



L'impacte de la qualitat de l'aire en la salut de les persones

jordi.sunyer@isglobal.org

Abril 2017

ISGlobal
Institut de
Salut Global
Barcelona

Una iniciativa de:



Institució
CERCA
Centres de Recerca
de Catalunya

CLÍNICA
PUMA
Hospital Universitari

Obra Social "la Caixa"
Parc de Salut
MAR

UNIVERSITAT
BARCELONA

upf.

Universitat
Pompeu Fabra
Barcelona

Generalitat
de Catalunya

GOBIERNO DE ESPAÑA
Ajuntament de
Barcelona

FUNDACIÓN
RAMÓN ARECES

Guió

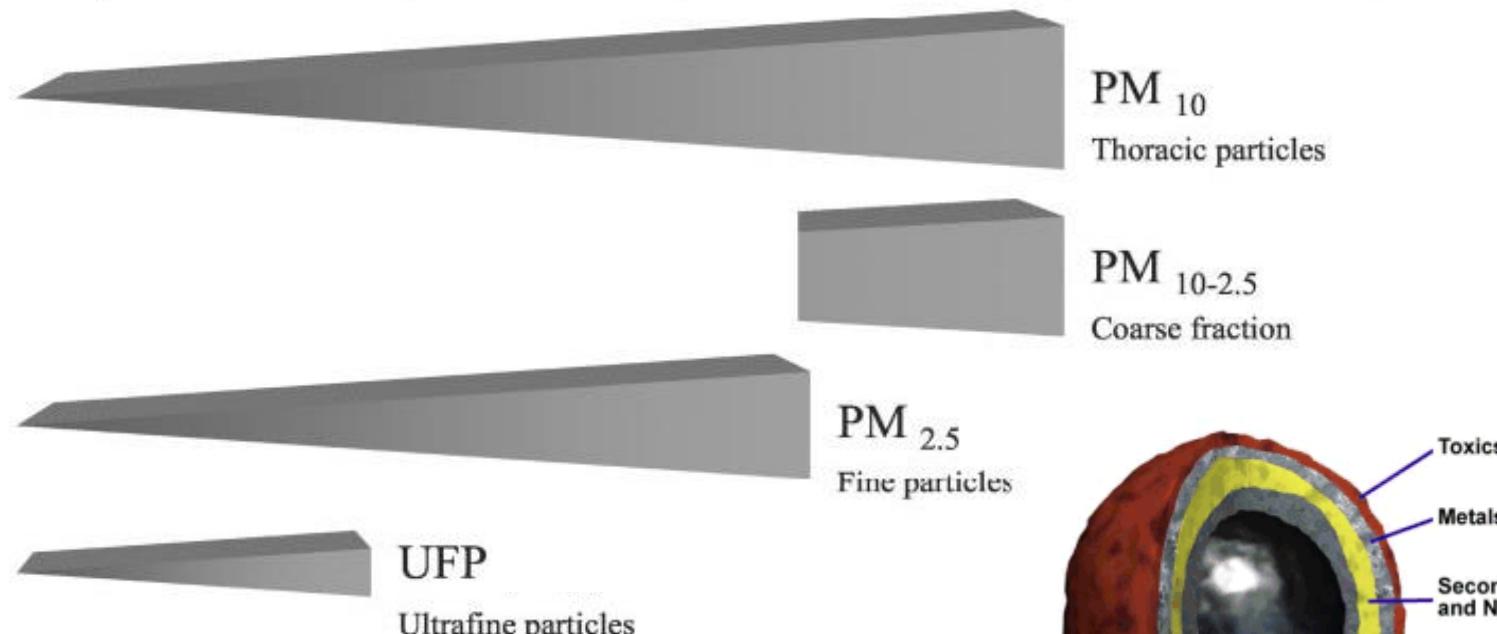
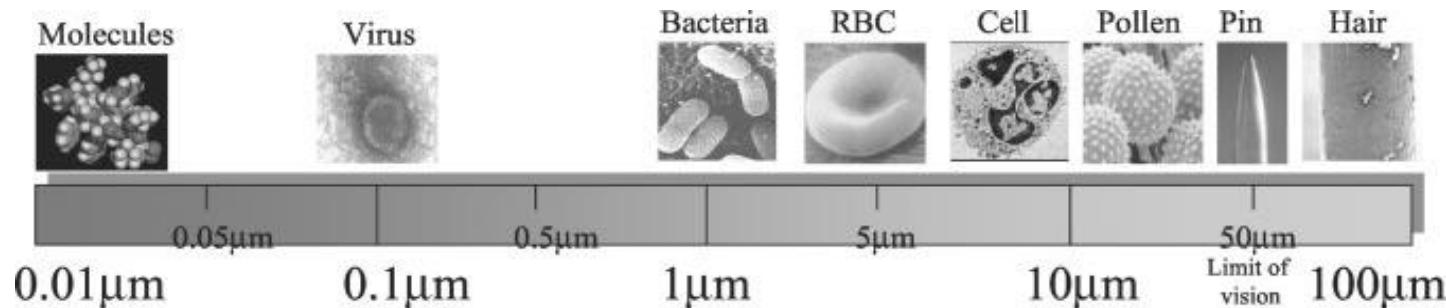
- L'aire de les ciutats
- Efectes sobre la salut
- Polítiques de mobilitat basades en salut

Ambient Aerosols

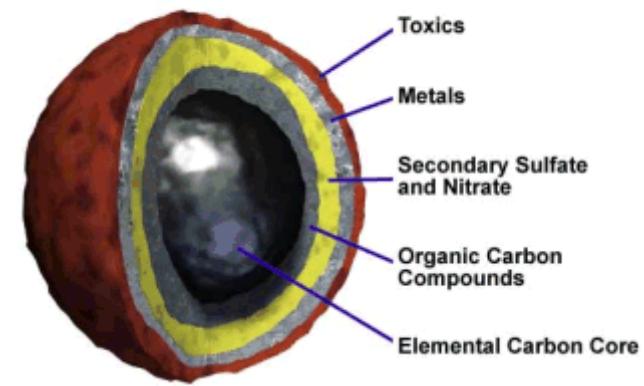
- Gases and primary particles
- Organic compounds
- Soot particles
- Metals
- Secondary particles
- Crustal material
- Biological material
-

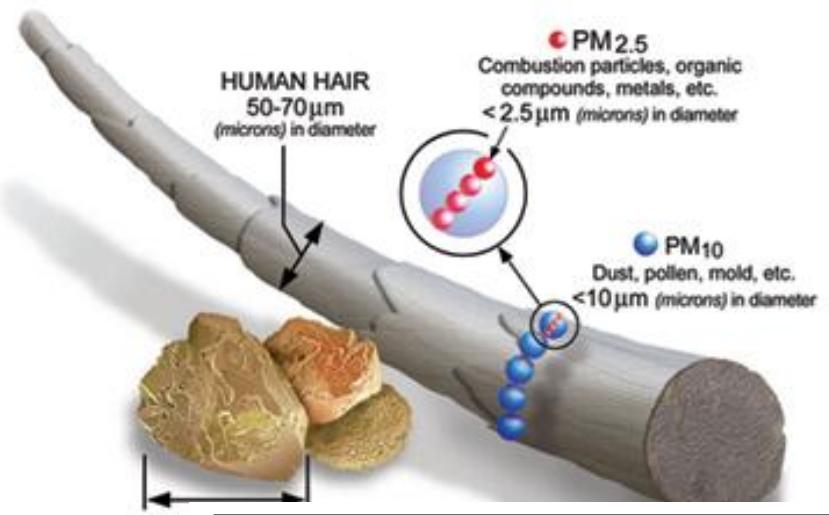


Ambient particulate matter (PM) is defined by its size



Brook et al. 2004





90 μm FINE!

Nose, throat:

Particles <30 μm

Trachea, bronchi, bronchioli:

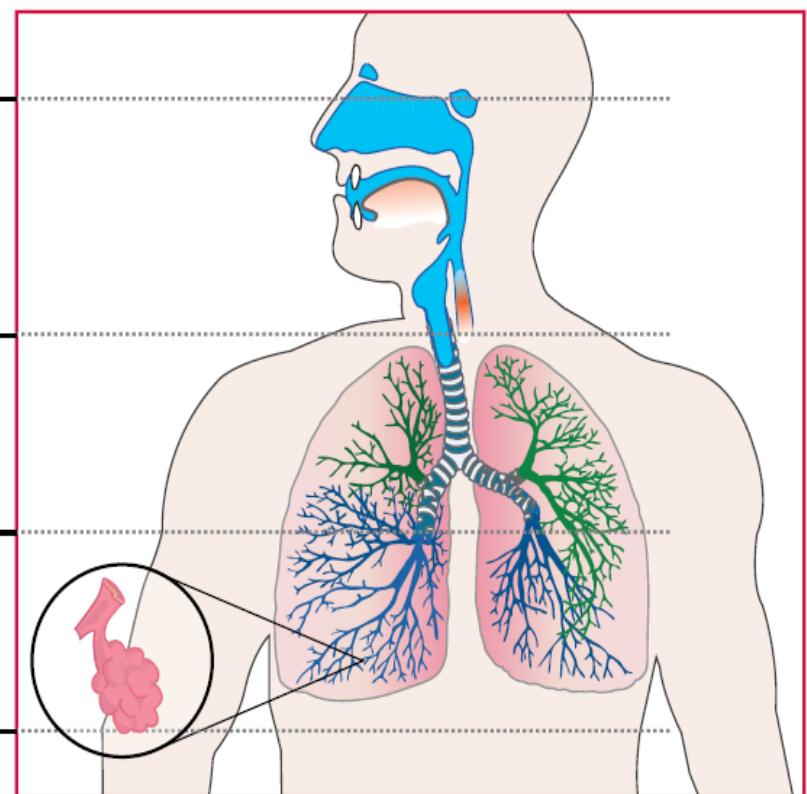
Particles <10 μm
 SO_2 , NO_2 , ozone

Pulmonary alveoli:

