Air pollution and childrens' respiratory health study in Raahe 1997-1998

Kati Oravisjärvi[1]* , Kirsi L. Timonen[2], Arja Rautio[3], Anna R. Kaasinen[4], Pekka Tiittanen[5], Tarja Wiikinkoski[6] and Juhani Ruuskanen[7]

[1]University of Oulu, Department of Process and Environmental Engineering, FI-90014 University of Oulu, P.O.Box 7300, Finland

[2]Kuopio University Hospital and Kuopio University, Department of Clinical Physiology and Nuclear Medicine, FI-70211 Kuopio, P.O.Box 1777, Finland

[3]University of Oulu, Thule Institute, Centre for Arctic Medicine, FI-90014 University of Oulu, P.O.Box 7300, Finland

[4]University of Eastern Finland, Department of Mathematics and Statistics, FI-70211 Kuopio, P.O.Box 1627, Finland

[5]National Institute for Health and Welfare, Unit of Environmental Epidemiology, Neulanen Research Centre, FI-70701 Kuopio, P.O.Box 95, Finland

[6]West Finland Regional Environmental Centre, P.O.Box 77, FI-67101 Kokkola, Finland

[7]University of Eastern Finland, Department of Environmental Sciences, FI-70211Kuopio, P.O.Box 1627, Finland

1 Introduction

Exposure to particle emissions can cause adverse health effects especially for susceptible subgroups such as children and elderly people, and people with pulmonary and cardiovascular diseases. The particles can be classified in the following ways: the mechanism of the formation, the size and the composition of the particles. (Vallius 2005). Fine particles ($PM_{2.5}$) are particles with an aerodynamic diameter less than 2.5 µm, and coarse particles (PM_{10}) particles with an aerodynamic diameter less than 10 µm. $PM_{2.5}$ is also called the respirable fraction, because this fraction can penetrate to the unciliated regions of the lungs. Fine particles consist of so called ultrafine particles (an aerodynamic diameter less than 0.1 µm). (Brunekreef and Holgate 2002, Penttinen 2004). Increase of PM_{10} pollution in outdoor air has been found to be associated with a range of adverse health effects, such as increased use of medication for asthma, attacks of asthma and chronic obstructive pulmonary disease, admission to hospital for cardiovascular causes and deaths from respiratory causes, heart attacks and strokes. (Donaldson et al. 2001). The levels of PM_{10} associated with adverse health effects are very low (Timonen et al. 1998). There are number of factors which suggest that ultrafine particles (aerodynamic diameter less than 100 nm) may be more toxic than larger particles. Ultrafine particles have a large surface area per given mass, and the surface may be able to act as a catalyst for specific reactions with cells or as a carrier for co-pollutants. They may be the most harmful ones for humans also because of their capability to penetrate deep into the lungs. (Oberdörster et al. 2004)

2 Objectives of the research

This study was done in 1997-1998 in Raahe. The study was divided to two parts. In the first part, the most significant sources of fine particles and their fractions were determined by using receptor modeling (Oravisjärvi et al. 2003). In the second part, the effects of short-term changes in particle air pollution on the respiratory health of symptomatic children living near a steel works were assessed. We studied if particulate air pollution is associated with adverse respiratory effects, and if specific sources of air pollution are responsible for these effects. (Oravisjärvi et al. 2008)

*Correspoding author, E-mail: kati.oravisjarvi@oulu.fi

3 Results

3.1 Measurement data

The air pollution and meteorological parameter measurements were carried out from January 8 to April 19, 1998. During January 1998, the monthly average temperature in Raahe was -6.5 °C. In February, March and April the corresponding temperatures were -10.7, -6.1 and -4.1 °C, respectively. The coldest daily average temperature (-22.8 °C) was observed on February. The prevailing wind directions over a period of four months were found to be in the north 15%, southwest 18% and south 20%. The wind directions in the study period are presented in Figure 1. (Oravisjärvi et al. 2003, Oravisjärvi et al. 2008).

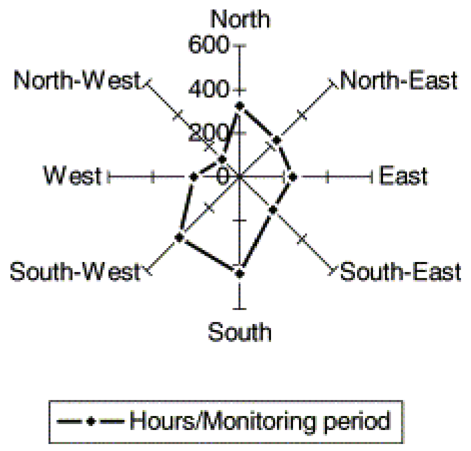

Figure 1 *Average wind rose in the study period (Oravisjärvi et al. 2003).*

$PM_{2.5}$ concentrations varied from 2.4 µg m^{-3} - 30.0 µg m^{-3}, with a mean of 10.1 µg m^{-3}, while the respective values for PM_{10} concentrations were 1.2 - 79.3 µg m^{-3} and the mean was 16.5 µg m^{-3}. The daily mean SO_2 concentration was 4.5 µg m^{-3} and it varied from 0.1 µg m^{-3} to 29.1 µg m^{-3}. (Oravisjärvi et al. 2003)

