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Air pollution effects on the lung and brain

Dr. Tamara Schikowski

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Symposia ‚Soot and climatic, environmental
and health impacts‘

Mitglied der

Leibniz
Leibniz-Gemeinschaft

Overview

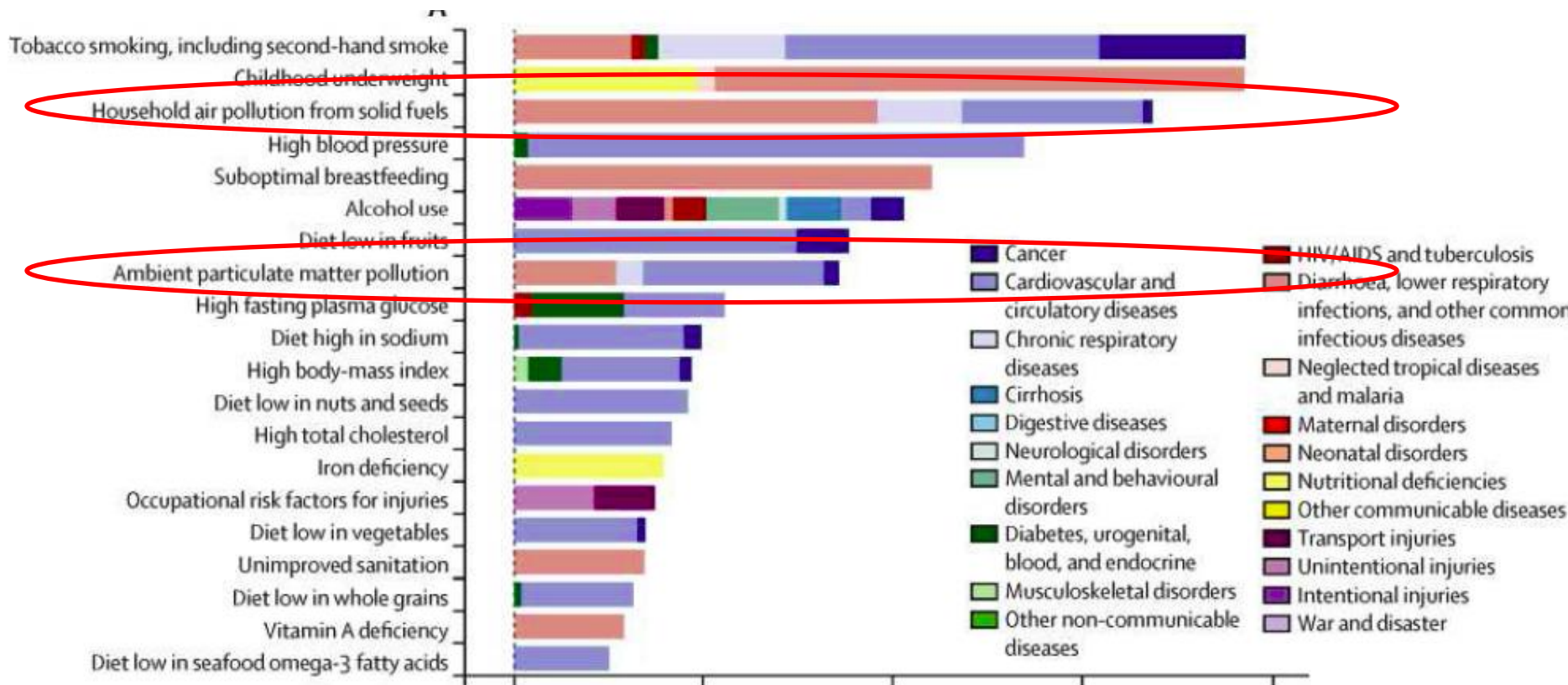
- Air pollution and health
- Outdoor air pollution effects on lung health
- Effects of air pollution on cognitive decline
- Global Challenges and Opportunities

„gravioris caeli" (heavy sky)

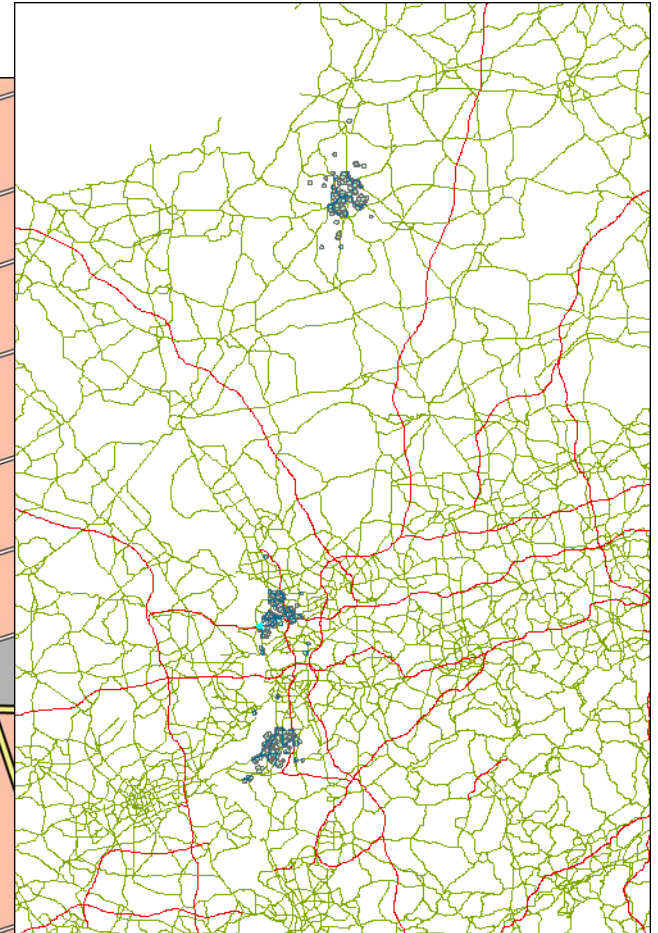
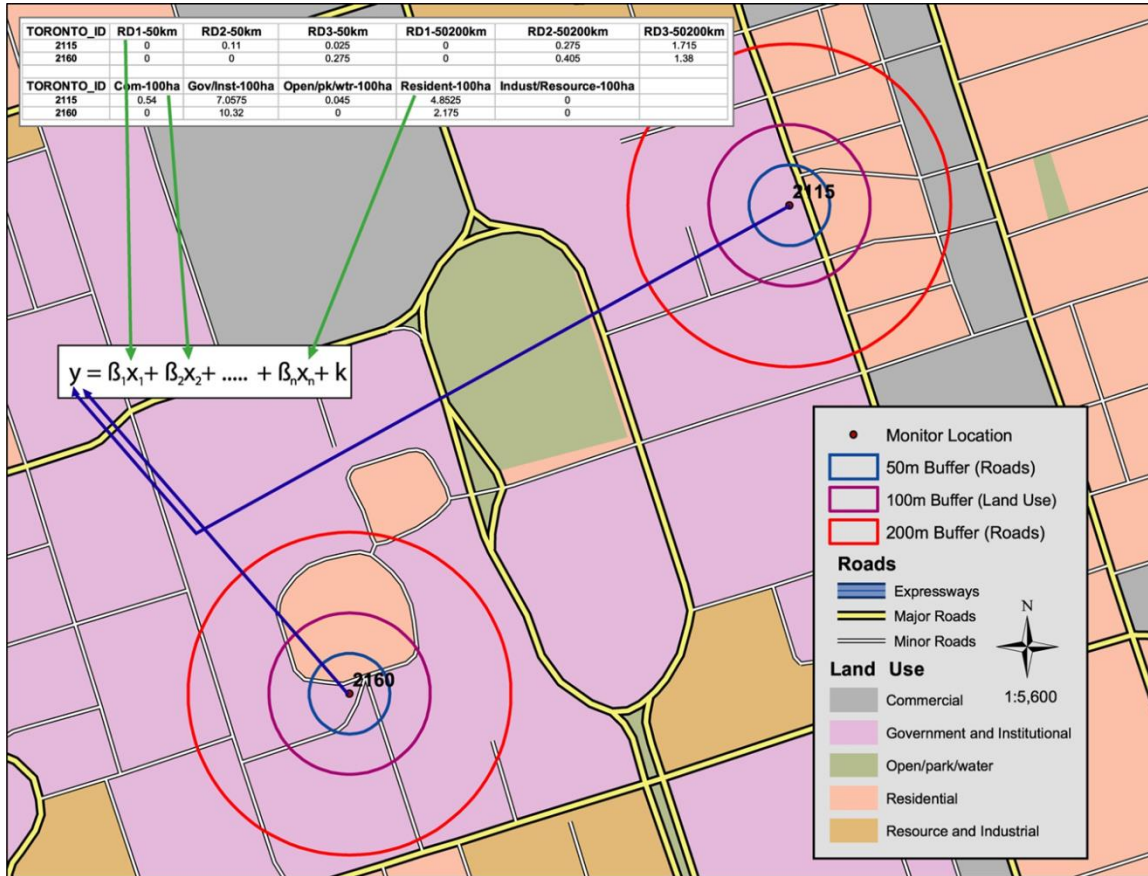