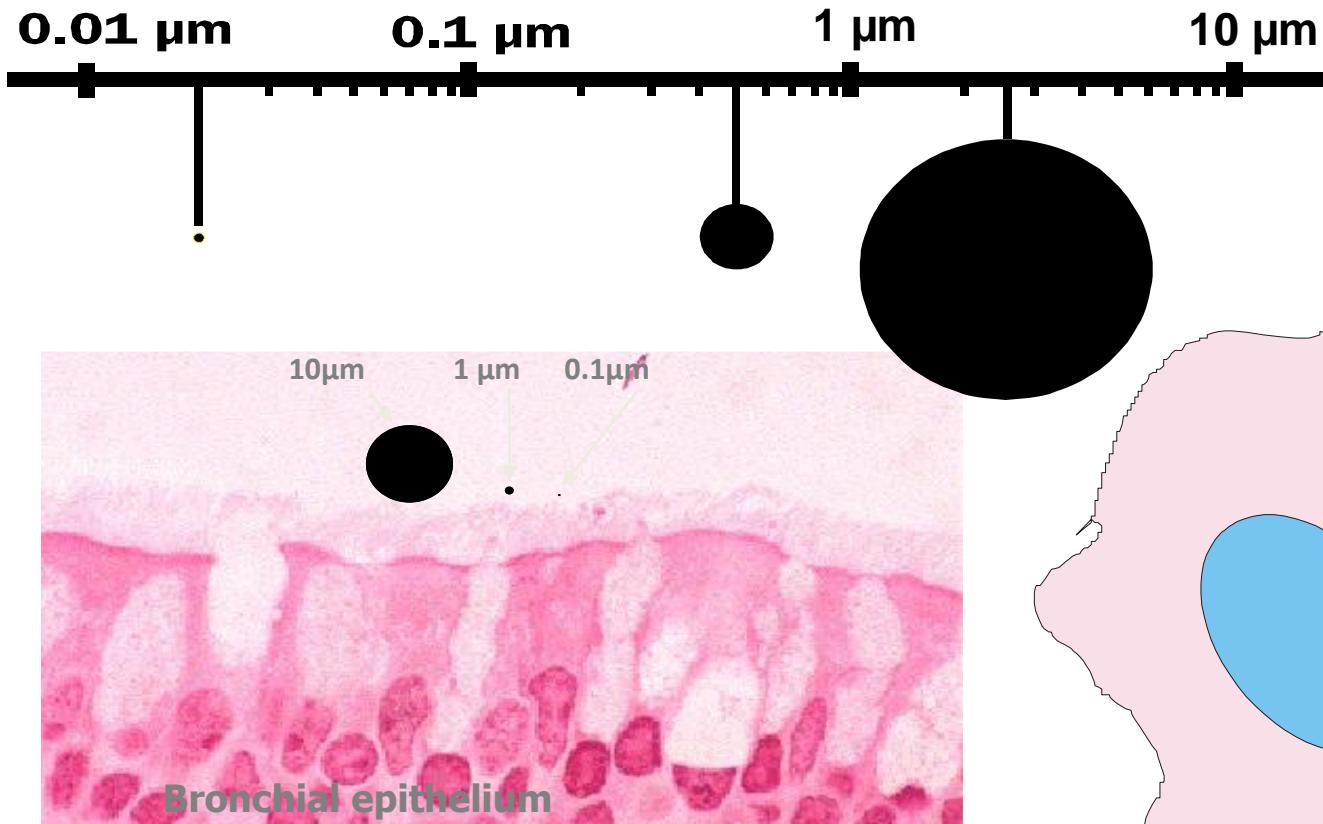
Particles <2-3 μm
 NO_2 , ozone

Pulmonary tissue, circulation:

Ultrafine particles <0.1 μm

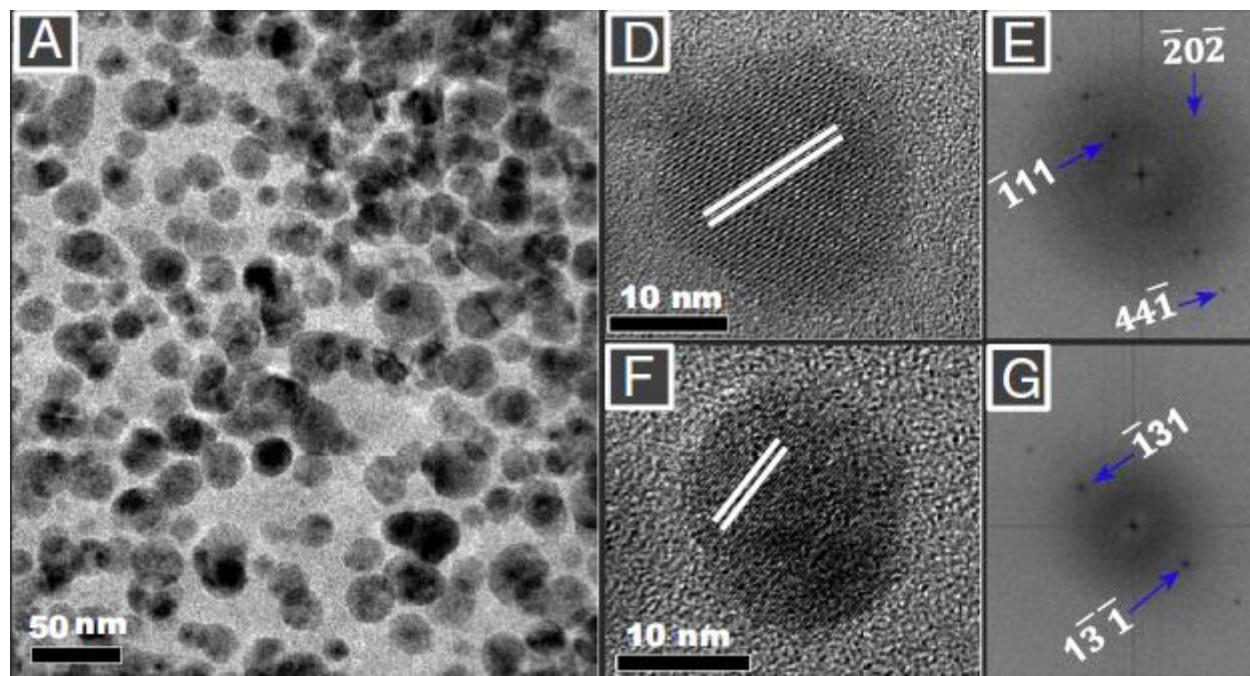
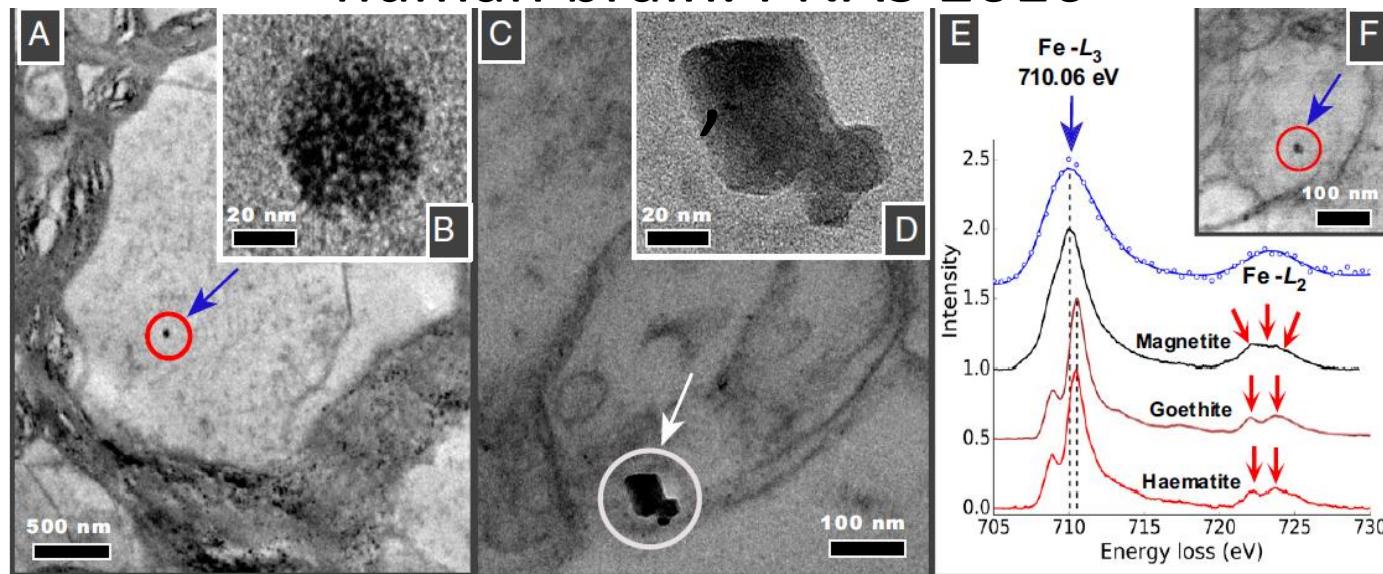


