

HEALTH EFFECTS OF PARTICLES FROM MOTOR ENGINE EXHAUST AND AMBIENT AIR POLLUTION (HEPMEAP)

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Overall objectives of the project:

Breathing elevated concentrations of microscopic air pollution particles has been shown to have adverse effects on respiratory and cardiac health. Consequently, the concentrations of these particles in the air we breathe are regulated within the member states of the European Union. The air quality standards are based on the concentration of particles in the air, yet it is clear that not all particles are alike. For example in a recent children's health study, allergic and respiratory symptoms were found to be greatest in children who attended schools near busy roads despite overall particle concentrations being similar across all of the schools examined. This observation suggested that traffic related particles might be especially detrimental to health. In the current study we examined whether this was true by collecting particles from sites throughout Europe, including four of the schools from the ISAAC II children's health study, where there were clear differences in traffic. We wished to examine whether there were differences in composition of particles collected from sites with heavy versus low traffic, or between sites with differences in diesel and gasoline engine use. In addition, we attempted to demonstrate that any difference in particle composition would affect their capacity to cause inflammation or damaging oxidation reactions in the lung using a range of experimental models. The capacity of these ambient particles to cause toxicity was compared with fresh gasoline and diesel particles, collected under controlled conditions.

Experimental approach and working method:

To address these issues we collected airborne particles, of differing size from various sites throughout Europe: five sites in the Netherlands, four schools and one road tunnel, two sites in Germany, and one site each in Italy and Sweden. Particle sampling was performed in the majority of sites on at least four occasions over a year. The sites were selected for clear differences in traffic density and type. Particles were chemically analyzed prior to testing in a range of models. These experimental models examined the hypothesis that the health effects of inhaled particles are related to their capacity to elicit inflammatory responses in the lung, which in turn is stimulated by their capacity to cause oxidation reactions, which itself is a function of their composition. After screening all the particles a small subset that displayed contrasts in their pro-inflammatory, pro-oxidant and compositional characteristics were tested to determine their capacity to cause inflammation. A smaller number of samples were tested in humans by adding the particles to the airways and examining their capacity to cause inflammation. Further human studies were performed by exposing healthy (young and elderly adults), asthmatic subjects and patients with chronic obstructive pulmonary disease (COPD) to controlled diesel exhaust exposures. Similar to the previous studies airway and systemic inflammation was assessed in these subjects. Finally, attempts were made to link the chemical and toxicological results obtained in this study with the previously observed health effects observed in the children respiratory health study at the four school sites in the Netherlands.

Achievements and results:

1. We found that the pro-oxidant and pro-inflammatory characteristics of ambient particles varied considerably between different sites when particles were compared at an equal mass. This was related to differences in particle composition.
2. The activity of particles at a particular site varied considerably throughout a year, but despite this there were still clear differences between particles from different sites.
3. Generally particles from sites with high traffic were more active than those from low

traffic sites.

4. Whilst certain studies have suggested that particles with an aerodynamic diameter between 0.1-2.5µm might drive most of the reported health effects we found that larger particles in the range 2.5-10µm were also highly reactive.
5. We found that healthy subjects displayed airway inflammation when exposed to fresh diesel exhaust particles, despite these having a low activity compared with ambient material. (
6. We derived preliminary evidence that particle activity, not just ambient concentration, could be related to the magnitude of respiratory and allergic symptoms in children attending schools near busy roads.
7. This study is the first to successfully integrate the disciplines of particle toxicity with epidemiological health effect assessment.

Early publications emanating from the project:

Nordenhäll C, Pourazar J, Ledin MC, Levin JO, Sandström T, Ädelroth E. Diesel exhaust enhances airway responsiveness in asthmatic subjects. *Eur Respir J.* 2001,17:909-15.

Pourazar J, Frew AJ, Blomberg A, Helleday R, Kelly FJ, Wilson S, Sandström T. Diesel exhaust exposure enhances the expression of IL-13 in the bronchial epithelium of healthy subjects, *Respir Med*, in press.