

10015 - Ambient nitrogen dioxide monitoring near a major highway using passive diffusion samplers  
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Exposure to nitrogen dioxide (NO<sub>2</sub>), a contaminant emitted by fossil fuel combustion, has been associated with an increased risk of asthma, especially in children. However, exposure assessment is an important limitation for large-scale epidemiological studies. The objectives of this pilot study were to assess the validity of passive diffusion samplers used in fixed locations to measure NO<sub>2</sub> concentrations in the vicinity of highways, and to assess the feasibility of using NO<sub>2</sub> passive monitoring to map traffic-related pollution in major Canadian cities. A total of 31 two-sided Ogawa<sup>TM</sup> passive samplers (using triethanolamine as a sorbent) were installed for seven days in groups of two or three at distances ranging from 0 to 1310 meters from a major highway where traffic density exceeds 100,000 vehicles/day. NO<sub>2</sub> concentrations measured ranged from 10.2 to 29.9 ppb, and coefficients of variations between replicates ranged from 5.2% to 18.6%, being lower than 10% in 8 out of 12 sampling locations. NO<sub>2</sub> concentrations significantly decreased with increasing logarithmic distance from the highway ( $p < 0.0001$ ) and were significantly lower upwind than downwind ( $p = 0.0013$ ). The overall R<sup>2</sup> of the regression model was 0.97. Three samplers located below the air intake of an air monitoring station measured a mean NO<sub>2</sub> concentration of 23.0 ppb (5 valid results; standard deviation 2.2 ppb), while the average of the hourly measurements made by the station during the same period was 28.0 ppb. Passive diffusion samplers used in replicate appear to be a reliable method to monitor ambient NO<sub>2</sub>. Also, based on these results, distance from highways appears to be a valid proxy exposure variable for traffic related air pollution in epidemiological studies. However, all these findings will require confirmation in multiple locations.

## **10091 - UNLEADED GASOLINE AND AMBIENT AIR QUALITY**

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Ambient air is mainly polluted by industry, energy production, car traffic and local household sources. Transport sources are gaining recently greater importance and turn to be one of the main sources of ambient air pollution in settlements. The substantial diversity of motor vehicles combined with traffic organization in the settlements and fuel type can provide information about the major pollutants contained in exhaust gases from internal combustion engines.

The release of huge amounts of lead, originating from gasoline ethylating aiming at promotion of their anti-detonation properties, is characteristic for air pollution by transport. Lead passes into the air through the exhaust gases in the form of aerosols – mainly oxides and salts. Lead in transport exhaust gases is the major source of lead in blood. It penetrates into human organism by direct inhalation of polluted air or indirectly through street dust, food, water.

The data on ambient air quality by the indicators airborne lead and NO<sub>2</sub> for the sampling site “Alexander Stamboliiski” (Sofia-center) are presented in table and graphs.

**11105 - Associations between mass and elemental composition of ambient, indoor, and personal fine particles and ST segment depressions**

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Cardiovascular hospital admissions and mortality have been associated with mass concentration of particulate air pollution. It is unclear, whether the observed health effects are rather due to chemical composition of particles than mass as such. ST segment depression during an exercise test is an indicator of myocardial ischaemia. We have earlier observed an association between the occurrence of ST segment depressions and 2 days lagged outdoor fine particle (<2.5 µm) concentration. In this study, associations between mass and elemental composition of outdoor, indoor and personal fine particles, and the occurrence of exercise induced ST segment depressions in subjects with stable coronary artery disease, were studied in Helsinki, Finland, in the framework of the ULTRA study. Daily outdoor fine particle samples were collected at a fixed site for 6 months. Indoor and personal fine particle samples were collected during the 24-h period preceding the biweekly clinic visit (N=511), but successful personal samples are only available for the 4 last months. Elemental composition of all outdoor samples (N=168) and part of the indoor and personal samples (N=233 for both) was determined using X-ray fluorescence spectrometry. In addition, absorbance of all the sample filters was