Size matters for the translocation

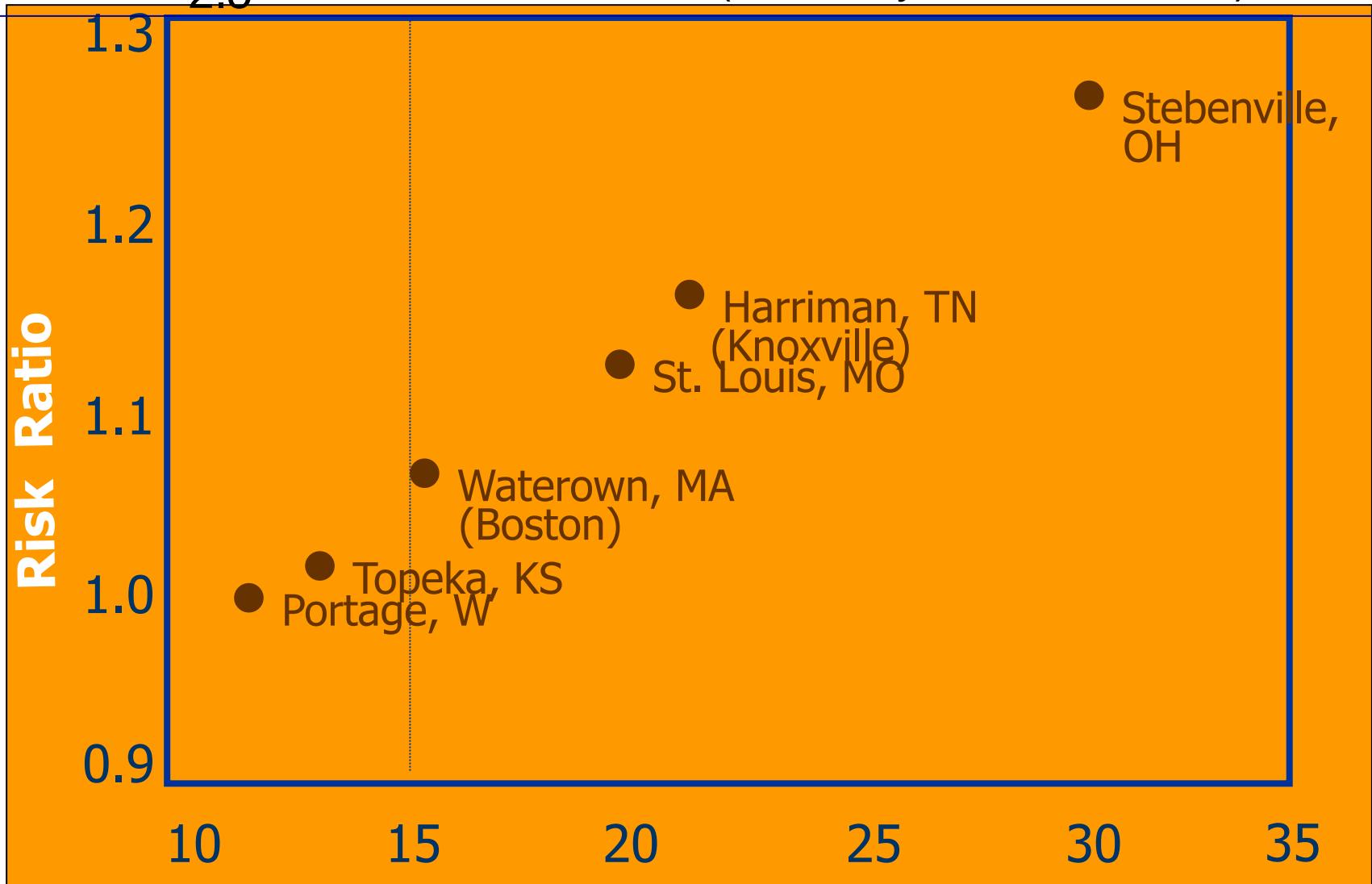


Courtesy: K. Donaldson & A. Peters

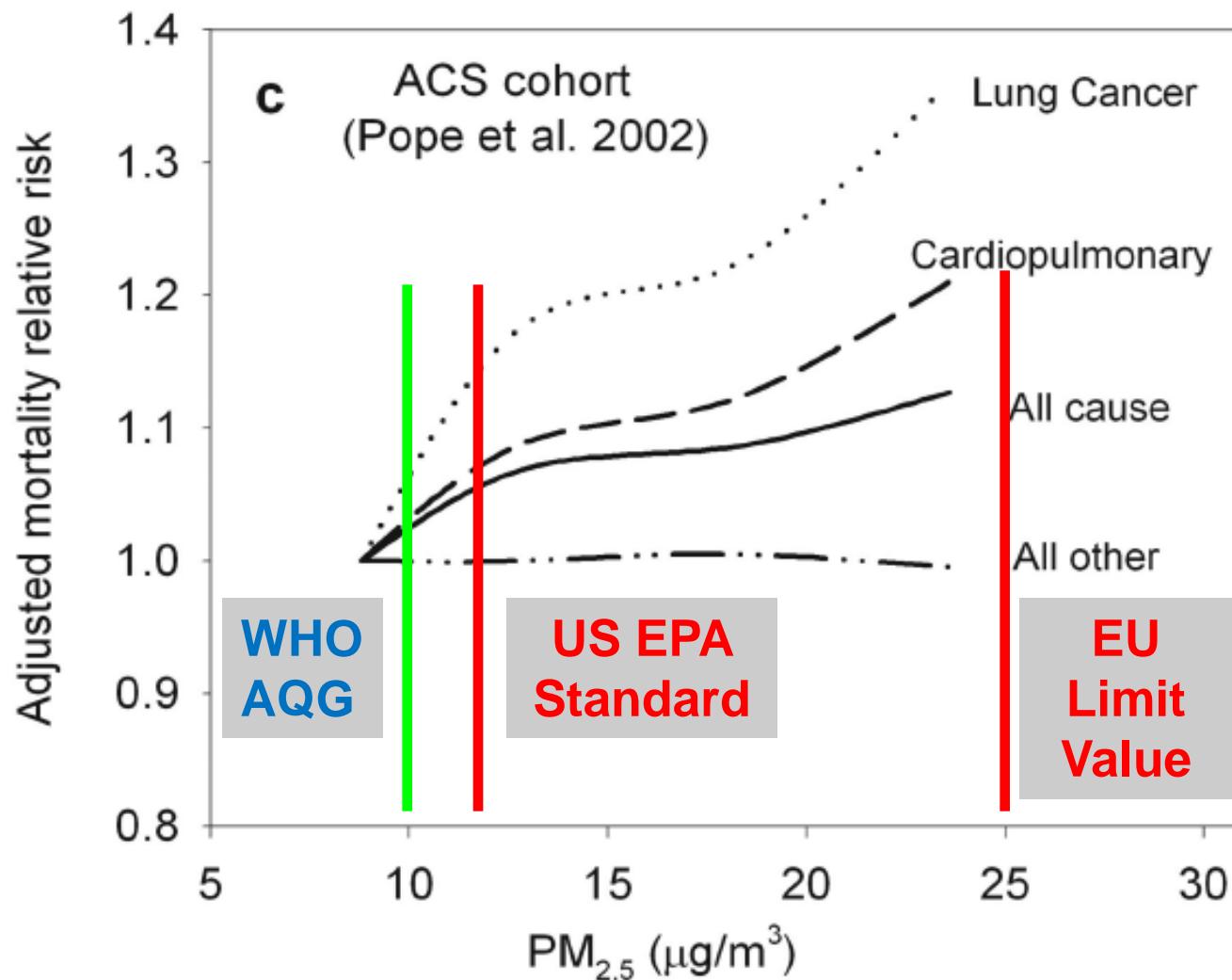
Maher BA. Magnetite pollution nanoparticles in the human brain. PNAS 2016



The six cities study: $\text{PM}_{2.5}$ –MORTALITY (Dockery , NEJM 1993)

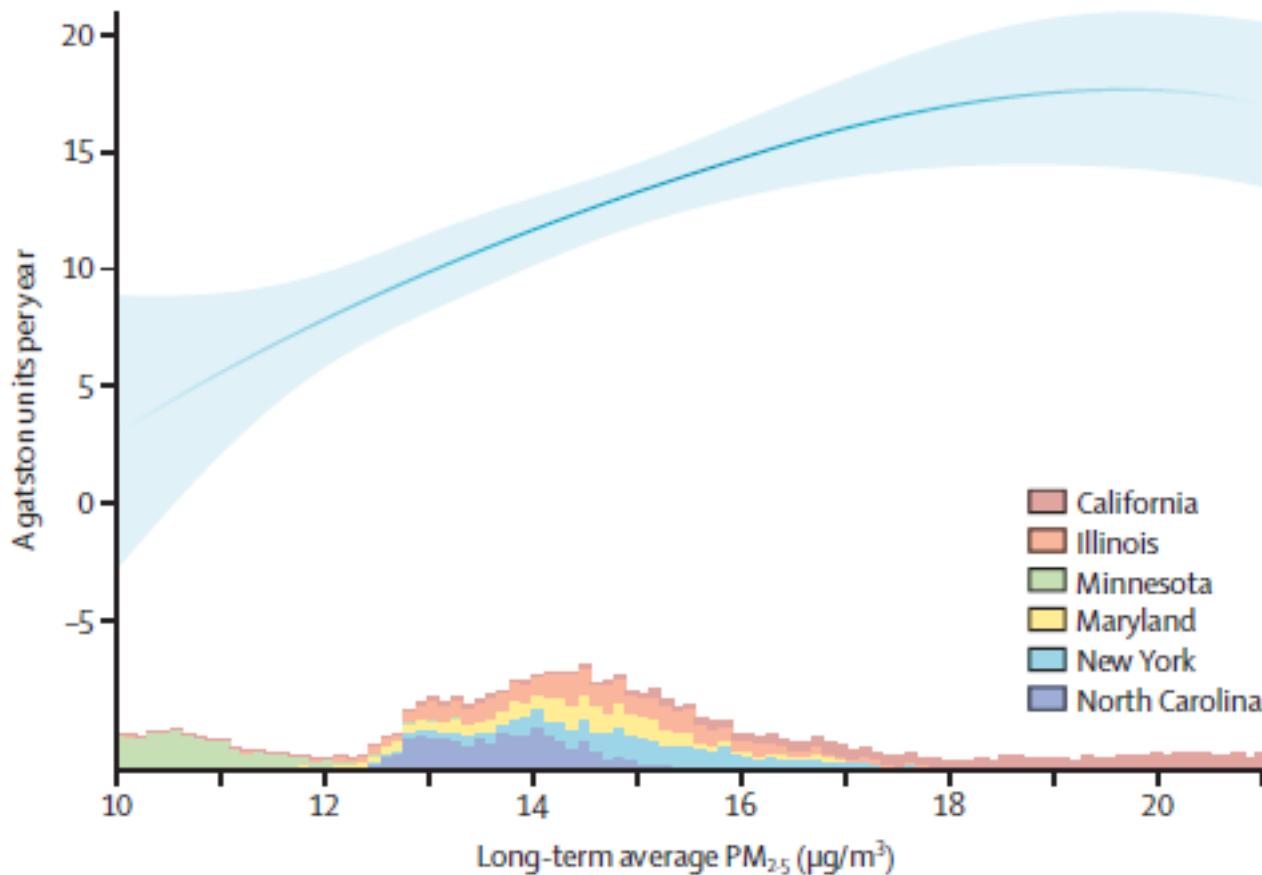


ACS cohort: Guidelines for PM_{2.5}



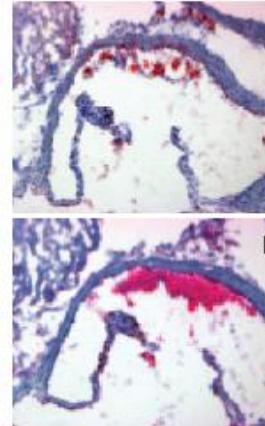
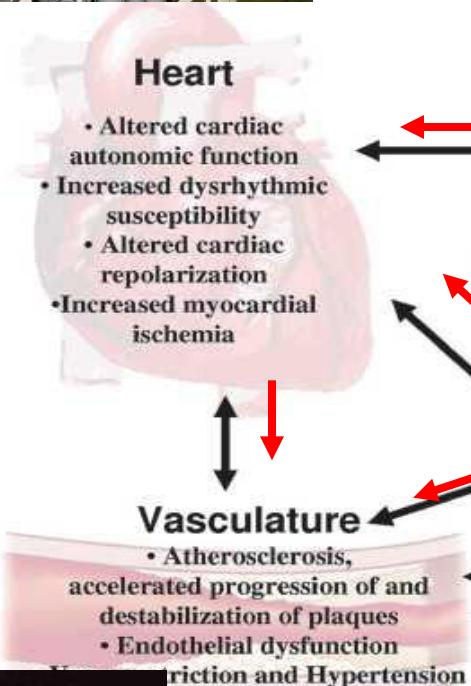
Pope et al 2002

Long-term Exposure to Fine Particles and Coronary Artery Calcification Progression



