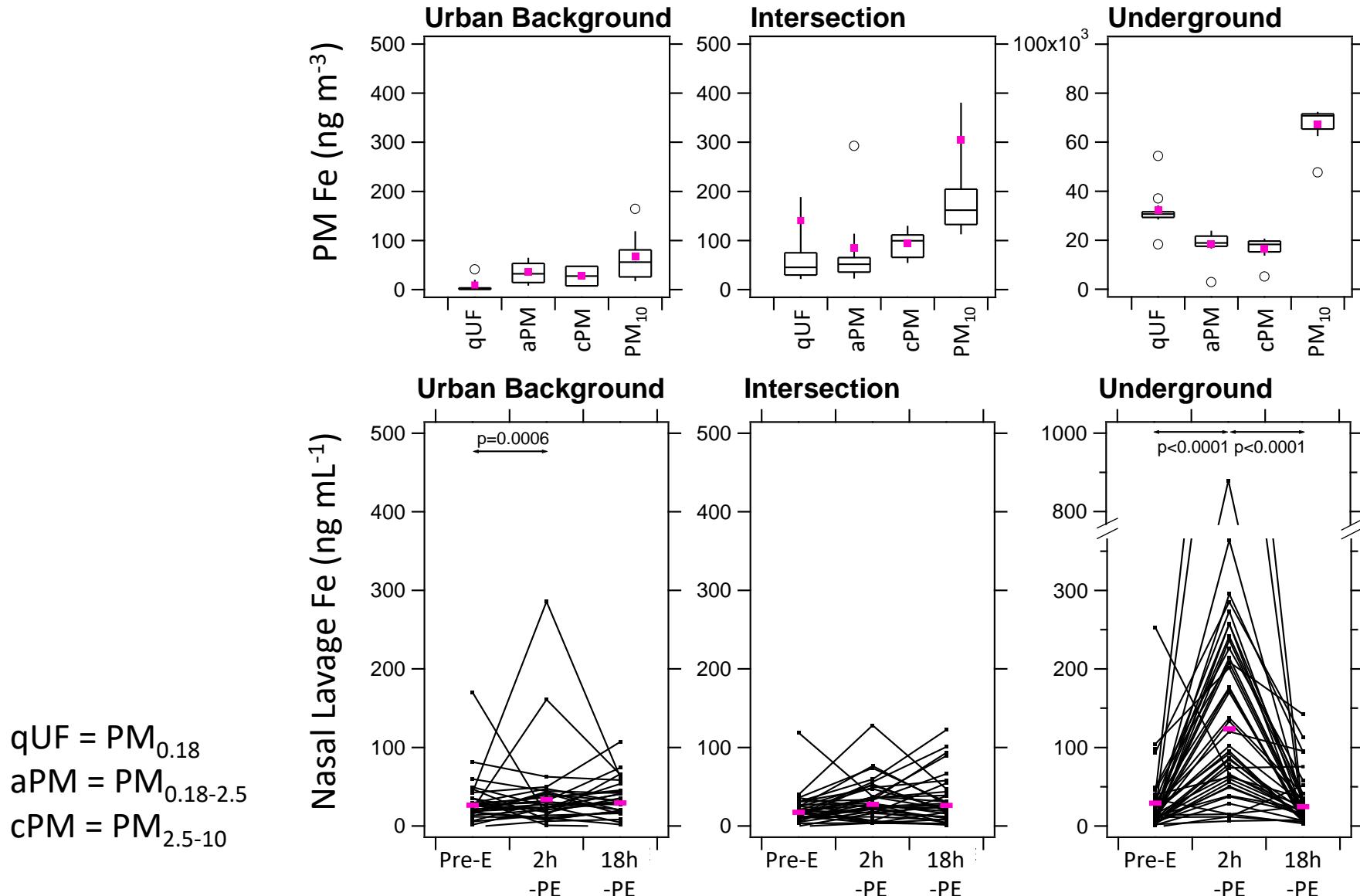
Strak M, Hoek G, Godri KJ, Gosens I, Mudway IS, van Oerle R, Spronk HM, Cassee FR, Lebret E, Kelly FJ, Harrison RM, Brunekreef B, Steenhof M, Janssen NA.