Claude Monet (1904):
Parliament of London (in
Smog) (Musée d'Orsay,
Paris)

Global Burden of Disease Study



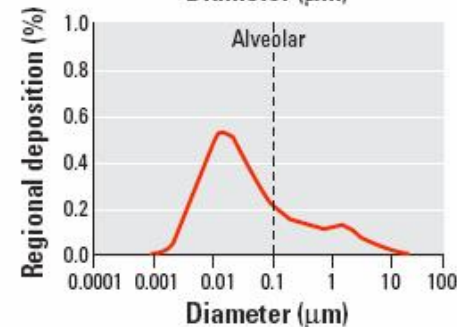
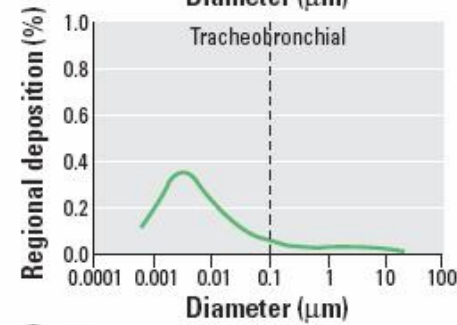
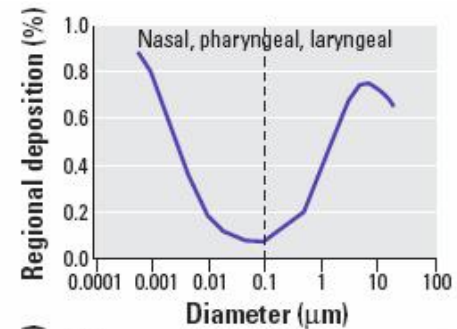
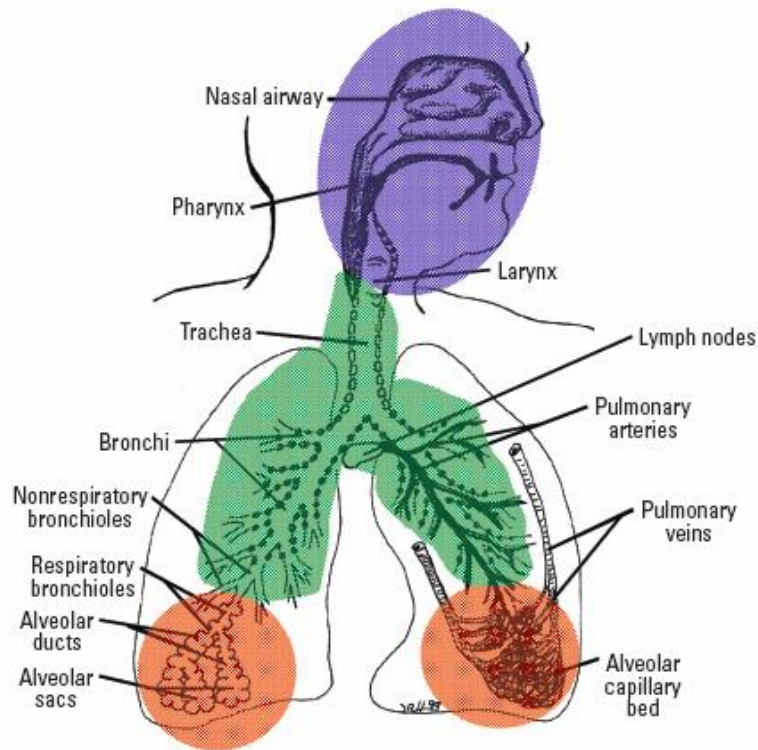
Exposure Measurement using LUR Models