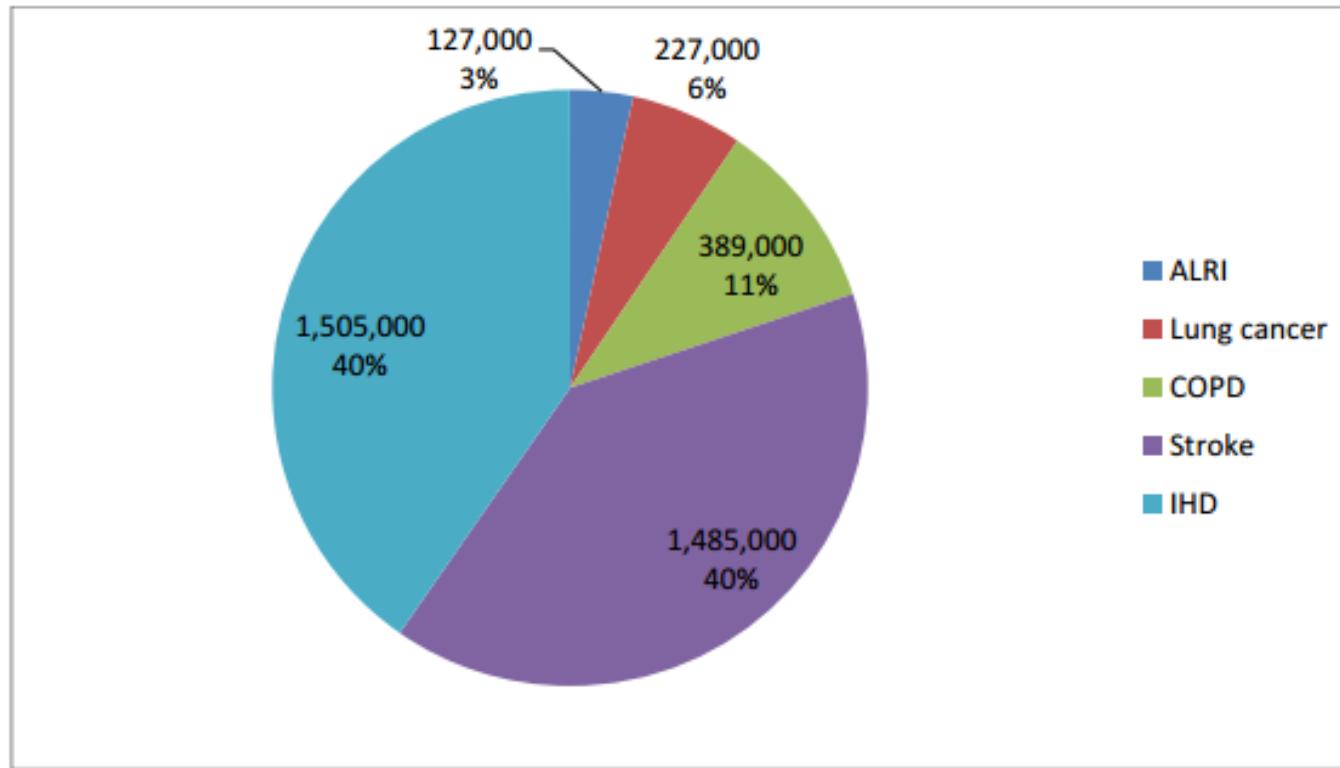
Kaufmann et al. Lancet 2016

Mechanisms by which exposure to PM affects our health



Particulate air pollution causes 3.5 million deaths

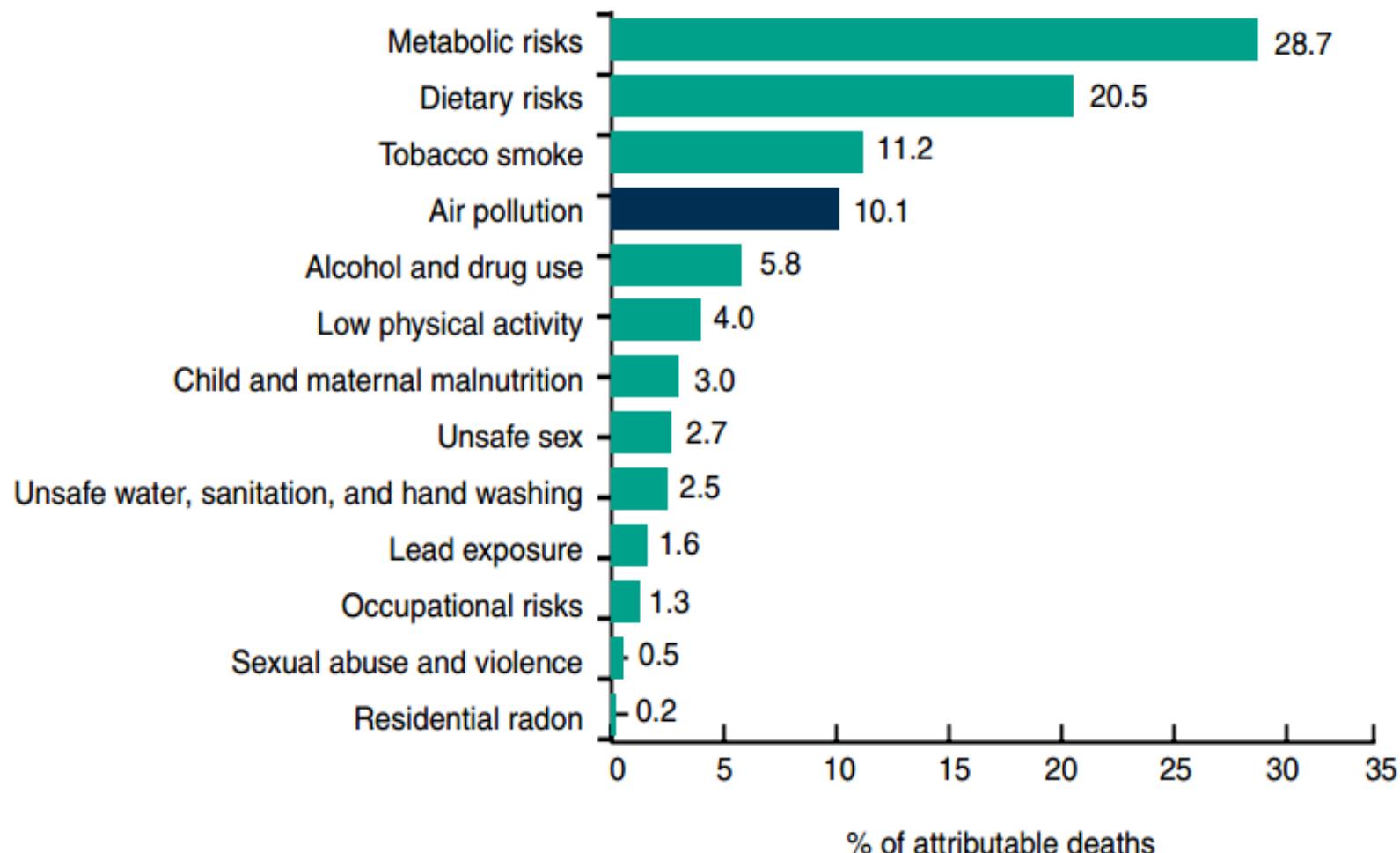
Figure 3. Deaths attributable to AAP in 2012, by disease



Percentage represents percent of total AAP burden (add up to 100%).

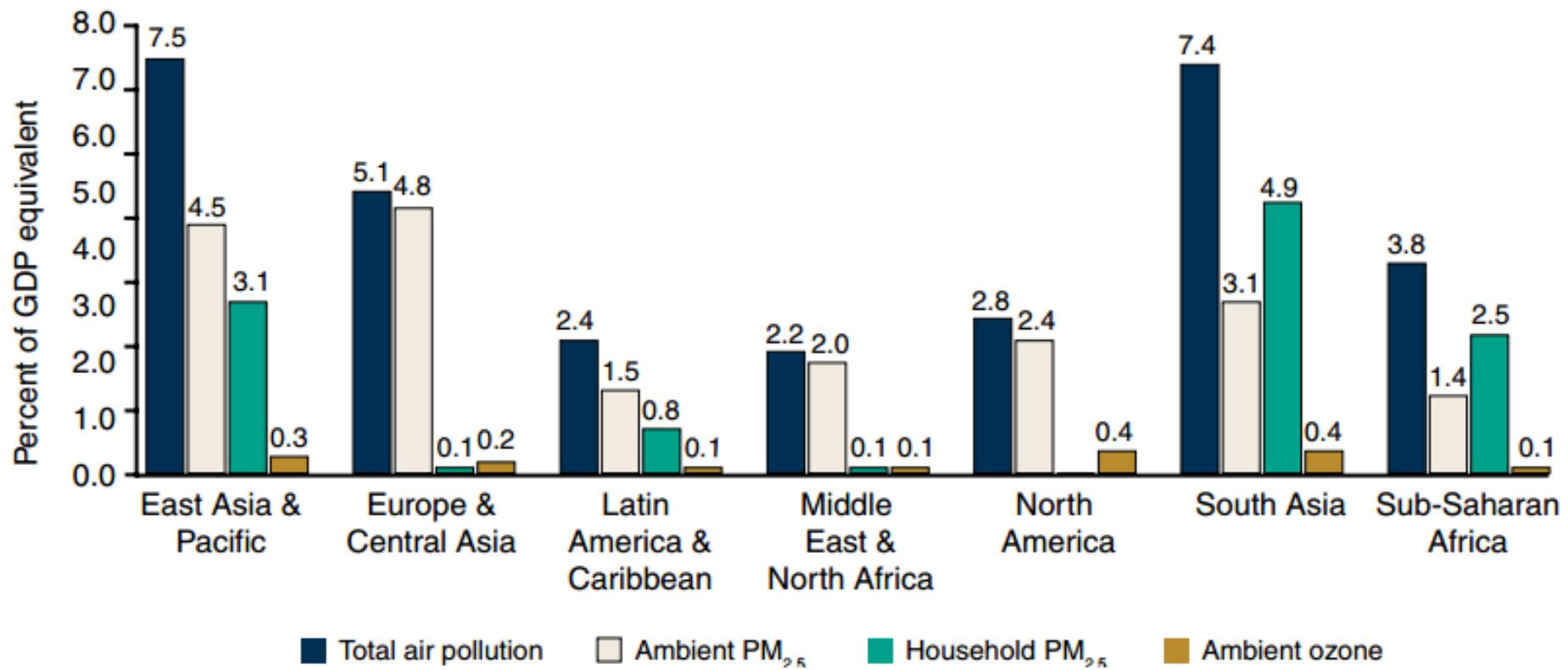
AAP: Ambient air pollution; ALRI: Acute lower respiratory disease; COPD: Chronic obstructive pulmonary disease; IHD: Ischaemic heart disease.