- $\text{PM}_{0.18} = 95 \mu\text{g m}^{-3}$  at the Underground
- Bulk of Underground  $\text{PM}_{10}$  is comprised of metals and EC+OC ( $44 \mu\text{g m}^{-3}$ )

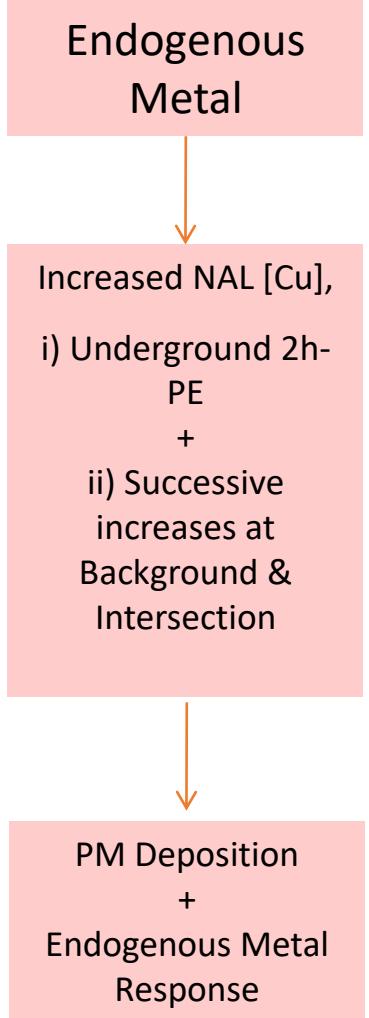
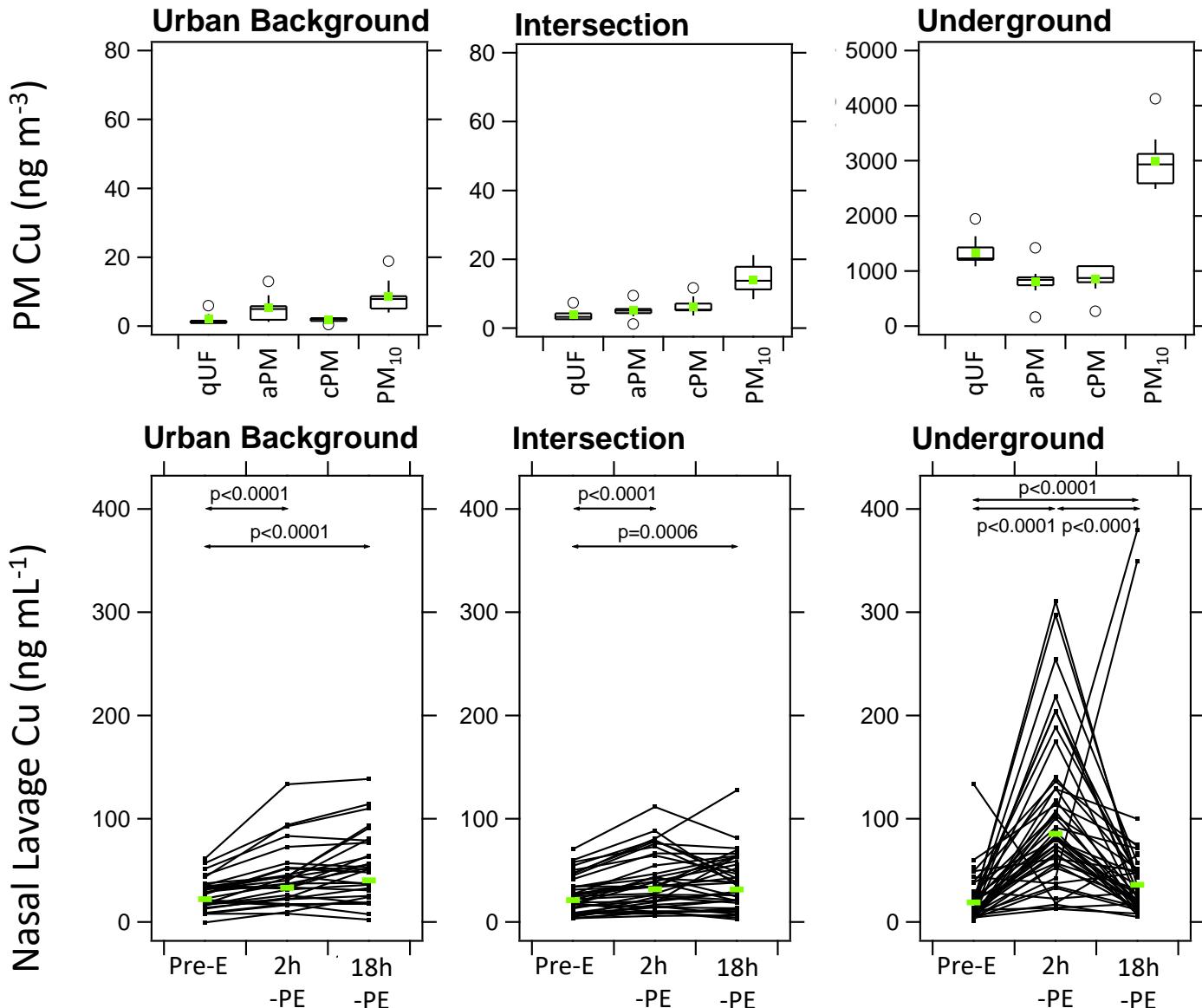