measured. During the clinic visit, ambulatory ECG was recorded during a 6-minute submaximal exercise test on a bicycle ergometer. Median outdoor, indoor and fine particle concentrations were 10.6, 9.2, and 9.6  $\mu\text{g}/\text{m}^3$ , respectively. There were 78 ST segment depressions larger than 0.1 mV during 361 exercise tests among 45 subjects. Fixed effects logistic regression was used to adjust for subject, trend, temperature, relative humidity, and increase in heart rate during exercise. Mass, absorbance, and a number of elements (e.g. S, Fe, K) of outdoor samples were associated with ST depressions. The associations were strongest for 2 days lagged levels. No single element was more strongly associated with ST depressions than mass. Indoor absorbance, or mass or elemental concentrations, were not more strongly associated with ST depressions than were outdoor levels, nor were personal absorbance or mass. We could not find a single component of fine particulate matter that would be mainly responsible for the health effects of particulate air pollution.

## **The effect of traffic-related air pollution on the respiratory health status of day-care-children in Tel-Aviv, Israel**

**Background:** Many epidemiological studies revealed the adverse health effect of traffic-related air-pollution on the respiratory health status of schoolchildren. Only few studies were carried out in pre-school children.

In 1999 we carried out two studies among children in Tel-Aviv: 1. Among schoolchildren. 2. Among day-care-children.

This presentation deals with the second study.

**Aims:** To evaluate the effect of traffic-related air pollution on the respiratory health status of Tel-Aviv 1-5 years old children.

**Methods:** A comparison between children residing in two areas of Tel-Aviv was carried out; The central area, exposed to traffic-related air-pollution, and the northern area, which was less-exposed. Prevalence of respiratory symptoms and diseases was compared.

The study tools were: 1. An ATS-NHLBI health questionnaire filled out by the parents. 2. Air-pollution monitoring stations. 3. Traffic counts.

**Results:** 540 children from 16 day-cares participated in our study; 299 of them lived in the exposed, and 241 lived in the less-exposed area. A trend of higher prevalence of respiratory symptoms could be observed among children residing in the exposed area. Standardized Odds Ratio (OR) values, were calculated from logistic models. OR for children living in the exposed area were: 1.40 for cough with cold, 1.93 for cough without cold, 1.51 for sputum with cold and 2.22 for wheezing most days and nights, compared with 1.0 for children living in the less-exposed area of Tel-Aviv.

Traffic counts, by car type, show that diesel-vehicles, which are the most polluting ones, consist about 11% to 18% of the traffic volume in the exposed area, and only about 8% in the less-exposed area.

NO<sub>x</sub> values, measured in community oriented monitoring stations, were higher in the exposed area.

## 11066 - Impacts of Diesel Traffic on Elemental Carbon and Fine Particles in Central London, UK

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Ambient PM<sub>2.5</sub> and elemental carbon (EC) concentrations were measured at two urban sites, Oxford Street and Hyde Park, in London to study the impacts of diesel exhaust particles (DEP) on air quality. On Oxford Street, the only vehicular traffic permitted during the daytime are the primarily diesel powered buses and taxicabs, thereby making the street's urban canyon type environment ideal for studying DEP. Comparatively, traffic impacts on PM<sub>2.5</sub> and EC concentrations in the 630-acre park, where motor-vehicles are prohibited, are substantially smaller. Furthermore, due to its' vast openness, the major influencing factor on the variation of PM<sub>2.5</sub> and EC is the weather, whereas, traffic is the major influencing factor on Oxford Street. We examined diurnal and day-to-day variations for PM<sub>2.5</sub> and EC at both sites. We used 37 mm quartz fiber filters to collect EC and PM<sub>2.5</sub> samples for integrated analyses, and an Aethalometer to measure real-time EC concentrations. The mean EC concentration was 11.7µg/m<sup>3</sup> (SD=3.8) for Oxford Street, similar to concentrations observed near heavily traveled freeways, and 2.7µg/m<sup>3</sup> (SD=1.1) in Hyde Park, comparable to typical urban/suburban background levels. The average PM<sub>2.5</sub> concentrations in Oxford Street and Hyde Park were 71.3µg/m<sup>3</sup> (SD=10) and 33.0µg/m<sup>3</sup> (SD=12.6) respectively. We observed peak EC concentrations on Oxford Street during the rush hours. The large difference in EC, but smaller difference in overall PM<sub>2.5</sub>, indicate that diesel traffic has larger impacts on EC than on fine particles. Diesel traffic impacts on other species (e.g., organic carbonaceous aerosols, PAHs) will also be assessed.