Overview

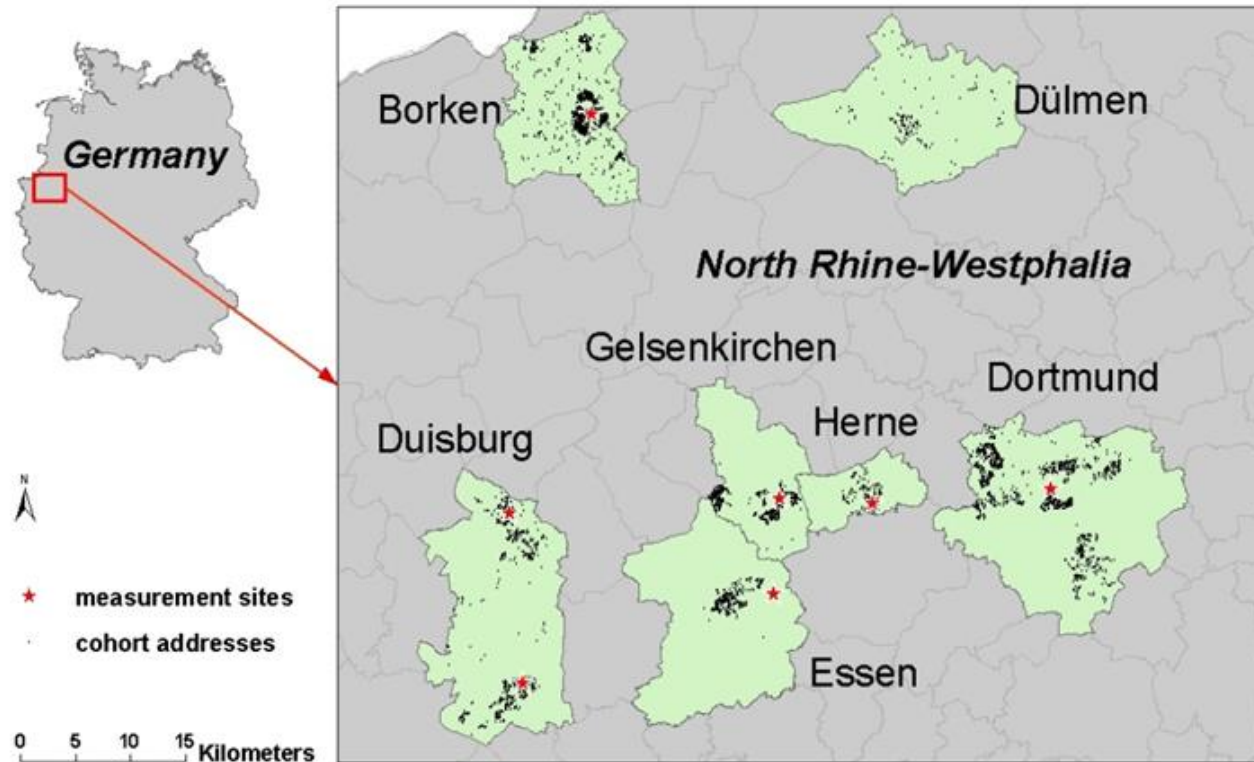
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Lung deposition

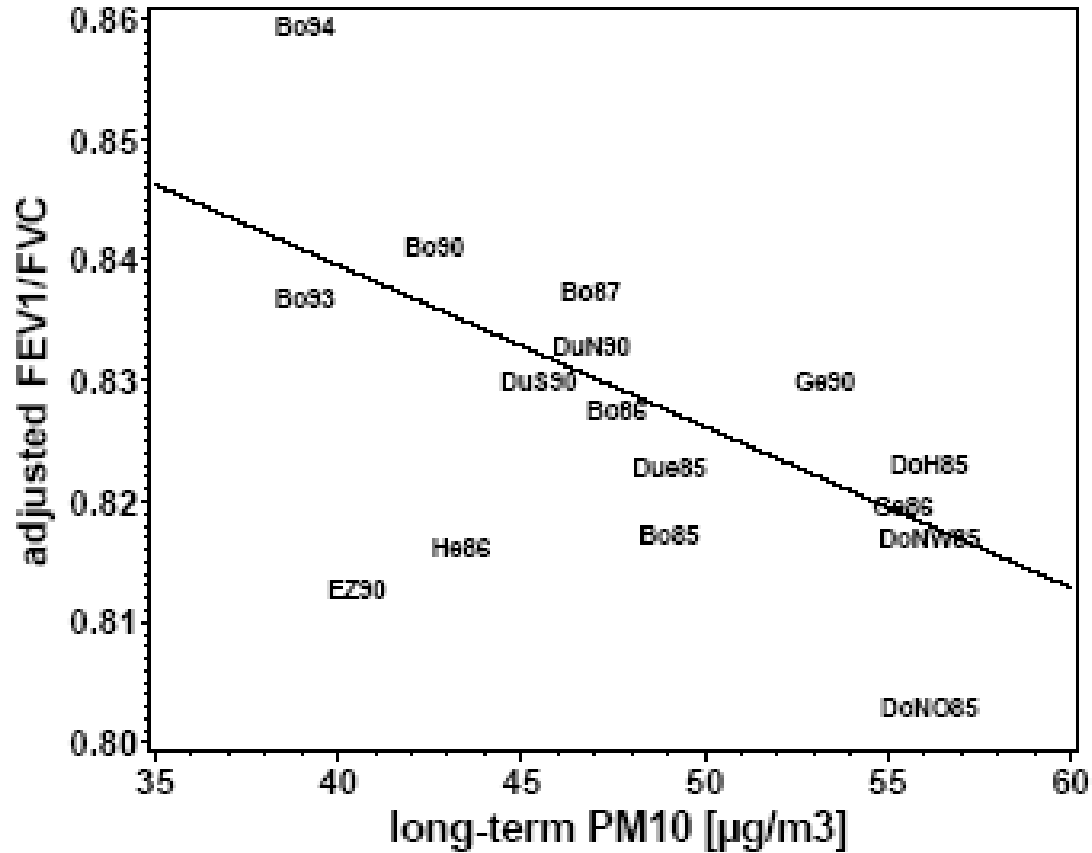


SALIA

(Study on the influence of air pollution on lung function, inflammation and aging)