# Trace Metal Responses - Fe

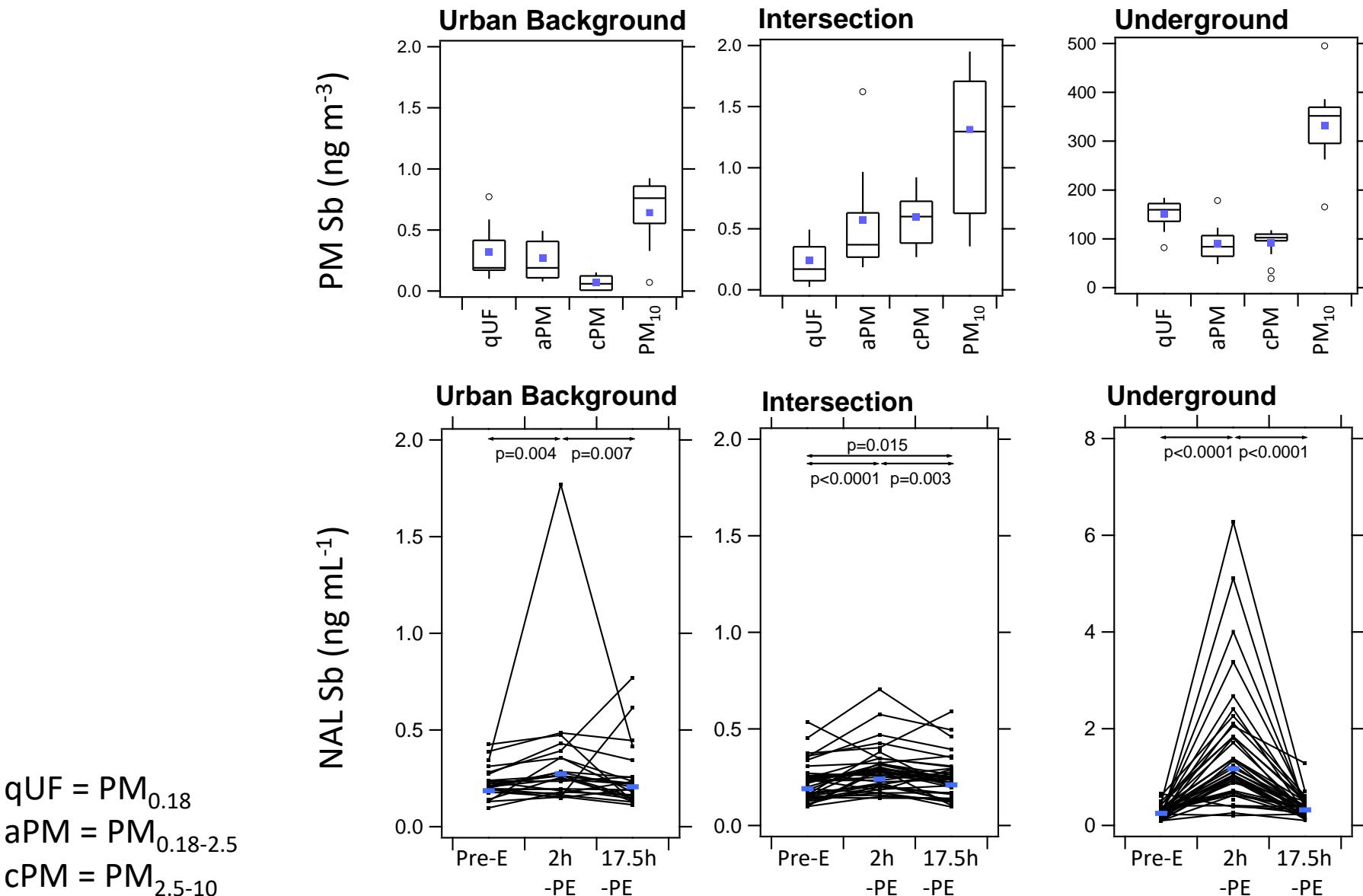


# Trace Metal Responses - Cu

$qUF = PM_{0.18}$   