FIGURE 1.1 Percentage of Attributable Deaths by Risk Factor: Globally, 2013



Sources: World Bank and IHME, using data from IHME, GBD 2013.

Economical* impact by region, 2013 (World bank 2016)



* welfare losses

Air pollution affects multiple organs immediately and has long-term consequences

- Respiratory Disease Mortality

- Respiratory Disease Morbidity

- Lung Cancer

- Pneumonia

- Upper and lower respiratory symptoms

- Airway inflammation

- Decreased lung function

- Decreased lung growth

- Insulin Resistance

- Type 2 diabetes

- Type 1 diabetes

- Bone metabolism

- High blood pressure

- Endothelial dysfunction

- Increased blood coagulation

- Systemic inflammation

- Deep Venous Thrombosis

- Stroke

- Neurological development

- Mental Health

- Neurodegenerative diseases

- Cardiovascular Disease Mortality

- Cardiovascular Disease Morbidity

- Myocardial Infarction

- Arrhythmia

- Congestive Heart Failure

- Changes in Heart Rate Variability

- ST-Segment Depression

- Skin Aging

- Premature Birth

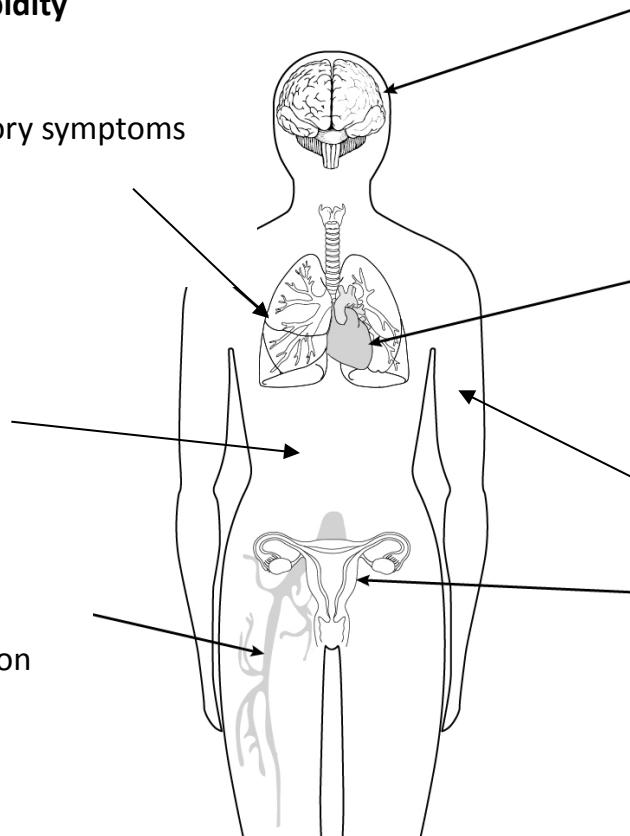
- Decreased Birth Weight

- Decreased foetal growth

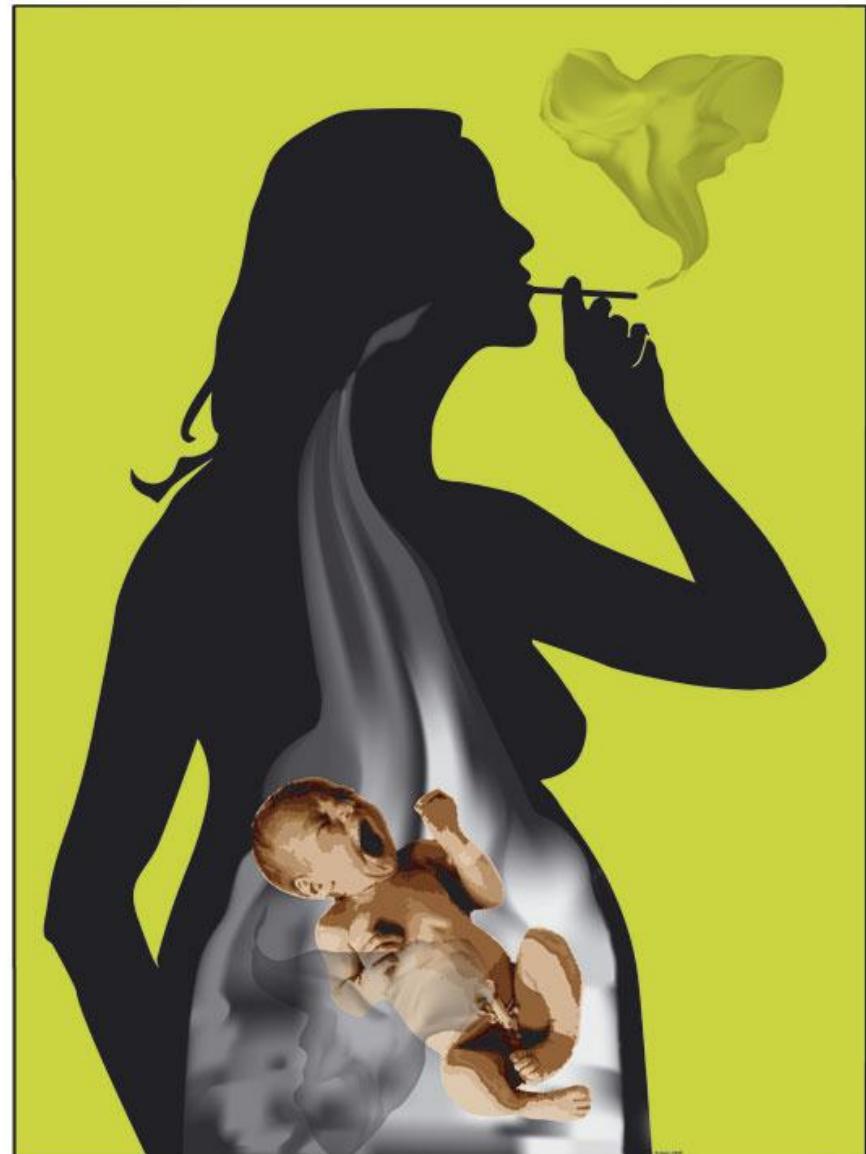
- In uterine growth retardation

- Decreased sperm quality

- Preclampsia



Developing fetus is susceptible to environmental insults

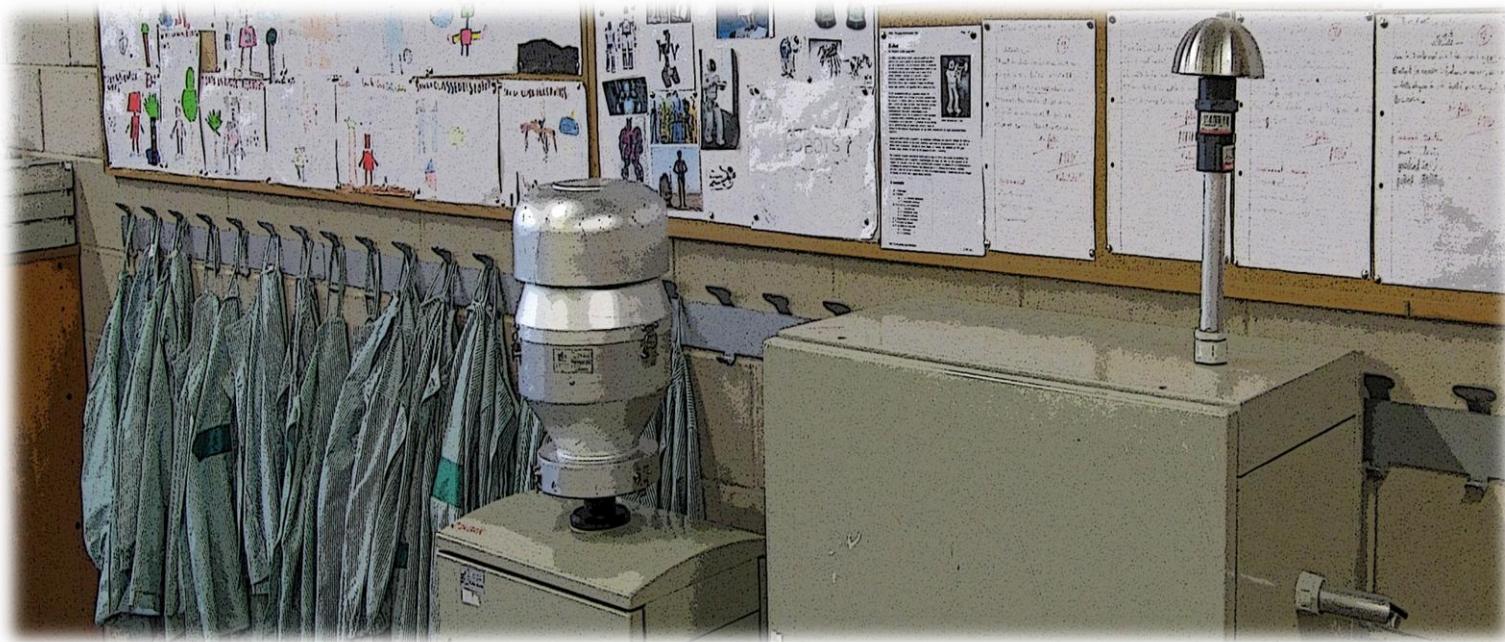


Reproductive and developmental effects of pre-natal air pollution

- Effects on fetus
 - Fetal growth
 - Length of gestation
 - Congenital anomalies
 - Stillbirth
 - Neurodevelopment
 - Lung function

- Effects on mother
 - Pregnancy-induced hypertensive disorders
 - Gestational diabetes