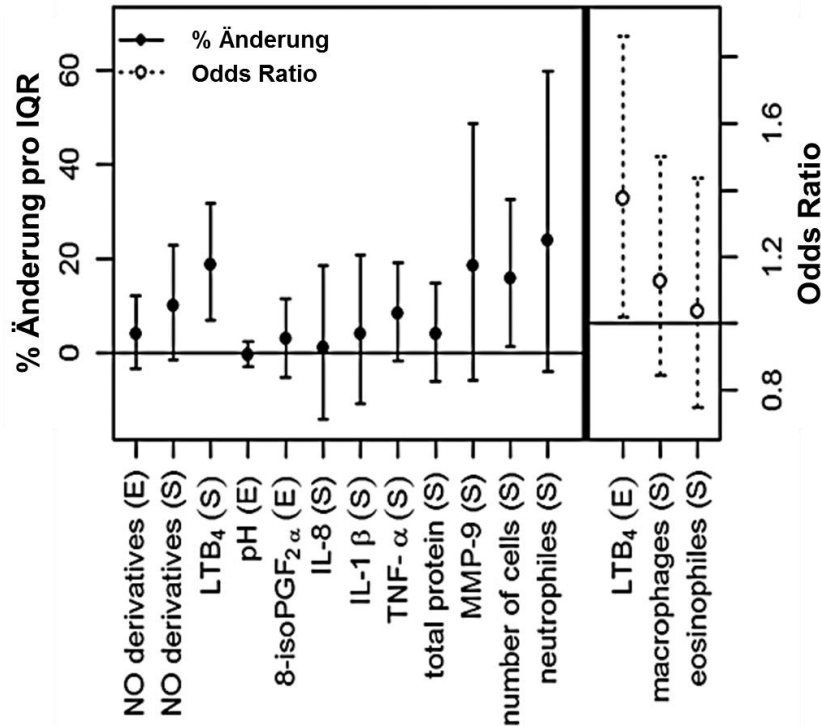


Association between COPD (low FEV1/FVC) and ambient PM10 among 4757 women (SALIA)