## 11045 - Spatial and Temporal Variation in Fine Particulate Concentrations in Seattle

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The extent of spatial variation in PM and the degree to which this variation is constant over time are important in designing and interpreting ecological studies of health effects. To measure this variation we analyse hourly nephelometry data collected outside the homes of participants in our panel study of PM and health outcomes. We have found that nephelometry is highly correlated with gravimetric measurements of fine particles in Seattle. The data were collected over ten\_day periods at 65 sites in Seattle, with most sites being used more than once, for a total of 20946 measurements. An analysis of variance gives standard deviations of  $.14 / (10^4 \text{ m}) \text{ bsp } [3\mu\text{g}/\text{m}^3]$  for variation in time adjusted for site and  $.069 / (10^4 \text{ m}) \text{ bsp } [1.4\mu\text{g}/\text{m}^3]$  for variations between sites adjusted for date. There is a pronounced twice\_daily cycle with peaks at 9am and 9pm and a range of  $0.15(10^4 \text{ m}) \text{ bsp } [3.2\mu\text{g}/\text{m}^3]$ . There is very little residual variation, suggesting that the daily cycle and the spatial pattern are approximately the same on different days. Stratifying the analysis by four substudies of the panel study yields similar results, as does restricting the analysis to sites with more than one ten\_day measurement period.

Different daily mortality dose-response relationships for PM10 from vehicles and wood fires

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Numerous time series studies have documented the effect of daily variations of PM10 on daily mortality. In a previous study of data for 1988-1993 such a relationship was also shown for Christchurch, New Zealand. Hot summer days also had an increased mortality due to heat. The air pollution situation in Christchurch has been studied in detail. PM10 in the winter primarily originates from wood fires for heating, and in the summer the source is almost exclusively motor vehicles. The particle size distribution and chemical composition of the particles has also been shown to be different in the two seasons. One centrally placed air monitoring station was used to indicate exposures. Christchurch is flat and has a hill on the southern boundary that limits escape of air pollutants from the area during calm nights.

Poisson regression time series analysis of daily air pollution, climate and mortality data was carried out using the APHEA protocol for the period 1988-1999. Hourly pollution and climate data were available for most hours, and missing data were modeled from climate data from another site in the city. Cold and hot temperature exposures were defined by variables for the minimum and maximum hourly temperature, respectively, and these were taken into account in the analysis of PM10 effects. Separate analysis for the winter period (May-August) and the summer period (September-April) showed that in the winter an increase of 10 ug/m<sup>3</sup> PM10 was related to a 1.2 % increase of total mortality (95% CI 0.36 – 2.0%) on the subsequent day. In the summer an increase of 10 ug/m<sup>3</sup> PM10 was related to a 3.4% increase of total mortality (95% CI 0.88 – 6.1%) on the same day. The difference in timing may be explained by the finding that in the winter the peak PM10 levels occur at 10-11 pm, and in the summer they occur at 9 am. The difference of the dose-response functions is likely to be due to the different sources and composition of the particles. PM10 emitted from vehicles appears to have a stronger daily mortality effect than PM10 emitted from wood fires. This is an unusual possibility to study the effects of different particles sources within the same population.