 $aPM = PM_{0.18-2.5}$   
 $cPM = PM_{2.5-10}$



# Trace Metal Responses - Sb

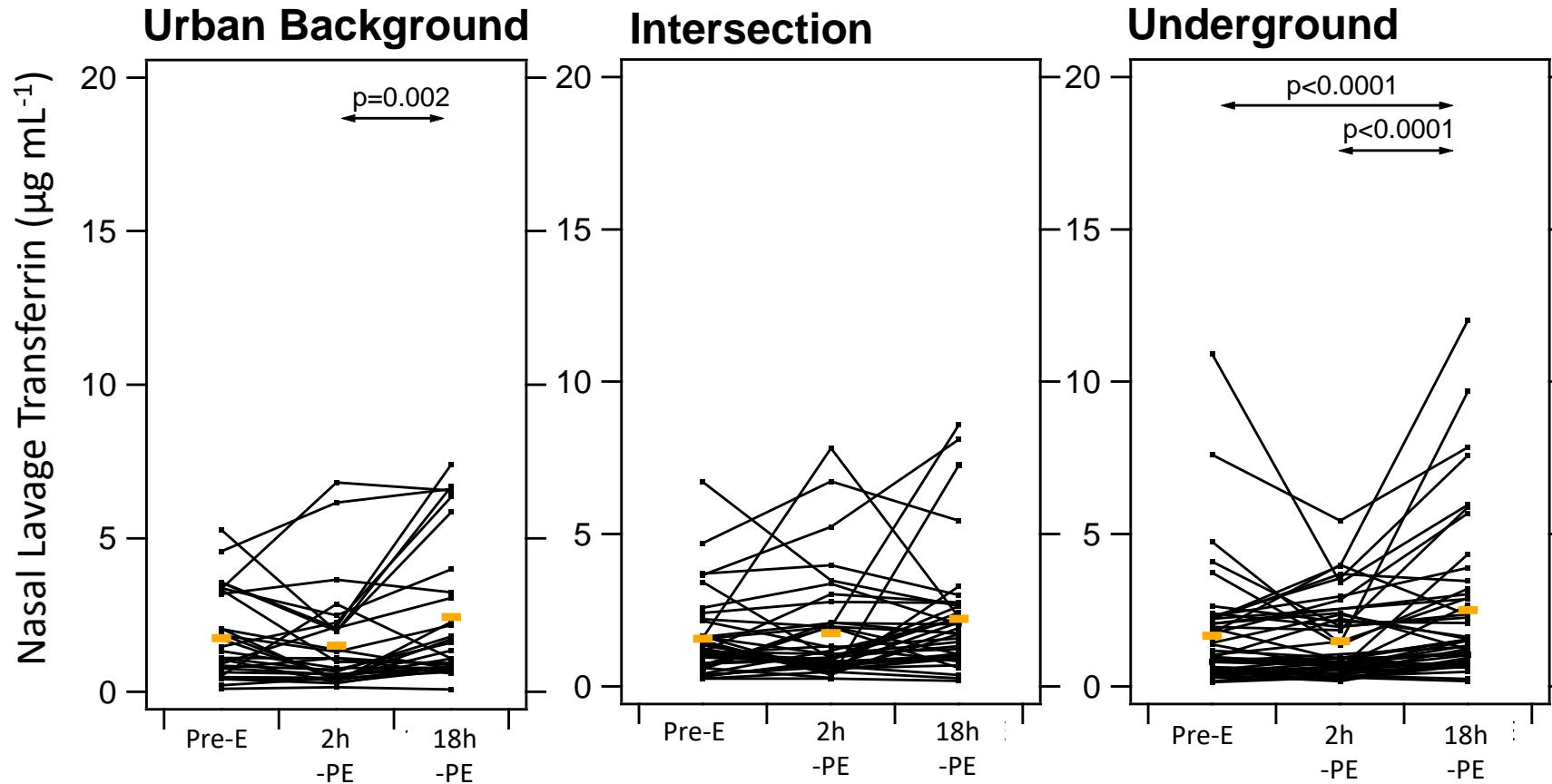