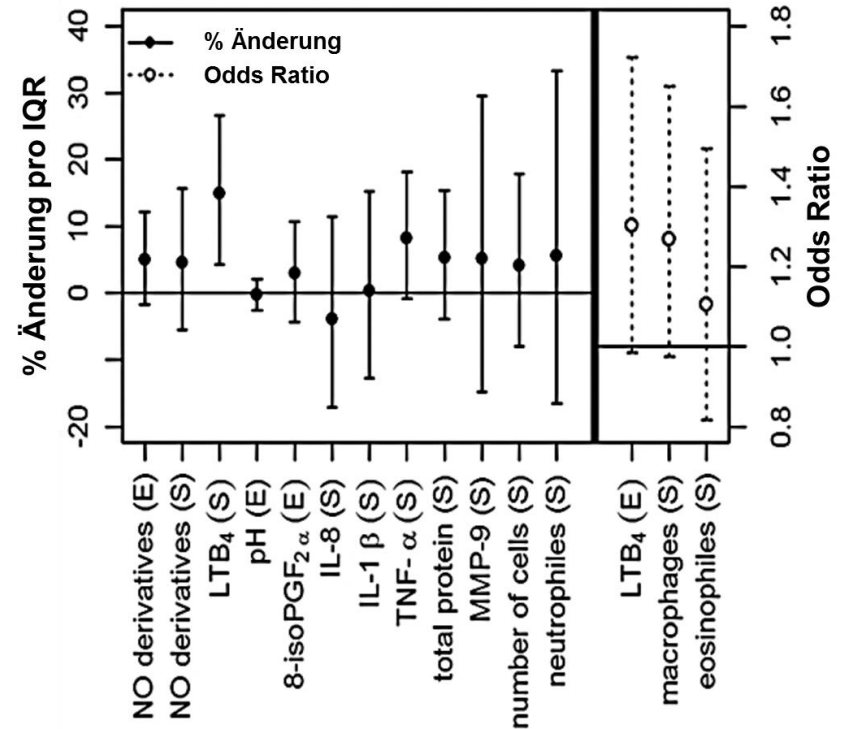


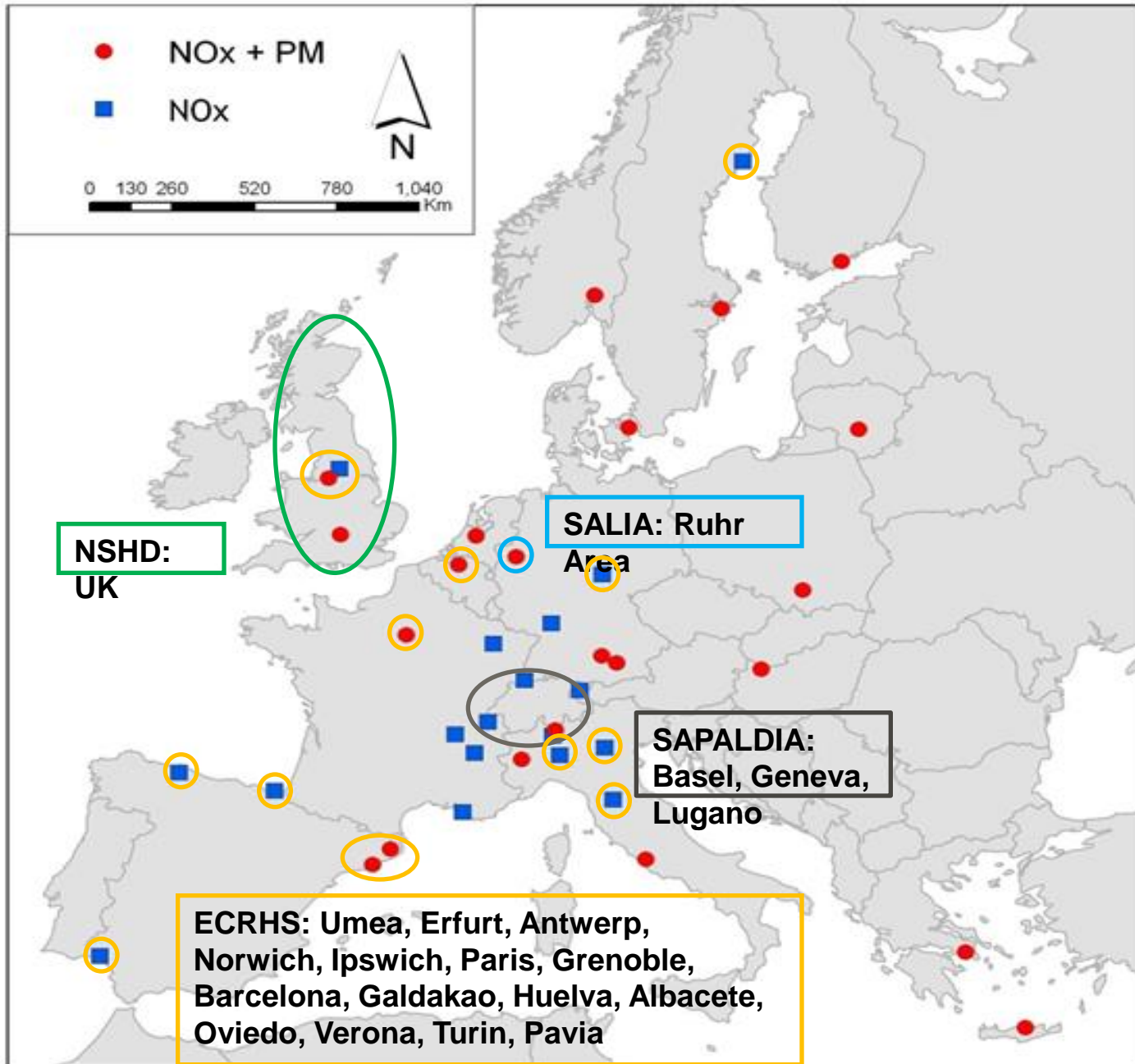
Air pollution and local inflammation

Zusammenhang zwischen Stickstoffdioxid (NO₂) und lokaler Inflammation

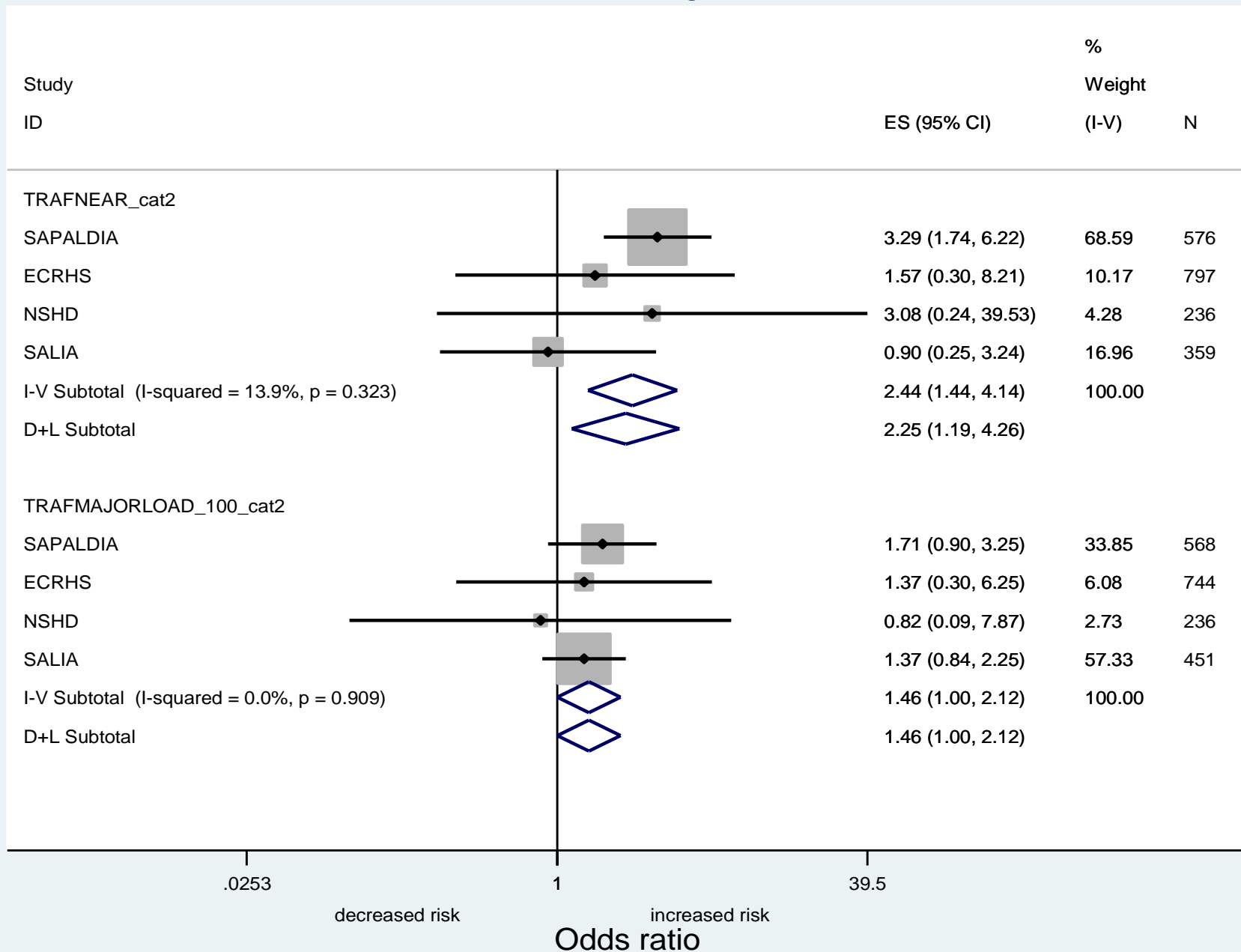


Zusammenhang zwischen Feinstaub (PM₁₀) und lokaler Inflammation



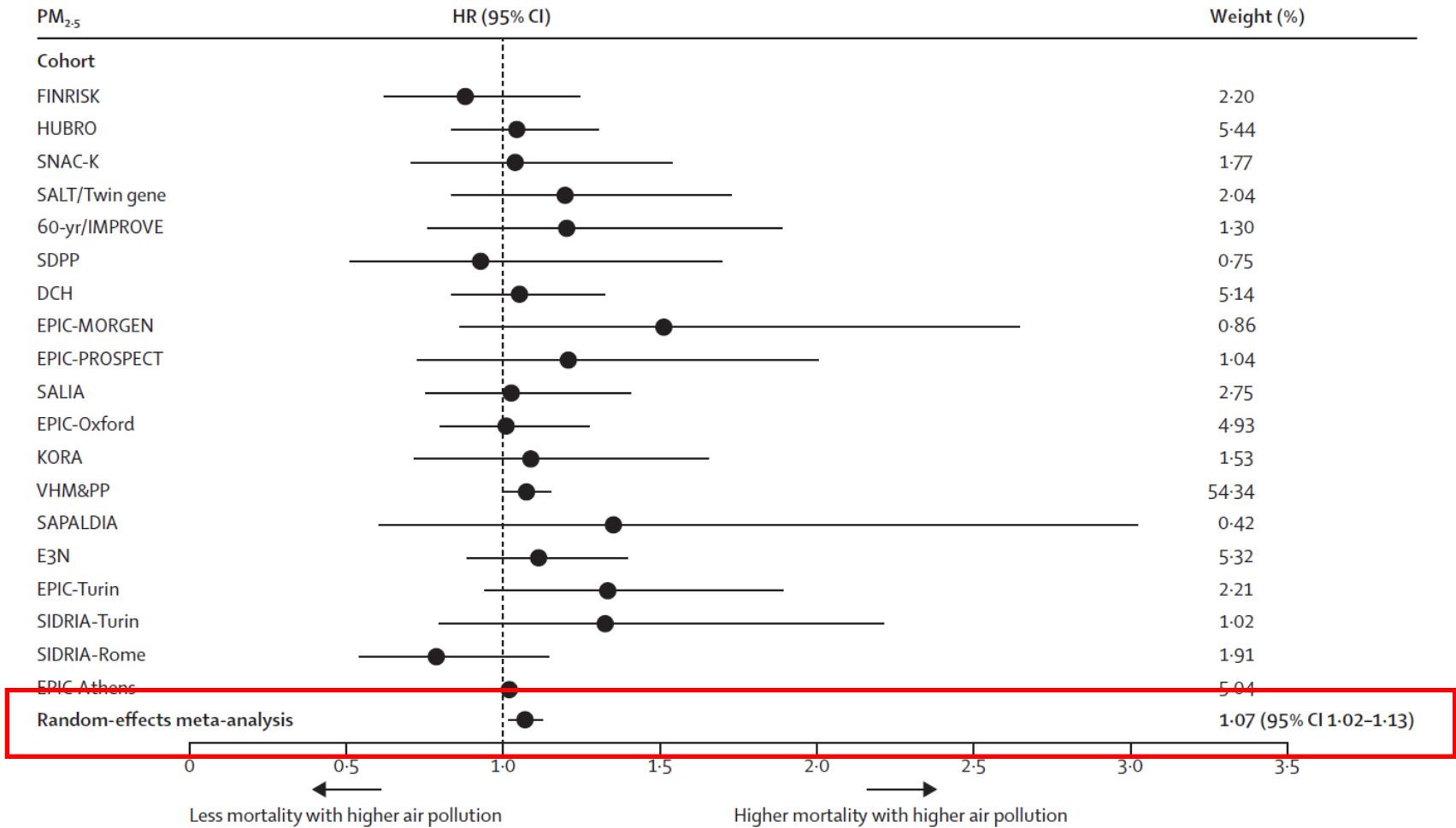


COPD incidence GOLD stage 1+ never smoker





ESCAPE: PM10 und Mortalität

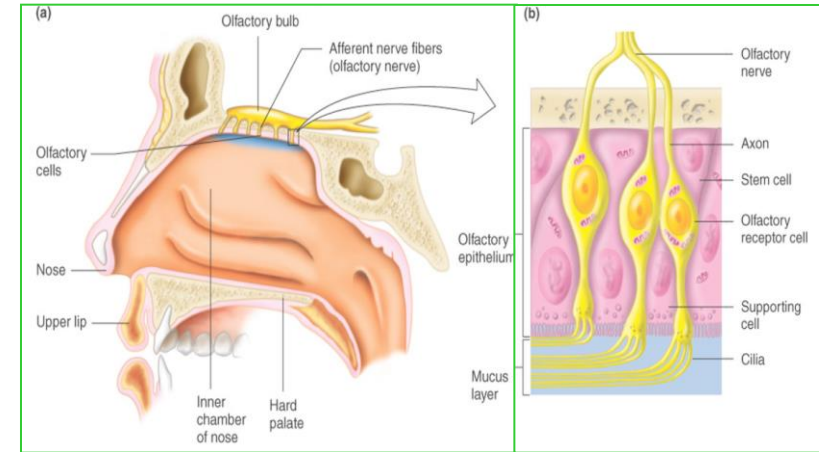


Overview

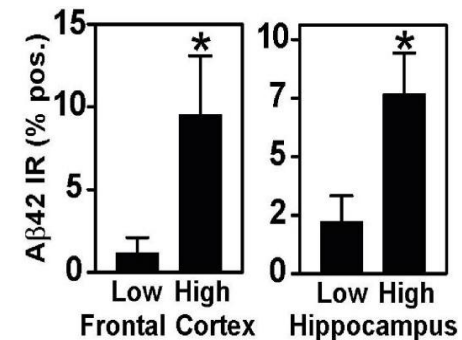
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Brain as novel target for inhaled particles?

- Translocation and accumulation of inhaled carbon nanoparticles in rat brain (*Oberdörster et al., 2004; Elder et al., 2006*).