10974 - Comparing different exposure metrics in the relationship between air pollution and birth outcomes in California

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Studies suggest air pollution is linked to perinatal outcomes; however the geographic characterization of the exposure differs between studies. Nearly all studies rely on exposure measurements taken from someplace proximal to the mother's residence rather than personal monitoring devices. There has been little comparison of different spatial averages for estimating air pollution exposures in the assessment of birth outcomes. Given the cost and availability of routinely collected data, applying larger spatial averages of exposures to individuals in large units, such as incidence over a county, allows for easier surveillance and evaluation. We use data from the state of California to compare different methods of assessing exposure from monitoring data for evaluating the relationship between birth outcomes and air pollution. Data for infant births was obtained from the state of California and geocoded for residence of the mother. Geocoded data were linked to monitoring data for particulate matter 2.5 (PM2.5) and carbon monoxide (CO). For this comparison, mean infant birthweight was used as an outcome measure. For the air pollution exposure, we compared several methods of calculating air pollution for PM2.5 concentrations and CO concentrations: 1) a weighted average of all monitored values for mothers living near a PM2.5 and CO monitors, weighted by distance between residence and monitor; 2), the average values from the monitor closest the mother's residence; 3) the average all monitored values within a mother's county. In addition, we assessed the relationship using only county averages and country rates of birth outcomes to compare ecological analysis with individual level analysis. If the county level values are similar to the more precise exposure measurements, then studies with only county-level geography will be able to provide valid associations. On the other hand, if the estimated associations between birthweight and exposure differ by method of calculating exposure, then more precise exposure estimates will be needed, likely at higher cost.

Views presented are of the authors and not necessarily of US EPA or NCHS.

10958 - AIR MONITORING FOR THE EAST BAY CHILDREN'S RESPIRATORY HEALTH STUDY: TRAFFIC-RELATED POLLUTANT CONCENTRATIONS

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The East Bay Children's Respiratory Health Study is examining the effects of chronic exposure to traffic-related pollutants on respiratory health of 3<sup>rd</sup> and 4<sup>th</sup> grade children attending ten neighborhood elementary schools in the San Francisco East Bay Area (Hayward, San Leandro and Oakland, CA). The schools were selected so pollutant concentrations at some locations were more likely to be impacted by Interstate (I) 880 running through the area. Simultaneous measurements of multiple pollutants were made outdoors at the schools over 1-2 week intervals for 14 weeks in spring and ten weeks in fall, 2001. Metal cabinets housed active and passive monitoring equipment at each school. Particulate matter was sampled over all hours (24 h per day) or schools hours (7 h per weekday) with battery-operated programmable pumps and inlet devices for PM<sub>10</sub> and PM<sub>2.5</sub>. Fine particle mass and black carbon (BC) were determined from the collected filters. Nitrogen oxides (NO<sub>2</sub> and NO<sub>x</sub>) were measured with passive samplers. Gasoline-related volatile organic compounds (VOCs) were measured over four-week intervals with passive samplers. Carbon monoxide (CO) was monitored continuously with an electrochemical sensor. Ranges of study average values at individual schools were: NO<sub>x</sub>, 33-66 ppb; NO<sub>2</sub>, 18-31 ppb; PM<sub>10</sub> mass, 27-32 µg/m<sup>3</sup>; PM<sub>2.5</sub> mass, 12-15 µg/m<sup>3</sup>; and BC associated with PM<sub>2.5</sub>, 1.6-2.6 µg/m<sup>3</sup>. Although pollutant concentrations varied by season and week, the simultaneous sampling design allowed for comparisons of concentrations among schools during each interval. Concentrations of pollutants were normalized to their interval averages for all schools. Relative concentrations among schools were consistent for all weeks in both seasons, suggesting measured concentration differences represent ongoing conditions and chronic exposures in the vicinities of the schools. Figure 1 summarizes normalized NO<sub>x</sub>, NO<sub>2</sub>, PM<sub>2.5</sub> and BC<sub>2.5</sub> all-hour concentrations. Concentrations were highest at school 10, situated ~65 m from I880. Overall, downwind proximity to I880 had observable effects on NO<sub>x</sub>, NO<sub>2</sub> and BC. Little or no effect on particle mass concentrations was observed. Variations in pollutant concentrations throughout neighborhoods surrounding several schools are being investigated.

Table 1. Relative pollutant concentrations (mean and (std. dev.)) by school for all-hour samples.