NO Endogenous Form

↓

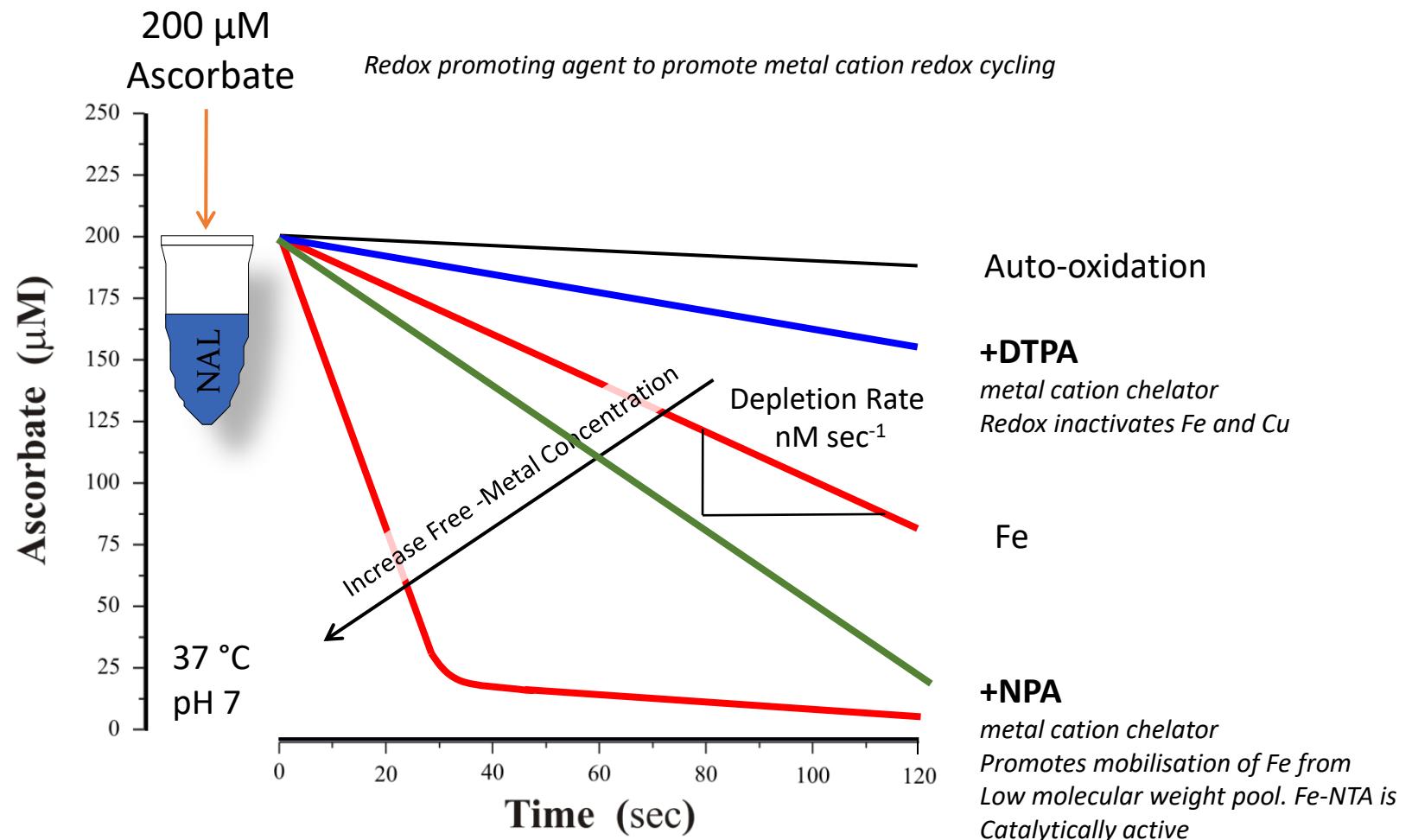
Increased NAL [Sb], greatest rise at the Underground 2h-PE