- Possible routes:
 - (1) nasal deposition → olfactory route
 - (2) Alveoli → circulation → blood-brain-barrier



- Association between PM exposure and neuropathology: post mortem analysis of brain tissue from residents of contrastingly polluted environments (Mexico) (*Calderon-Garciduenas et al., 2002; Peters et al., 2006*)
 - Inflammation (NF- κ B, iNOS, COX-2)
 - DNA-damage
 - A β 42-accumulation

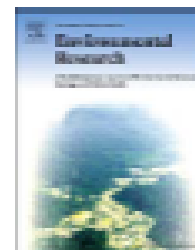




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Long-term exposure to traffic-related particulate matter impairs cognitive function in the elderly[☆]

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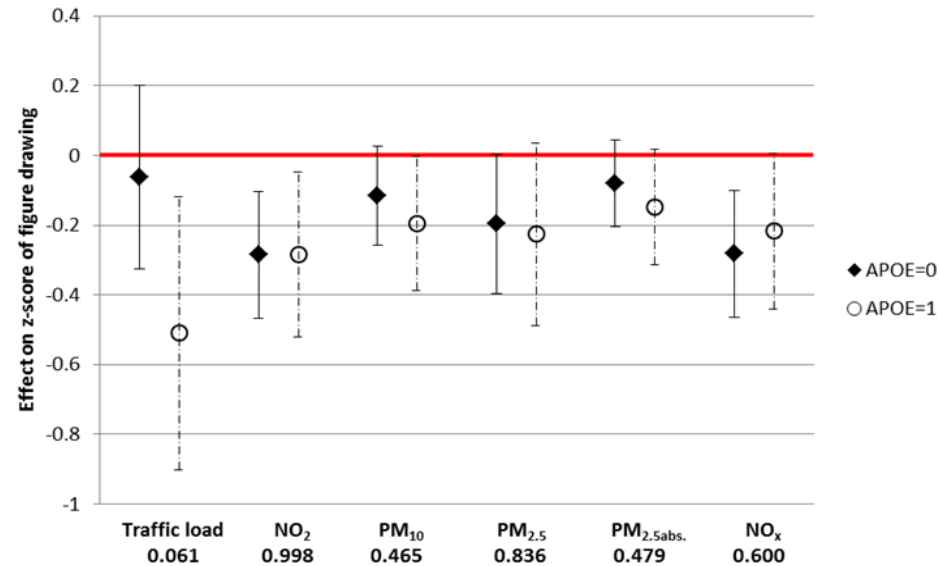
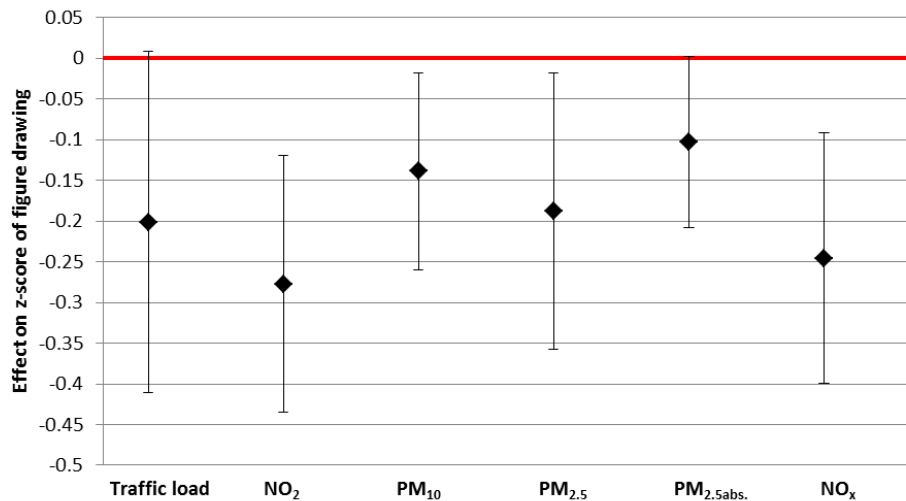
Vehicle emissions

