Acute effects of particulate matter on respiratory diseases in Austria.

Manfred NEUBERGER, MD, Michael G. SCHIMEK, DPhil PhD, Hanns Moshammer, MD, Helger HAUCK, PhD

AIRNET
A Thematic Network on Air Pollution and Health

NERAM
Network for Environmental Risk Assessment and Management

Air Quality in Austria

Improvements with gaseous pollutants – problematic fine particles

During the 1980s Austria achieved the highest SO_2 reduction among the signatory states of the Helsinki Protocol[1], however, other sources of fine particulate matter like diesel traffic increased. At present annual averages of 20-30µg/m³ are measured for PM_{10} and 15-20µg/m³ for $PM_{2.5}$.

The Austrian Project on Health Effects of Particulates-AUPHEP in 1999-2001 investigated short term effects of particulate matter (PM) on lung function, morbidity and mortality in Vienna, Linz, Graz and a rural control area.

site/ period	PM_1 µg m^{-3}		$PM_{2.5}$ µg m^{-3}		PM_{10} µg m^{-3}		TSP µg m^{-3}		CPC cm^{-3}	
	mean	max	mean	max	mean	max	mean	max	mean	max
VIENNA										
year	**14.9**	**75.1**	**18.6**	**96.4**	**26.5**	**104.6**	**36.1**	**153.5**	**26234**	**62835**
winter	15.5	75.1	19.5	96.4	26.9	104.6	37.5	153.5	31119	62835
summer	14.2	32.6	17.5	42.7	26.1	58.3	34.6	75.6	20555	41749
LINZ										
year	**14.7**	**48.3**	**18.8**	**76.4**	**29.9**	**127.4**	**42.9**	**193.8**	**23387**	**82520**
winter	17.6	48.3	22.3	76.4	35.3	127.4	50.8	193.8	30650	82520
summer	11.9	34.4	15.2	46.4	24.5	60.6	35.4	99.8	16154	47517
GRAZ										
year	**17.5**	**70.4**	**21.1**	**81.2**	**31.0**	**114.1**	**38.4**	**142.1**	**22540**	**54075**
winter	20.9	70.4	26.7	81.2	38.3	114.1	45.7	142.1	29300	54075
summer	14.1	40.9	15.5	43.4	24.3	59.1	31.1	74.6	16374	39289

Hospital admissions

Table 1: *Percent increase in respiratory hospital admissions per 10 µg PM/m³*

Vienna	PM_1		$PM_{2.5}$		PM_{10}	
age	male	female	male	female	male	female
1-6		13.23		8.01		9.31
7-14				6.27		5.53
65+			5.47	5.60	4.22 x	
rural						
1-6						
7-14						
65+			9.89	10.53		4.22

x) estimate for lag 2 (for lag 10 it was 4.23)

Increased admissions for respiratory diseases in Vienna and the rural control area

Applying semi-parametric generalised additive models daily hospital admissions in Vienna for respiratory diseases (asthma and COPD) were found related to high concentrations of PM. For $PM_{2.5}$ this relationship became significant in elderly Viennese (age 65 years and older) after a lag of 2 days in males and a lag of 3 days in females. A second peak of respiratory morbidity at lag 10 reached significance for PM_{10} in elderly men only. In the rural area only the second peak was found, reaching significance for $PM_{2.5}$ at lag 10 for males and at lag 11 for females. Besides this increase of hospital admissions in the elderly which has also been observed in other studies at higher concentrations of PM, we detected in Vienna an increase of respiratory admissions in children which was mainly due to asthma and significant for girls only. In pre-school children this increase reached significance after a lag of 4 days and in school children after a lag of 2 days. **Table 1** shows significant estimates for the increase in hospital admissions encoded ICD 490-496 at hospital discharge.

Independent of the PM effects we found an immediate increase of respiratory admissions in children of both sexes after an increase in NO_2, which is related to motor traffic.

Mortality

Increased cardiovascular and respiratory mortality in Viennese elderly

Based on several severe air pollution episodes, a temporal correlation between high concentrations of particulate matter (PM) and SO_2 pollution and acute increases in respiratory and cardiopulmonary mortality had been established in Vienna for the 1970's. After air pollution had decreased in Austria in the 1980's - as documented by data on SO_2, and total suspended particles (TSP) - no such associations between day-to-day changes of SO_2 and TSP with mortality have been documented any more.

But ongoing analysis of the AUPHEP data show that at least in Vienna there is still a significant association of cardiovascular mortality with particulate matter (PM_{10}, $PM_{2,5}$, PM_1).

Lung function of children

Acute effects in school children

At the elementary school nearest to the monitoring station in Linz 164 children participated in medical examinations for signs of acute infection and in lung function tests performed every second day on about 20 of them, so that each of the 69 girls and 95 boys had spirometry about every fortnight from October 2000 to May 2001. Forced oscillatory resistance as well as FVC, FEV1, MEF_{25}, MEF_{50}, MEF_{75}, and PEF were obtained [2]. In all analyses, each child served as its own control, because we used the difference of the individual lung function parameter to the arithmetic mean of this parameter of all tests during the school year as the outcome variable.

The mixed model showed significant results for the carbonaceous fraction of $PM_{2.5}$, indicating bronchial obstruction on days when particulate total carbon (TC) was increased. The lung function impairment was not significantly related to elemental carbon (EC), but to organic carbon in $PM_{2.5}$, which had a higher variable concentration across the period of observation. Total mass of fine particulate matter (PM_1 as well as $PM_{2.5}$) showed a tendency to increase bronchial obstruction. The coefficients were also negative for PM_{10} (-1.07), particle number concentration measured by condensation particle counter (-0.89), and the gases NO_2 (-0.56) and SO_2 (-0.13).

Key messages

In spite of improvements in Austrian air quality both particulate matter and NO_2 still pose a threat to the health of children and elderly people.

Sources for these air pollutants such as road traffic and in particular diesel powered vehicles (which today make up more than 50% of Austrian cars due to low prices for diesel fuels) have to be reduced.

Acknowledgements:

This study was supported by the Clean Air Commission of the Austrian Academy of Science and conducted within the AUPHEP project. We thank the Municipality of Linz (Departments of Health and Environment) and the AUPHEP team for their support.

References

1. **Neuberger M., Kundi M, Krejci W, Wiesenberger W (1999): Lung function from age 6 to 18 years (cohort study in the city of Linz on males born 1979) Atemw.-Lungenkrkh., 25: 324–325**
2. **Moshammer H, Neuberger M (2003). The active surface of suspended particles as a predictor of lung function and pulmonary symptoms in Austrian school children. Atmospheric Environment 37: 1737-1744**