# Transferrin Response



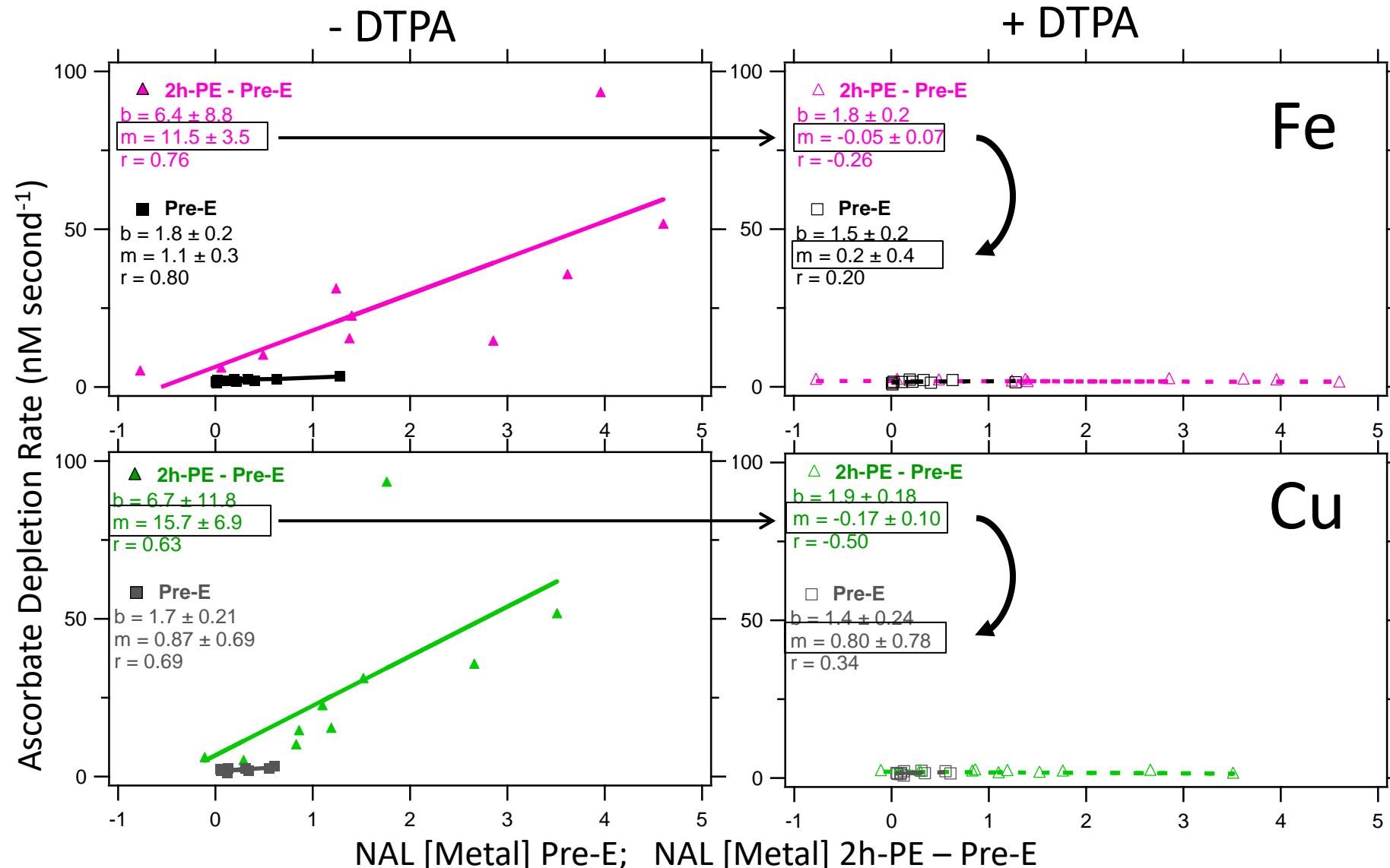
- Irrespective of the elevated Fe dose associated with exposure at the Underground, a homogeneous temporal response was observed across sites.
- It is unclear if transferrin was capable of binding the increased Fe PM concentrations deposited in the upper airway following an Underground exposure challenge.