ABSTRACT

Animal studies have suggested that fine particulate matter (PM) can translocate from the upper respiratory tract to the brain and cause brain inflammation. Brain inflammation is involved in the pathogenesis of neurodegenerative diseases. Hypothesizing therefore that long-term exposure to fine PM might contribute to the development of Alzheimer's disease (AD), the objective of this study was to investigate the association between exposure to fine PM and mild cognitive impairment (MCI) which is associated with a high risk of progression to AD. A study group of 399 women aged 68–79 years who lived for more than 20 years at the same residential address has been assessed for long-term exposure to PM and tested for MCI. The exposure assessment comprised background concentration of PM₁₀ and traffic-related PM indicated by the distance of the residential address to the next busy road. The women were assessed for MCI by a battery of several neuropsychological tests and their odor identification ability. Consistent effects of traffic-related air pollution exposure on test performances including a dose-response relation were found. The associations were adjusted for potential confounders using regression analysis. These results indicate that chronic exposure to traffic-related PM may be involved in the pathogenesis of AD.

Association between mild cognitive impairment and exposure to air pollution

Figure drawing



Main findings:

- Air pollution was associated with mild cognitive impairment in particular the subtest figure drawing
- APOE carriers are more susceptible to traffic-related air pollution exposure

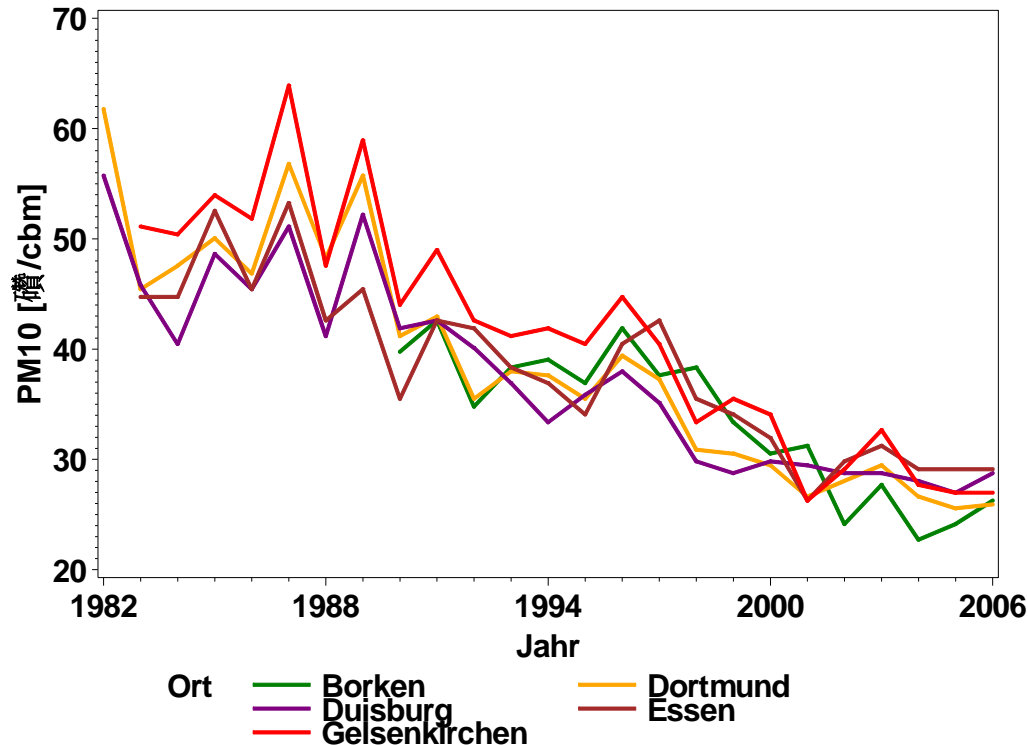
Overview

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- **Global Challenges and Opportunities**

Global Challenges and Opportunities



Global Challenges and Opportunities



- 1987 Introduction of the Clean Air Plans
- Decrease in heating with fossil fuels mainly coal
- Closure of coal mines
- Filter introduction to high chimney stacks



Global Challenges and Opportunities

Strategies to reduce burden of air pollution:

- Improvement of fuels
- Emission controls of point sources
- Emission controls on mobile sources
- Cleaner cookstoves with ventilation

Reduced Exposure to PM₁₀ and Attenuated Age-Related Decline in Lung Function

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ABSTRACT

BACKGROUND

Air pollution has been associated with impaired health, including reduced lung function in adults. Moving to cleaner areas has been shown to attenuate adverse effects of air pollution on lung function in children but not in adults.

METHODS

We conducted a prospective study of 9651 adults (18 to 60 years of age) randomly selected from population registries in 1990 and assessed in 1991, with 8047 participants reassessed in 2002. There was complete information on lung volumes and flows (e.g., forced vital capacity [FVC], forced expiratory volume in 1 second [FEV₁], FEV₁ as a percentage of FVC, and forced expiratory flow between 25 and 75% of the FVC [FEF₂₅₋₇₅]), smoking habits, and spatially resolved concentrations of particulate matter that was less than 10 μm in aerodynamic diameter (PM₁₀) from a validated dispersion model assigned to residential addresses for 4742 participants at both the 1991 and the 2002 assessments and in the intervening years.