Pollu- tant	School ID									
	1	2	3	4	6	7	8	5*	9*	10*
NO <sub>x</sub> n=18	0.85 (0.05)	1.13 (0.11)	1.00 (0.12)	0.82 (0.12)	0.78 (0.05)	0.67 (0.08)	0.92 (0.11)	1.26 (0.23)	1.17 (0.10)	1.42 (0.18)
NO <sub>2</sub> n=19	0.93 (0.04)	1.04 (0.08)	0.89 (0.09)	0.80 (0.09)	0.90 (0.06)	0.88 (0.08)	1.00 (0.10)	1.13 (0.08)	1.12 (0.11)	1.34 (0.17)
PM <sub>2.5</sub> n=10	0.98 (0.14)	1.13 (0.21)	0.96 (0.11)	0.93 (0.13)	0.99 (0.17)	0.92 (0.08)	0.99 (0.06)	0.95 (0.07)	0.97 (0.10)	1.20 (0.16)
BC <sub>2.5</sub> n=11	0.89 (0.08)	1.08 (0.06)	0.94 (0.14)	0.94 (0.07)	0.85 (0.06)	0.84 (0.06)	0.90 (0.06)	1.15 (0.12)	1.17 (0.11)	1.32 (0.21)

\*School within 300 m downwind of I880.

## **10957 - Effects of particulate air pollution on blood counts in patients with coronary heart disease**

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Epidemiological studies showed adverse effects of particulate air pollution on cardiovascular mortality and morbidity suggesting that individuals with cardiac disease are more susceptible to particulate air pollution than healthy individuals. Systemic effects might be based on alterations in the blood, secondary to pulmonary inflammation caused by particle deposition in the alveoli.

A panel study was conducted as part of the EPA Rochester particle centre to assess the association between daily variations in particulate air pollution and changes in biomarkers of inflammation in 58 patients with coronary heart disease in Erfurt, Germany between October 2000 and April 2001. The study protocol comprised 12 bimonthly clinical examinations with an interview, resting ECG, blood pressure measurement, urine sample and blood sample. Ambient exposure to particulate air pollution was measured at a central site using an aerosol spectrometer covering the size range from 10 nm to 2.5 µm. Fixed effect linear regression models were used to assess the association between 24-h mean concentrations of ultrafine particle number (particles < 0.1 µm) and fine particle mass concentrations (particles < 2.5 µm) and blood cell counts. Effects were adjusted for trend, weekday, temperature and relative humidity. Out of 681 observations 514 observations had complete information on all covariates.

Mean ultrafine particle number and fine particle mass concentrations were 13400/cm<sup>3</sup> and 16 µg/m<sup>3</sup> respectively. Results indicate a decrease in red blood cells (RBC) in association with fine particle mass (PM<sub>2.5</sub>) and ultrafine particle counts (UP). The decrease in RBC was strongest for the ultrafine particles at lag 4 with an effect estimate of  $-0.03 \times 10^6/\mu\text{l}$  RBC 95%CI(-0.06 to 0.003) per increase of 10000 UP per cm<sup>3</sup>. The hematocrit showed results consistent with those observed for the red blood cells. However, the results were not statistically significant. Total white blood cell counts (WBC) also decreased in association with ambient particle concentrations. For an increase of 10000 UP per cm<sup>3</sup> a decrease of 260 (p<0.05) WBC per µl was observed for lag 1 and a decrease of 300 (p<0.05) WBC per µl for lag 4. Fine particle mass showed a significant, but smaller effect for lag 4 than particles in the ultrafine range.

The results indicate a systemic response to ambient fine and ultrafine particles in patients with coronary artery disease. The decrease in red blood cells is consistent with findings of Seaton et al. (1999) suggesting peripheral sequestration of red blood cells as a possible explanation for cardiovascular effects. However, the underlying mechanisms as well as the pathophysiological significance of these findings need further elucidation.

**Modelling NO<sub>2</sub> dispersion for a health impact study in the city of São Paulo, Brazil**

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Air pollution in Sao Paulo has been constantly measured by the State Environment Agency, mainly by fixed monitoring stations, but there is no detailed inner city information over the variation between places with different traffic densities. This study intended to identify a gradient of dispersion of the traffic-related air pollution that could help to classify exposure and eventually correlate it with adverse health effects.