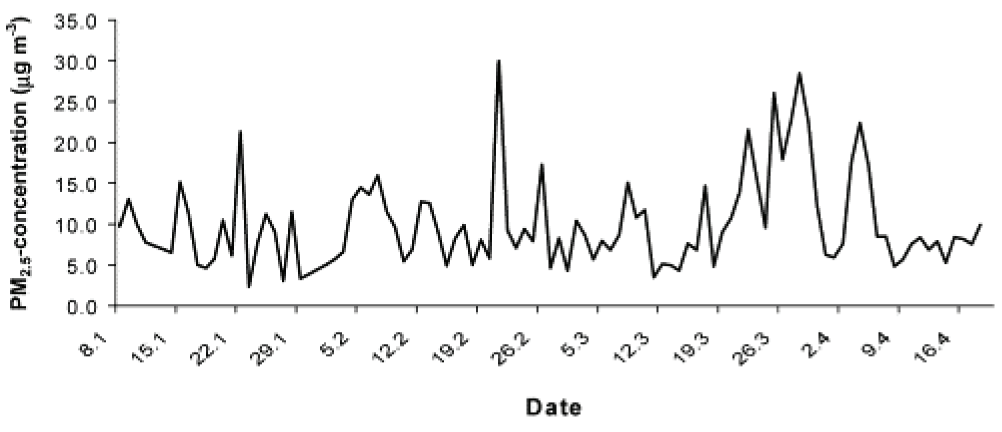

Figure 2 *Measured daily $PM_{2.5}$ concentrations in the study period (Oravisjärvi et al. 2003).*

3.2 Fine particle sources

The used statistical method was factor analysis-multiple linear regression (FA-MLR). The five main $PM_{2.5}$ emission sources were identified: long-range transportation (44%), the sintering plant (11%) and the steel smelting plant (3%) of the steel works, soil and street dust (7%) and a mechanical engineering works. Unidentified sources were responsible for 35% of the $PM_{2.5}$ particles on average. However, the contribution of the mechanical engineering works could not be determined. (Oravisjärvi et al. 2003)

3.3 Questionnaire and PEF measurements

In November 1997, a screening questionnaire on respiratory symptoms was distributed in schools of Raahe to 1 355 primary school children, 6 to 13 years of age. The questionnaire was completed by parents. The questionnaire was returned by 1 172 children (86 %). Using the results of questionnaire, a total of 126 children with chronic respiratory symptoms were asked to participate in this study. In all, 56 of these children (44 %) agreed to participate to the study. The children were followed up for 3.5 months in the winter time 1998. Acute changes in respiratory health were measured as changes in peak expiratory flow (PEF), which was done in morning and evening. (Oravisjärvi et al. 2008)

The screening questionnaire showed that the prevalence of ever doctor diagnosed asthma was 5.7 % among the primary school children. During the past 12 months, 5.5 % of the children were reported to have wheezing and 4.3 % shortness of breath with wheezing. Dry nocturnal cough in the past 12 months was reported for 14 % of the children. Boys were more often reported to have chronic respiratory symptoms than girls. (Oravisjärvi et al. 2008)

There were no statistically significant association between particulate air pollution and respiratory health among symptomatic children. The only pollutant, which had significant association with PEF (morning-PEF) was Copper (measured 3 days before), but the meaning of this association is difficult to asses, because other variables of Cu were non-significant association with morning or evening PEF. (Oravisjärvi et al. 2008)

4 Relevance of the research

Particulate air pollution has been associated with adverse health impacts. Continuous air quality measurements are nowadays a requirement in Finland and municipalities are response for carrying out the monitoring. The purpose of this study was to investigate the quality of ambient air in Raahe and to get more information about the impacts of short-term changes in air pollution on the respiratory health of children living near the steel factory. In addition, the aim was to find out the proportions of main pollution sources and to assess if there is a connection between measured air pollution, and children's respiratory health in Raahe. We specifically wanted to examine which sources of air pollution could be shown responsible for adverse health impacts. The study has generated new knowledge on the correlation of particulate emissions and respiratory health.

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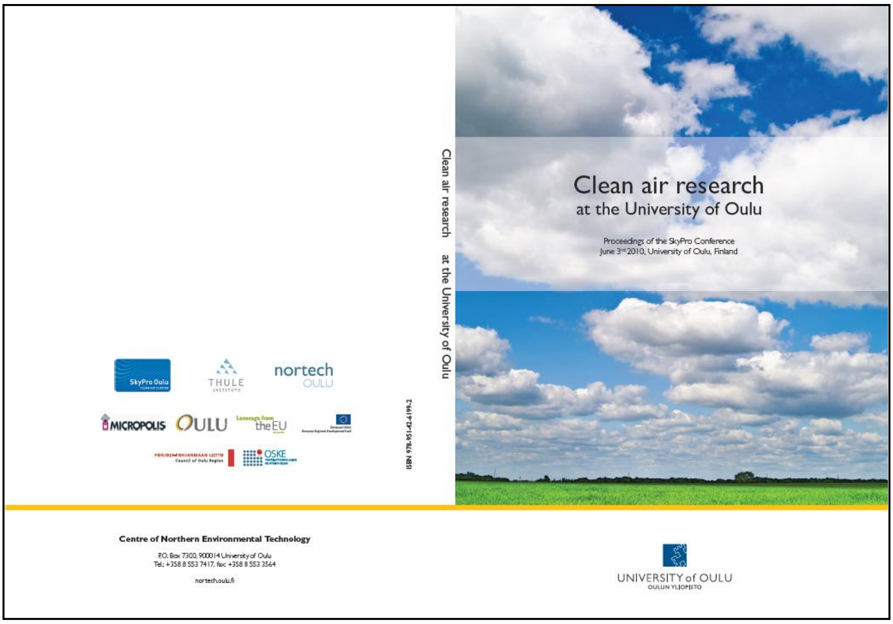

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