RESULTS

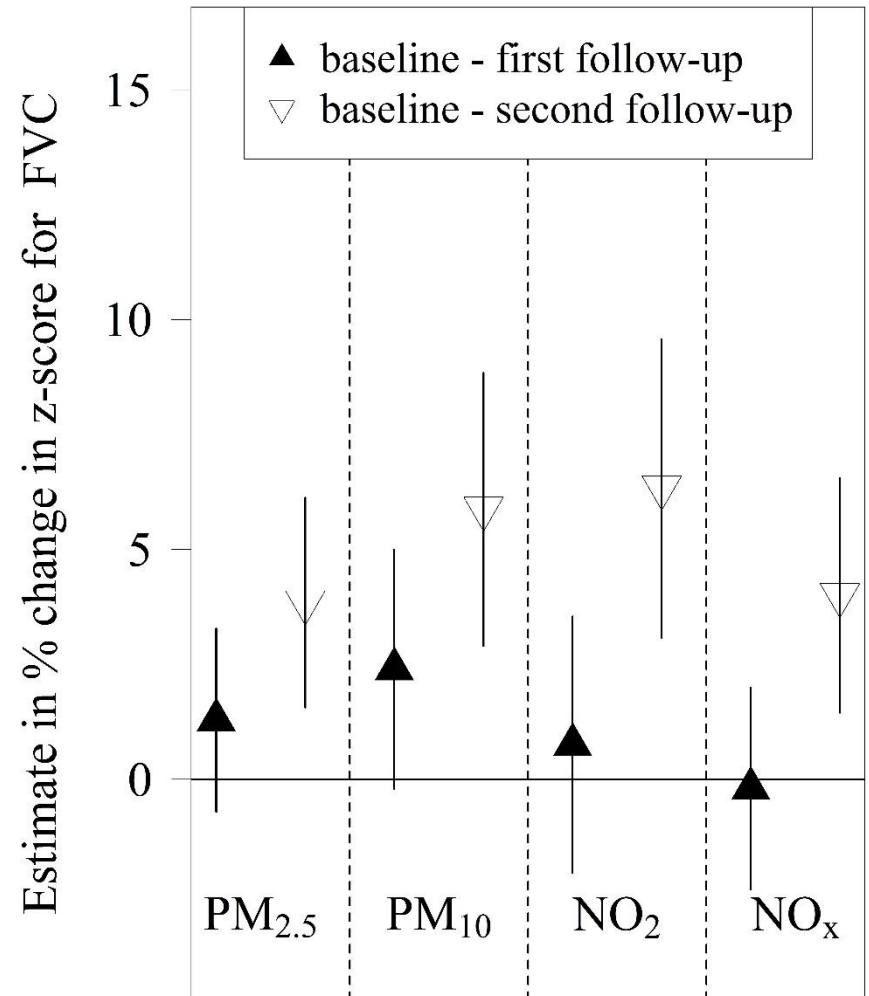
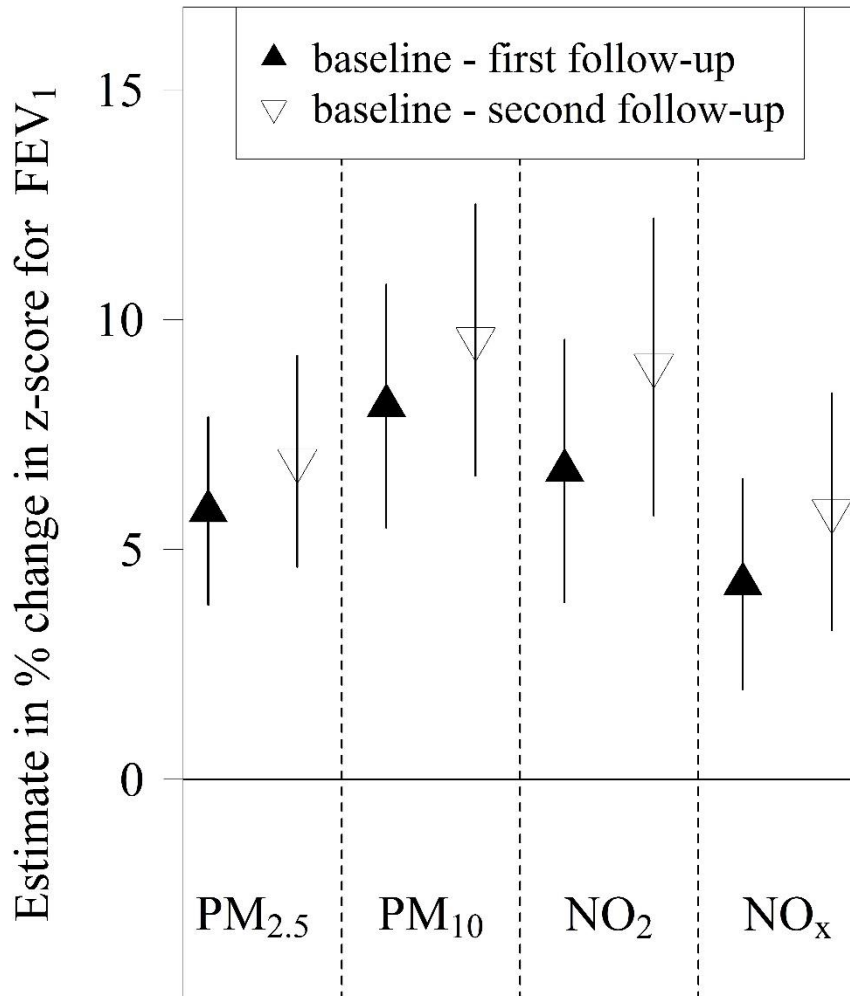
Overall exposure to individual home outdoor PM₁₀ declined over the 11-year follow-up period (median, -5.3 μg per cubic meter; interquartile range, -7.5 to -4.2). In mixed-model regression analyses, with adjustment for confounders, PM₁₀ concentrations at baseline, and clustering within areas, there were significant negative associations between the decrease in PM₁₀ and the rate of decline in FEV₁ (P=0.045), FEV₁ as a percentage of FVC (P=0.02), and FEF₂₅₋₇₅ (P=0.001). The net effect of a decline of 10 μg of PM₁₀ per cubic meter over an 11-year period was to reduce the annual rate of decline in FEV₁ by 9% and of FEF₂₅₋₇₅ by 16%. Cumulative exposure in the interval between the two examinations showed similar associations.

CONCLUSIONS

Decreasing exposure to airborne particulates appears to attenuate the decline in lung function related to exposure to PM₁₀. The effects are greater in tests reflecting small-airway function.



Relative improvement of lung function after air pollution improvement



Shifting the problem?



Future opportunities

- Existing collaboration with two large cohort studies in China: Taizhou and Pingding
- Combination of air pollution data and health data from these two cohort
- Investigate ethnic difference in susceptibility to air pollution

Thank you for your attention



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