The BREATHE project: BRain dEvelopment and Air pollution ultrafine particles in scHool childrEn



centre de recerca
en epidemiologia
ambiental

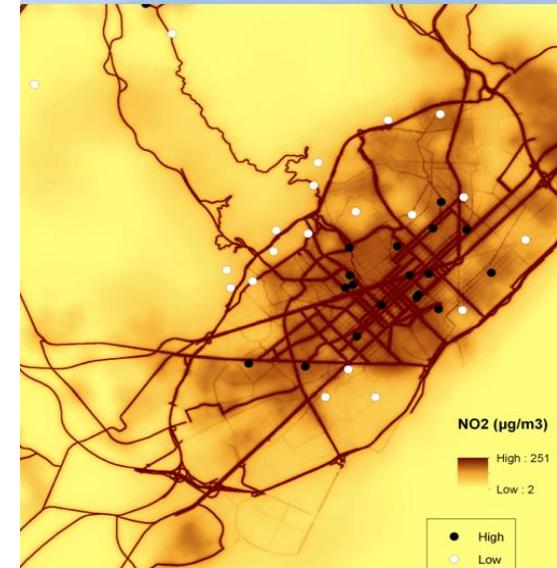


BREATHE

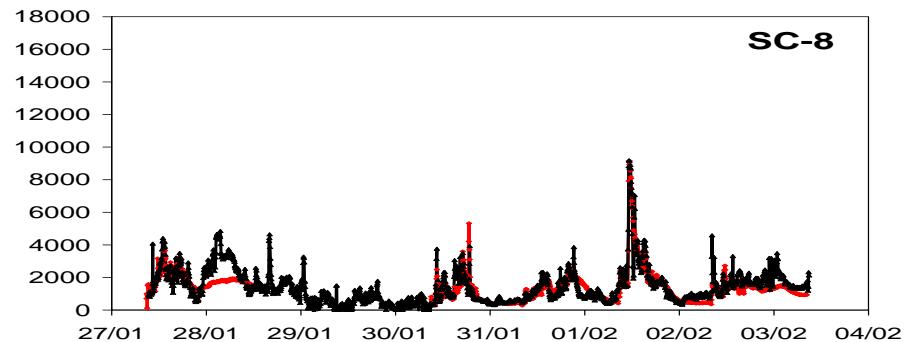
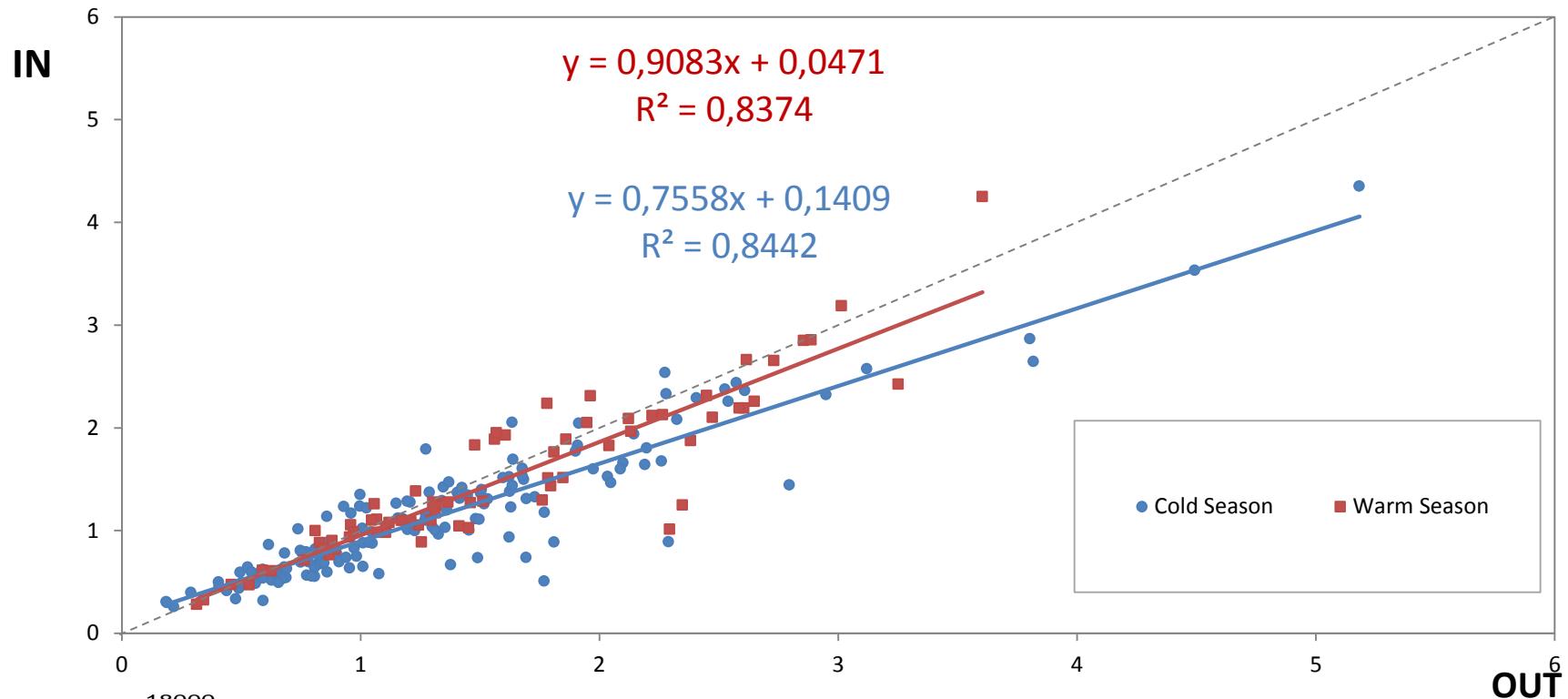
Brain Air
School
investigation

School study

- Schools stratified by traffic pollution
- Match each pair by similar social context
- Two sampling periods of one week by season
- Five monitoring stations at the same time: in/out & high/low, fixed site
- 39 schools, 1,092 PM filters during 2012



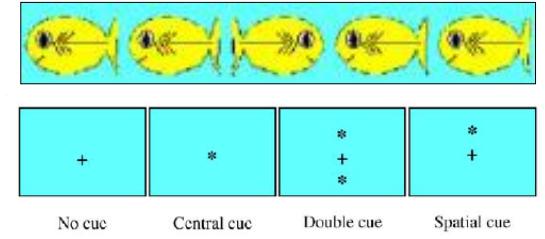
SCHOOL ELEMENTAL CARBON ($\mu\text{g}/\text{m}^3$) IN-OUT BY SEASON



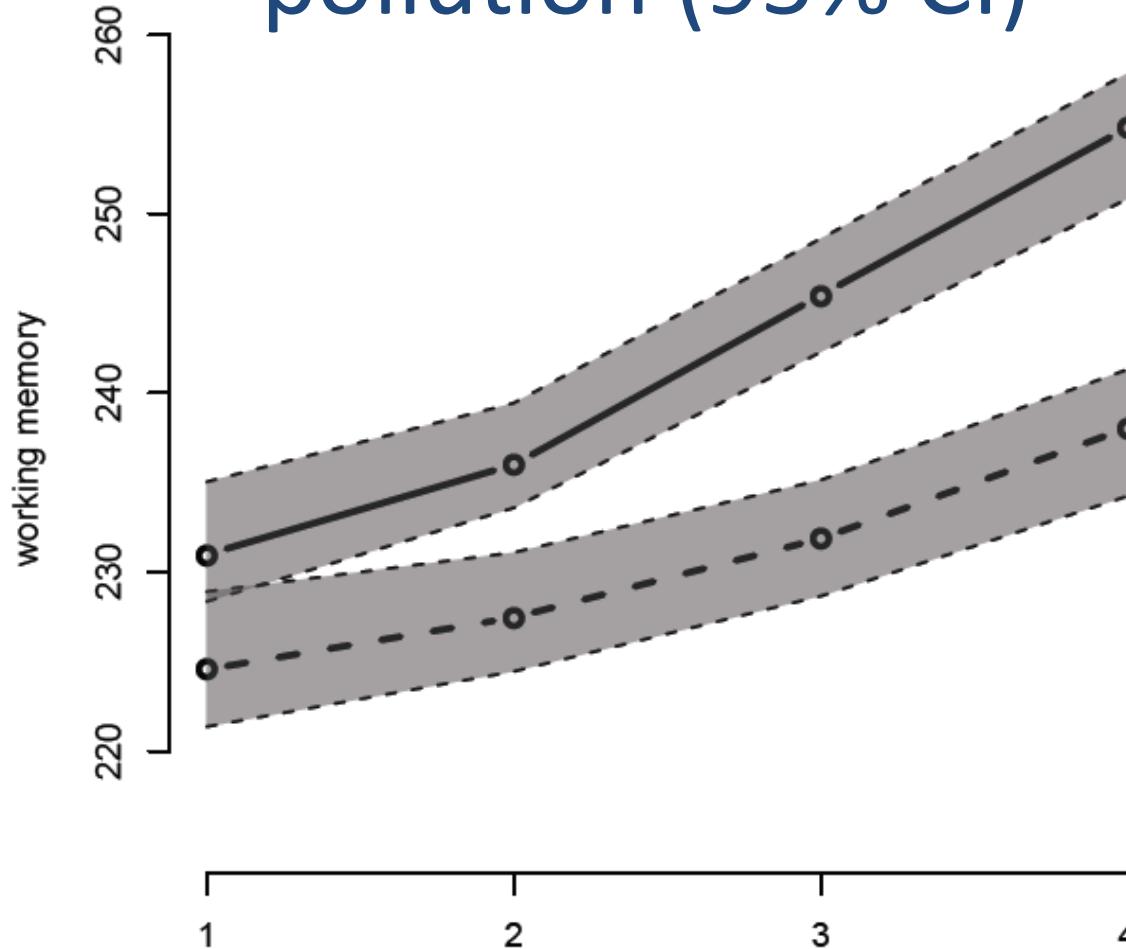
Rivas I, 2014

Neuropsychological study

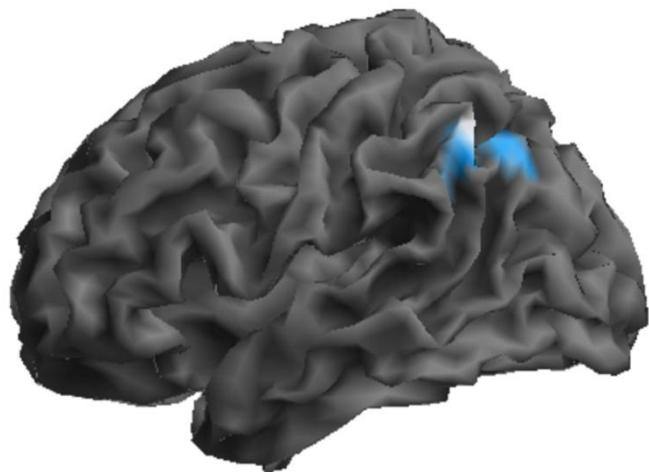
- All school children (n=4,085) without special needs in grades 2 - 4 (7-10 years of age)
- 2,897 (59%) agreed
- 10,112 computerized cognitive tests
- Every 3 months (4 repeats) tests



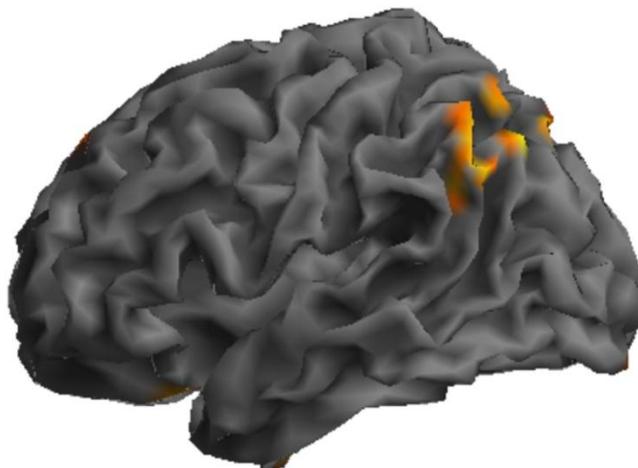
Working memory yearly development by low (—) and high (- -) traffic pollution (95% CI)



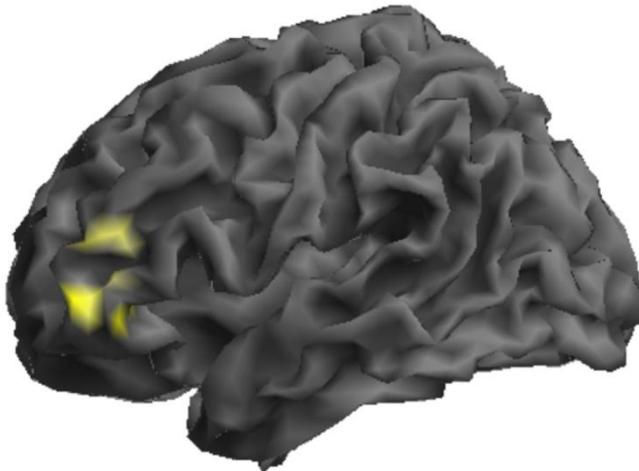
Adjusted for sex, maternal education, residential neighbourhood socio-economic status and school pair; school and subject as nested random effects.