We measured NO<sub>2</sub> concentration, as an indicator of traffic-related air pollution, using Palmes diffusion tubes in a sample of 36 sites located on streets chosen to be representative of different road shapes and traffic densities in Sao Paulo. Measurements were done in two one-week periods during winter-time (July and August 2000) when it is expected the highest background pollution in the city. The Palmes tubes were prepared by the Environmental Health Department, Wageningen University (WAU), The Netherlands. In each study period, two tubes were installed in each of the 36 sampling sites, being that two additional tubes were also installed in a subsample of 10 sites. The NO<sub>2</sub> concentration was determined by a spectrophotometric Saltzman reaction. The tubes of the sample were analysed in the laboratory of the Faculty of Public Health, University of São Paulo (USP), Brazil, and the tubes of the subsample in the WAU laboratory following a standardized quality control protocol. Average concentrations of NO<sub>2</sub> were estimated for two traffic density strata (heavy and local) defined by the city Traffic Engineering Company. Statistical analyses included t test and intra-class correlation coefficient.

The overall average concentrations of NO<sub>2</sub> were 62.84µg/m<sup>3</sup> (95% CI: 58.17µg/m<sup>3</sup> – 67.51µg/m<sup>3</sup>) and 49.03µg/m<sup>3</sup> (95% CI: 44.84µg/m<sup>3</sup> – 53.22µg/m<sup>3</sup>) in the first and second sampling periods, respectively. When the sites were divided by the traffic density, we found: heavy traffic (n = 19): 63.27 µg/m<sup>3</sup> (95% CI: 58.27µg/m<sup>3</sup> – 68.28µg/m<sup>3</sup>); local traffic (n = 17): 47.12 µg/m<sup>3</sup> (95% CI: 42.37µg/m<sup>3</sup> – 51.87µg/m<sup>3</sup>) (*p*<0.001). The intra-class correlation coefficient, used to assess the agreement between the duplicate tubes analysed in São Paulo, was 0.82 (95% CI: 0.70 – 0.93) in the first sampling period and 0.89 (95% CI: 0.82 – 0.96) in the second. When the two laboratories were compared, we found the following intra-class correlation coefficients: 0.94 (95% CI: 0.87 – 1.00) and 0.82 (95% CI: 0.62 – 1.00) for the first and second sampling periods, respectively.

The use of Palmes tubes is a sound technique to identify different levels of NO<sub>2</sub> in São Paulo, with a good repeatability and reproductibility. The differences in NO<sub>2</sub> levels between heavy and local traffic sites are great enough to suggest the use of a more refined classification of exposure in epidemiological studies in the city.

**Personal Exposures to PM<sub>2.5</sub> and Black Carbon Among NYC Youth: Influences of Temporal and Spatial Factors**

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The TEACH study characterized exposures to urban air toxics among inner-city high school students in NYC and Los Angeles. The study involved personal, home indoor, home outdoor, central-site urban outdoor, and upwind outdoor monitoring for PM<sub>2.5</sub>, VOCs, and aldehydes. PM<sub>2.5</sub> samples are collected for 48 hours on Teflon membrane filters using 4 L/min cyclones. PM<sub>2.5</sub> filters are also analyzed for reflectance and a suite of elements. Reflectance, reported as a trace metal clean absorption coefficient (Abs<sub>TMC</sub>), has been shown to be a convenient surrogate for elemental carbon (r=0.90). Elemental carbon particles are emitted in large quantities by diesel vehicles. Here we focus on personal exposures to PM<sub>2.5</sub> and Abs<sub>TMC</sub> among 32 subjects measured in NYC in both winter and summer. In each season, up to five different students were measured simultaneously each week over a 7-8 week monitoring campaign. Central site monitoring on the school roof in Harlem provided a measure of temporal variations in concentrations. Home outdoor measurements for subjects provided a measure of spatial variations in concentrations. Personal exposures to both PM<sub>2.5</sub> and Abs<sub>TMC</sub> were associated with the school roof levels, suggesting that a portion of the variations in personal exposures is driven by temporal changes from week to week in ambient levels, consistent with recent studies. For Abs<sub>TMC</sub>, there was evidence of an additional influence of home outdoor concentrations, suggesting a spatial driver as well, possibly related to local diesel traffic density. These results illustrate the potential influences of both spatial and temporal factors on personal exposures to black carbon among NYC youth.