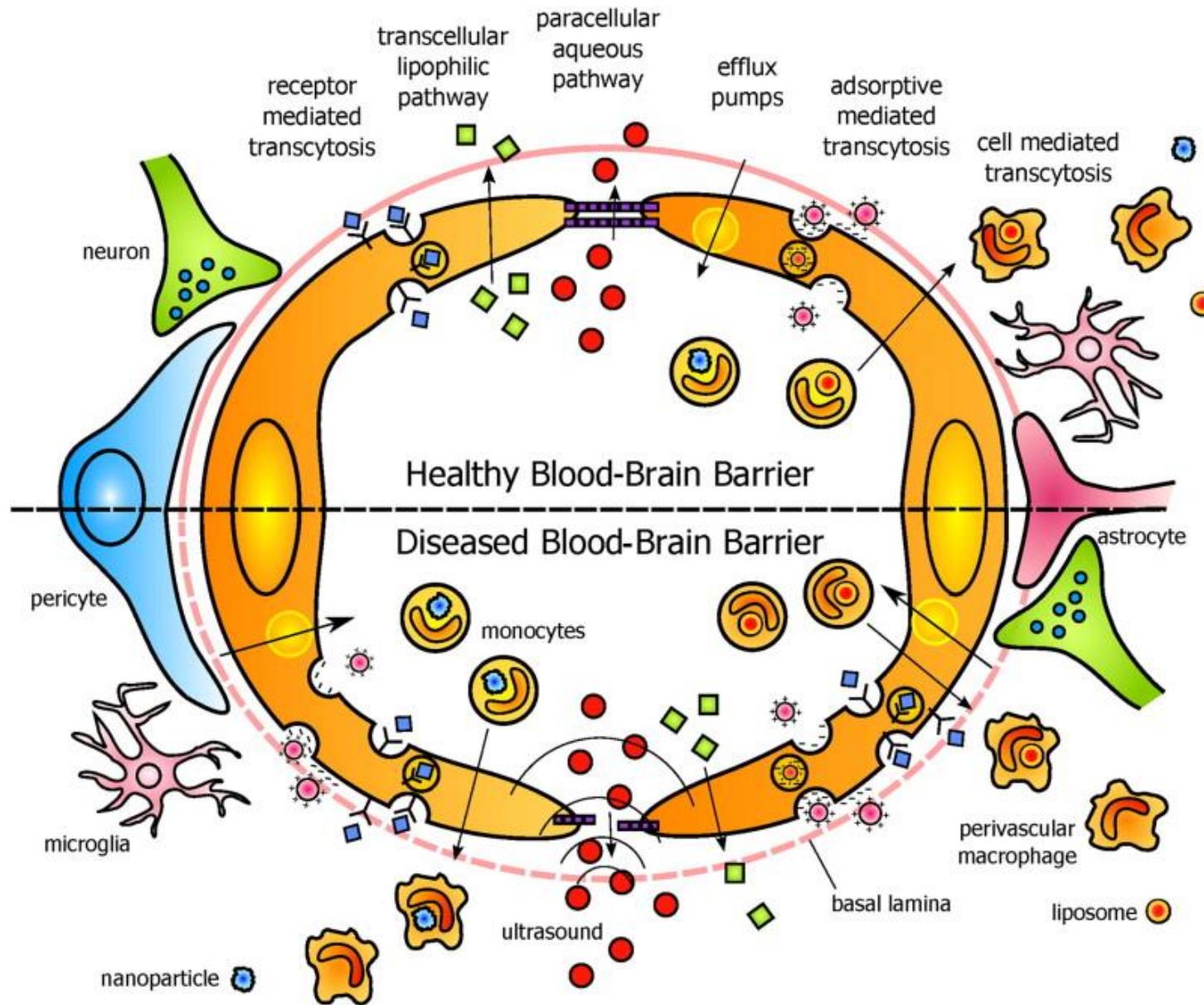
# Assessment of Redox Activity



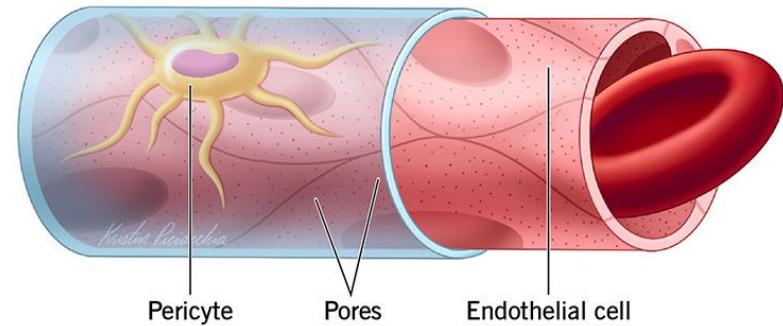
*Establishing the catalytic metal activity of BAL samples*

# Redox active metal in nasal lining fluids

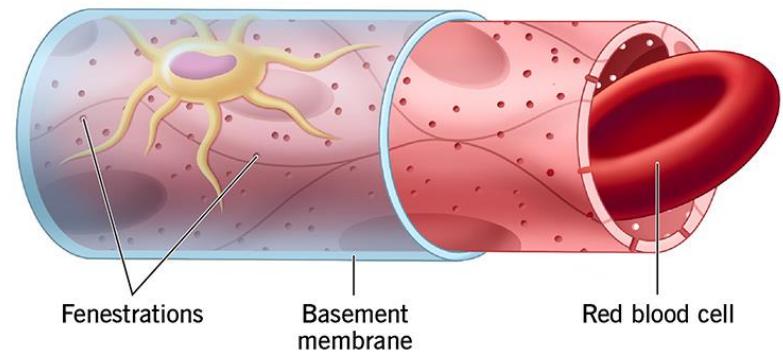




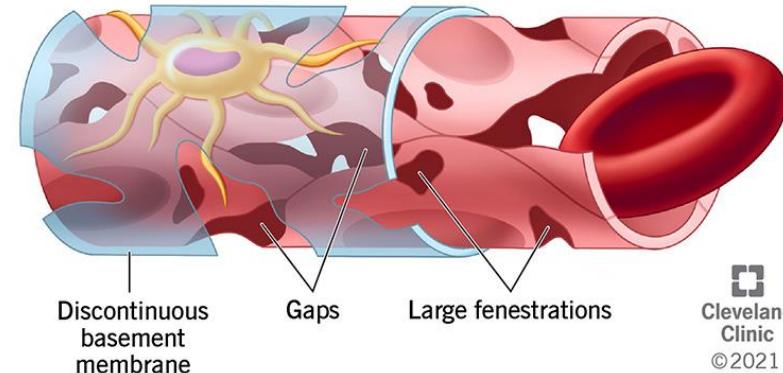
Continuous Capillary



Fenestrated Capillary



Sinusoidal Capillary



Cleveland  
Clinic  
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# Acknowledgements

## RAPTES study:

Strak M, Hoek G, Godri KJ, Gosens I, Mudway IS, van Oerle R, Spronk HM, Cassee FR, Lebret E, Kelly FJ, Harrison RM, Brunekreef B, Steenhof M, Janssen NA

## Traffic study:

Strak M., Hoek G., Godri K.J., Gosens I., van Oerle R., Spronk H.M., Cassee F.R., Lebret E., Kelly F.J., Harrison .R.M, Brunekreef B., Steenhof M., Janssen N.A.

## Mental Health Studies:

Newbury J.B, Stewart R., Fisher H.L, Beevers S., Dajnak D., Broadbent M., Pritchard M., Pritchard M., MacCrimmon S., Shiode N., Heslin M., Hammoud R., Hotopf M., Hatch S.L., Mudway I.S., Fecht D., Gulliver J., Bakolis I.



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