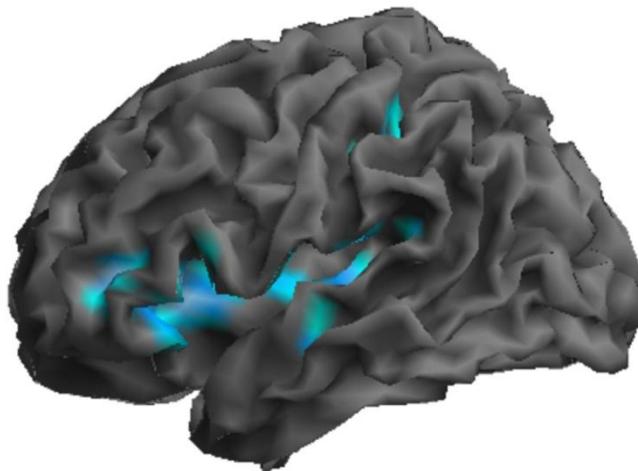
Pollutant-related decrease



Age-related increase



Pollutant-related increase

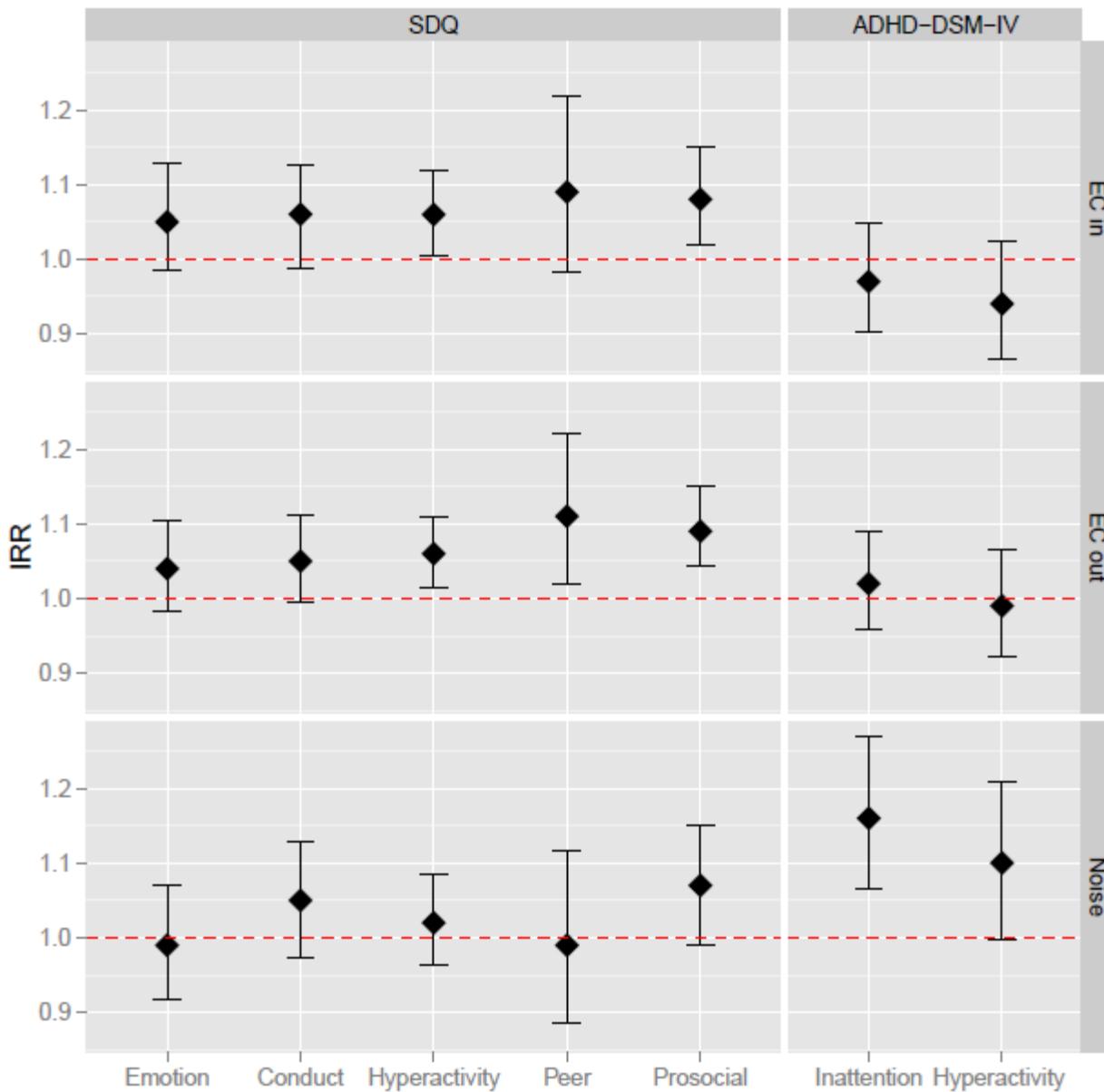


Age-related decrease

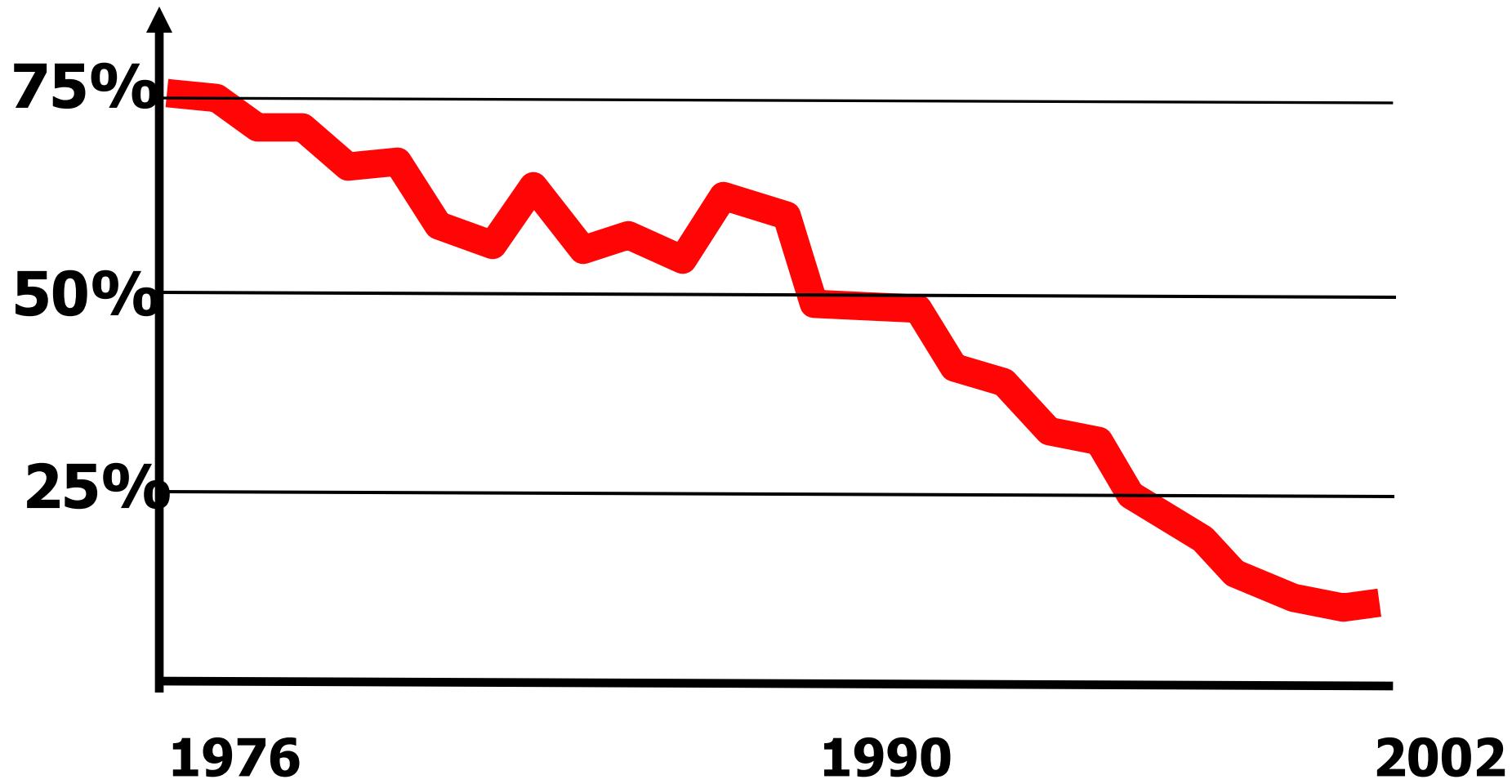
Change in cognitive growth per IQR increase in PM2.5 sources (Basagaña, EHP 2016)

	Indoor	Outdoor
sulphate	0.52 (-2.4, 3.4)	-0.31 (-3.9, 3.3)
mineral	0.8 (-2.2, 3.8)	4.1 (0.81, 7.4) *
nitrate	0.61 (-1.4, 2.6)	2.5 (-0.38, 5.4)
traffic	-5.1 (-9.2, -1.1) *	-3.6 (-6.6, -0.63) *
metallurgy	0.18 (-2.6, 2.9)	1.6 (-1.1, 4.3)
heavy oil	0.53 (-2.2, 3.3)	-1.2 (-4.3, 1.8)
organic/textile/chalk	0.37 (-2.1, 2.9)	-0.1 (-4.2, 4)
sea salt	-1.4 (-4.6, 1.9)	2.5 (-2, 6.9)
road dust	1.7 (-2.9, 6.3)	0.39 (-2.6, 3.4)

