

Title of the project: Relationship between Ultrafine and fine Particulate matter in Indoor and Outdoor air and respiratory Health		
Acronym of the project: RUPIOH		
Type of contract	Shared cost	Total project cost € 1.735.323
Contract number QLK4-CT-2001-00452	Duration 36 Months	EU contribution € 1.370.000
Commencement date 1 January 2002		Period covered by the progress report 1 January 2004 - 31 December 2004
PROJECT COORDINATOR		
Name Gerard Hoek	Title PhD	Address PO Box 80176 3508 TD Utrecht the Netherlands
Telephone +31 30 2539498	Telefax +31 30 253 5077	E-mail address g.hoek@iras.uu.nl
Key words Air pollution , Indoor , Particles, Asthma, Exposure		
List of participants		
Contractor 1 (Coordinator)	University Utrecht, Institute for Risk Assessment Sciences	
Contractor 2	Energy research Centre of the Netherlands, Unit Clean Fossil Fuels	
Contractor 3	University of Birmingham, Division Environmental Health Risk Management	
Contractor 4	University Helsinki, Department of Physics	
Contractor 5	National Public Health Institute, Department of Environmental Health	
Contractor 6	National And Kapodistrian University Of Athens, Dept. Of Hygiene-	

	Epidemiology
Contractor 7	National Observatory Athens, Inst. For Environmental Research Sustainable Development

Objectives:

The *objectives* of the study are to improve exposure assessment for ultrafine particles and assess the effect of improved exposure characterization on estimated health effects by investigating:

1. The relationship between outdoor and indoor particle number counts on timescales relevant for epidemiological studies
2. The relative strength of the association between outdoor and indoor exposure to airborne particles characterized by particle number counts, PM₁₀ and PM_{2.5} concentrations and respiratory health of sensitive subjects

Results and Milestones:

The project has been completed in the third year. The study was conducted in Amsterdam, Athens, Birmingham and Helsinki, covering a wide range of climatic and air pollution conditions within Europe. At a central site, PM_{2.5}, PM₁₀ and total particle number counts will be measured in outdoor air continuously. In each city, between 30 and 37 non-working, non-smoking patients with asthma or chronic obstructive pulmonary disease (COPD) were recruited. For each subject, measurements of PM_{2.5}, PM₁₀ and particle number counts inside the home and directly outside the home were conducted during one week. The air exchange rate of each home was measured. A time activity diary was kept to collect information about ventilation patterns and indoor particle sources. Respiratory health was recorded by measurement of lung function, respiratory symptoms and medication use three times a day. Urine was collected each morning for determination of CC16 (a marker of lung damage). During a six-month period, subjects will complete a daily diary with questions about respiratory symptoms, restriction of daily activities and medication use.

The main results of the project are:

1. The highest particulate matter concentrations at the central site were found in Athens and the lowest in Helsinki. The contrast between Athens and other cities was less pronounced for particle number than for PM₁₀, coarse particles and soot
2. The low temporal correlations between concentrations at the central site of PM_{2.5} and particle number supports the notion that particle number and mass are separate characteristics of particulate matter, requiring separate monitoring.
3. Concentrations measured at the central site were highly correlated with concentrations measured near the homes spread over the metropolitan area for all pollutants, including particle numbers. Thus, a central site is a good estimate for the temporal variation.
4. Absolute concentration levels of particle number differed substantially between homes and central site. This suggests that it is virtually impossible to characterize the city-average concentration of PNC with one site. Considerably smaller spatial variability was found for PM_{2.5} and PM₁₀.
5. The *correlation* between residential outdoor and central site ambient particle concentrations did not differ significantly between homes located in the city

- centre versus suburbs; in urban background versus high-traffic roads. A central site thus characterizes temporal variation equally well for diverse locations.
6. Residential outdoor concentrations were higher than central site ambient measurements when the home was located in a high-traffic intensity street major street and in the city center. The contribution from motorized traffic was more important for particle number and particle absorbance than for $PM_{2.5}$ and PM_{10} , documenting that mass based particle measurements do not reflect the impact of motorized traffic adequately.
 7. The measured air exchange rates (ACH) were in the low range of previously reported values. Amsterdam had the highest mean ACH and Birmingham and Athens the lowest.
 8. The large variability of ACH between homes was partly explained by weather conditions (season, temperature) and reported use of ventilation facilities (opening of doors / windows).
 9. Daily average particle number concentrations measured at a central site were poorly to moderately correlated with indoor concentrations. In three of the cities, the correlation of $PM_{2.5}$ at the central site and indoors was substantially higher. Very high indoor-outdoor correlations were found for fine particle sulfate and absorbance ('soot').
 10. Hourly average particle number concentrations during nighttime hours ('non-source period'), showed moderately high correlations between indoor and outdoor concentrations, suggesting that indoor sources were partly responsible for the difference in correlation between particle number and particle mass / sulfur /soot.
 11. Regression slopes, describing the quantitative relationship between indoor and outdoor concentrations, were lower for particle number than for $PM_{2.5}$ and particularly sulfate and 'soot'
 12. Indoor concentrations were less correlated with outdoor concentrations at a central site when the distance to the central site increased. There was no difference in correlation between homes in minor roads compared to homes located in major roads. Correlations were higher in the summer and increased with increasing air exchange rate.
 13. Homes located in a major street did not have higher particle number concentrations than homes located in minor roads, in spite of the substantial increase in home outdoor concentrations. Soot concentrations were significantly increased in traffic homes.
 14. Smoking affected especially $PM_{2.5}$, PM_{10} and to some extent soot, but not particle numbers. Candle burning and fireplace use were important sources especially for particle number
 15. Consistent associations between PM_{10} and especially the coarse fraction of PM_{10} and various respiratory symptoms reported in a six-month daily diary were found. $PM_{2.5}$ and particle number concentration were not associated with any of the reported symptoms.
 16. We found no association between lung function and particle number or particle mass concentrations. Improving the exposure assessment by using home outdoor and home indoor levels of particulate air pollution instead of central site measurements did not change the observed associations.
 17. Daily variation in particulate air pollution levels, measured at central site, indoor

or outdoors at home, was not associated with daily changes of lung Clara d protein CC16 measured in urine, a marker for lung damage, a levels in any of t cities.

Milestones of the project:

1. Completion of the study manual and SOPs (month 6)
2. Completion of health and air pollution data collection (month 18)
3. Completion of data management and analysis manual (month 18)
4. Completion of processing of health and air pollution data (month 24)
5. Completion of chemical analysis PM2.5 samples (month 24)
6. Completion of the study report (month 36)

Benefits and Beneficiaries:

Exploitation of these results will be by the health sector, by the environmental regulations sector, industry and the scientific community. Benefits will derive from better designs of epidemiological studies by more appropriate exposure assessment; better design of air quality networks taking into account the large spatial variation found in cities for ultrafine particles; more informed policy decisions on which particles to regulate.

Future Actions (if applicable):