Noise and air pollution on behaviour (SDQ) and ADHD symptoms (Forns, EHP 2015)



Interventions: % of days above standards in Los Angeles (US)



The NEW ENGLAND JOURNAL of MEDICINE

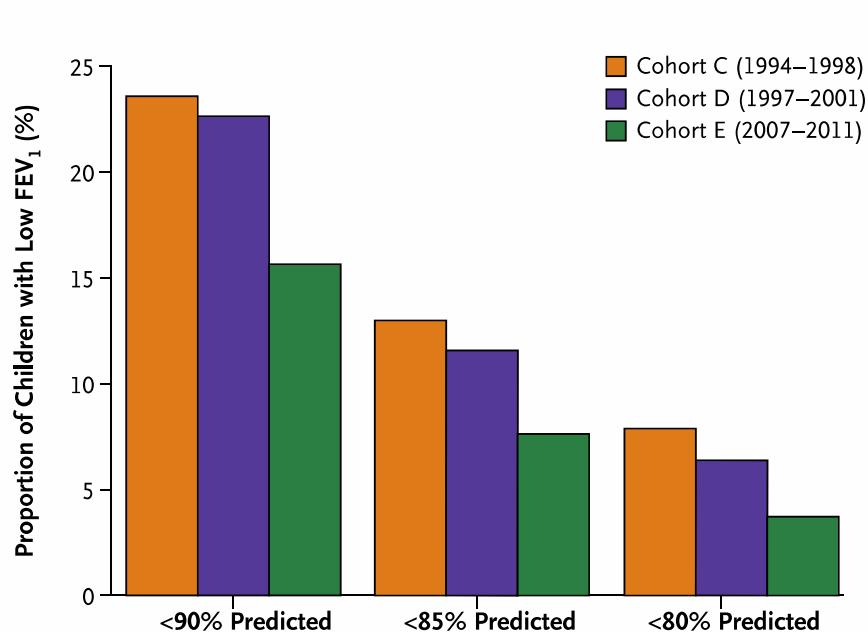
ESTABLISHED IN 1812

MARCH 5, 2015

VOL. 372 NO. 10

Association of Improved Air Quality with Lung Development in Children

W. James Gauderman, Ph.D., Robert Urman, M.S., Edward Avol, M.S., Kirolos 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.



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 6.3% to 3.6% across the three periods, as the air quality improved ($P=0.001$).

CONCLUSIONS

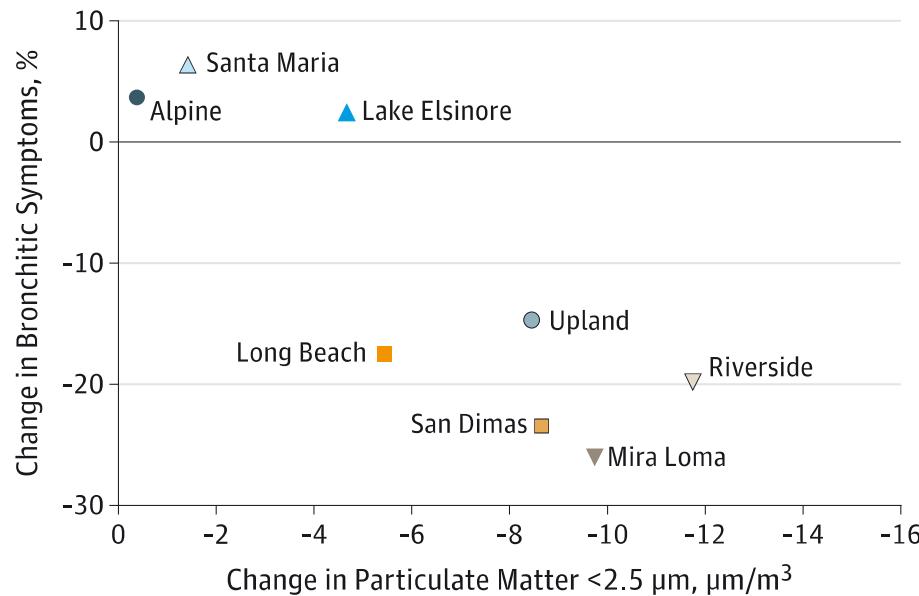
We found that long-term improvements in air quality were associated with statistically and clinically significant positive effects on lung-function growth in children. (Funded by the Health Effects Institute and others.)

(Funded by the Health Effects Institute and others.)

Association of Changes in Air Quality With Bronchitic Symptoms in Children in California, 1993-2012

Kiros Berhane, PhD; Chih-Chieh Chang, PhD; Rob McConnell, MD; W. James Gauderman, PhD; Edward Avol, MS; Ed Rapaport, MPH; Robert Urman, PhD; Fred Lurmann, MS; Frank Gilliland, MD, PhD

RESULTS The 3 cohorts included a total of 4602 children (mean age at baseline, 8.0 years; 2268 girls [49.3%]; 2081 Hispanic white [45.2%]) who had data from 2 or more annual



children without asthma ($n = 3710$), the ORs were 0.84 (95% CI, 0.76-0.92) for nitrogen dioxide, 0.85 (95% CI, 0.74-0.97) for ozone, 0.80 (95% CI, 0.70-0.92) for PM_{10} , and 0.79 (95% CI, 0.69-0.91) for $\text{PM}_{2.5}$; with absolute decrease in prevalence of 1.8% for nitrogen dioxide, 1.7% for ozone, 2.2% for PM_{10} , and 2.3% for $\text{PM}_{2.5}$. The associations were similar or slightly stronger at age 15 years.

CONCLUSIONS AND RELEVANCE Decreases in ambient pollution levels were associated with statistically significant decreases in bronchitic symptoms in children. Although the study design does not establish causality, the findings support potential benefit of air pollution reduction on asthma control.

Diagnosis

- Tenim la diagnosi ben feta
- Una ciutat amb l'aire contaminat
- La contaminació s'origina sobretot pel tràfic
- La contaminació originada pel tràfic és un problema de salut de dimensions importants
- Ara toca trobar solucions.

Efectes secundaris del vehicle a motor URBÀ

- Contaminació aire
- Soroll
- Manca exercici físic
- Ocupació de l'espai (verd)

Intervenció

- Vehicle urbà:
 - Bicicleta (elèctrica)
- Compartir el transport
 - Més i millor transport públic
 - ‘net’
- Transport mercaderies ‘net’
- Reduir vehicles privats
 - Corredors verds
 - Carrils bici
 - Super-illes
- **Cars free cities**



Gràcies

jsunyer@creal.cat

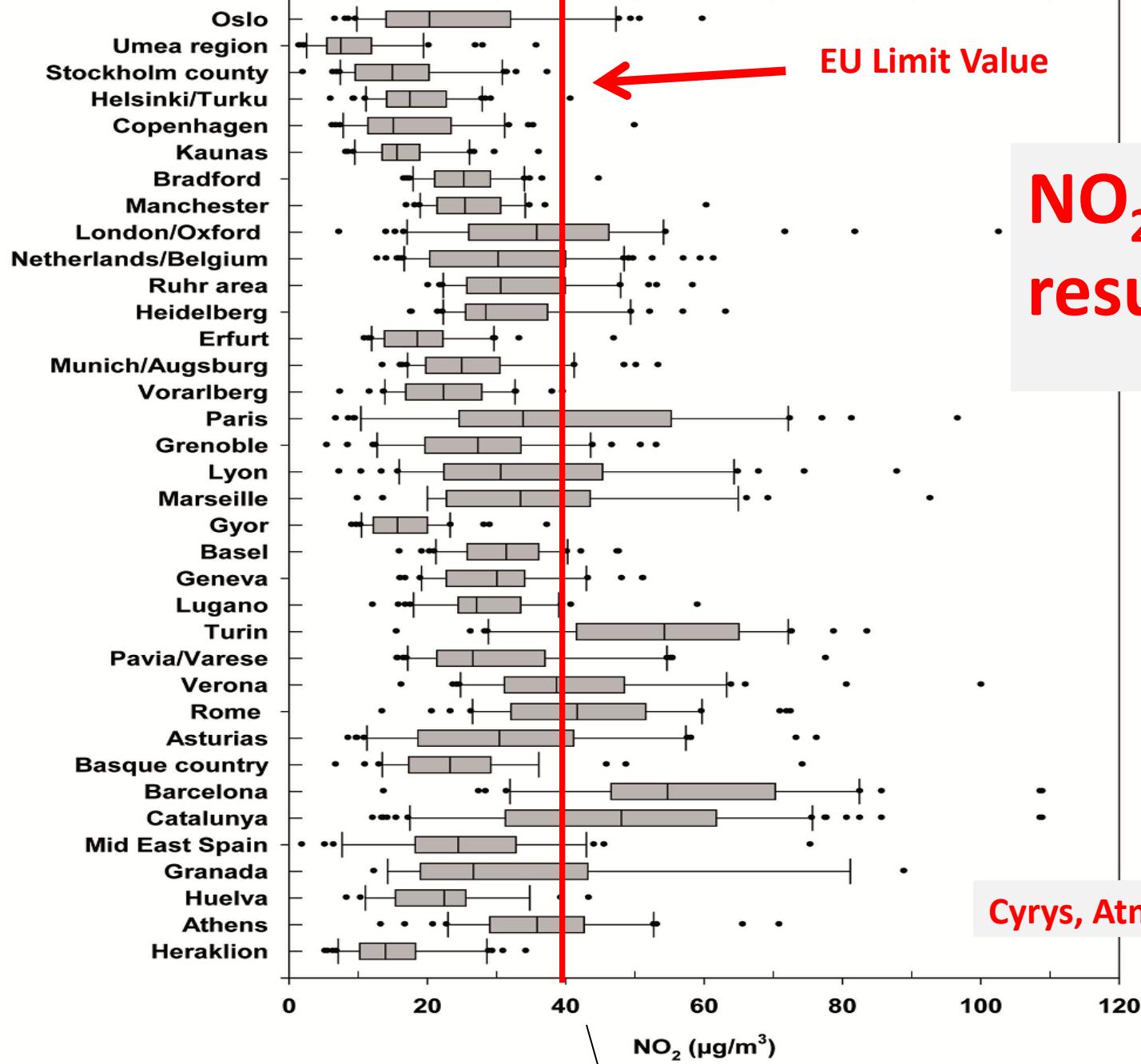


Intervenció ‘cars free cities’

- Més i millor transport públic
- Reduir vehicles privats
 - Corredors verds
 - Carrils bici
 - Super-illes
- Vehicles (transport públic, mercaderies) nets

COMPARTIR

NO₂ results



Cyrys, Atm Env 2012