10891 - DIMINISHED LUNG FUNCTION IN YOUNG ADULTS IS ASSOCIATED WITH LONG-TERM PM10 EXPOSURES: PL Kinney and E Chae, Mailman School of Public Health at Columbia University, New York, NY, USA.

We previously reported associations between long-term ozone exposures and diminished lung function in a cohort of 1496 non-smoking first year Yale University students (745 male; 751 female). No particle exposure data were available in that analysis. In an effort to address the possible role of long-term particle exposures in compromising maximally attained lung function in young adults, we obtained PM10 data from the USEPA AIRS database for US monitoring sites in operation from 1986-1997. Data were averaged within years and extrapolated to previous, unmeasured years using a linear regression on annual concentrations during the available time period. Upon recruitment, lung function was measured and residential histories obtained by questionnaire on each subject. PM10 concentrations were interpolated to residential locations for each year of life using data from the three nearest monitoring sites. These residential concentration estimates were then averaged over all years of life (and all corresponding residential locations) for each subject to obtain subject-specific long-term PM10 exposure estimates. Similar procedures were used for ozone exposure estimation. Height-, race-, and sex-adjusted lung function (FVC, FEV1, FEF75, and FEF2575) were analyzed via multiple linear regression on estimated life-time PM10 and ozone exposures, while controlling for body size, sex, race, SES, and long-term ETS exposures, obtained from questionnaire. PM10 but not ozone was associated with diminished lung function. These results suggest that the deleterious effects of PM on lung function may persist into the young adult years, when lung function growth nears its lifetime maximum.

10889 - PREDICTORS OF PERSONAL PAH EXPOSURES  
AMONG MINORITY WOMEN IN NEW YORK CITY:  
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As part of a multi-year birth-cohort study examining the roles of environmental factors in adverse birth outcomes, developmental deficits, and asthma among children, we measured personal exposures to polycyclic aromatic hydrocarbons (PAHs) among 350 pregnant women in Northern Manhattan and the South Bronx. Non-smoking women of African American and/or Hispanic race/ethnicity were identified and recruited at prenatal clinics at Columbia Presbyterian Medical Center and the Harlem Hospital Center. During the third trimester of pregnancy, each subject was monitored for one 48-hour period using battery-operated pumps attached to PM<sub>2.5</sub> cassettes containing quartz filters and polyurethane foam (PUF) samplers. Filters and PUF samples were extracted together and analyzed for PAH concentrations by GC/MS. Data were collected on indoor source factors – including smoking and cooking pattern - by questionnaire. Data on traffic volumes from major roadways was obtained from NY State sources and linked via GIS with residential locations. We evaluate predictors of personal exposure in a multiple regression model including exposure to environmental tobacco smoke (ETS), workplace exposures, housing characteristics, neighborhood and census tract level characteristics, nearby point sources of pollution,

and proximity of residence to traffic. The information gleaned from this effort could aid in further identification of sources of PAH exposure to be targeted in future interventions to reduce and ultimately prevent risks posed from environmental exposures.

*10867 - Geographies of Susceptibility in the Air Pollution-Mortality*

*Association: A Zonal Time Series from Hamilton, Canada*

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## **Abstract**

**Background:** Numerous time series studies have found significant associations between ambient air pollution and mortality. All of these studies have used central monitor or regional average pollution estimates that assume homogenous ambient concentrations over the entire urban area. This assumption of spatial homogeneity may be incorrect for some pollutants, leading to exposure misclassification. More important and less explored than spatial variation in pollution exposure is the location of susceptible individuals and groups who may also display intra-urban spatial patterns. Assessment of intra-urban associations based on local estimates may reduce possible bias due to exposure misclassification and failure to account for effect modifiers with local spatial patterns.

**Objective and Hypotheses:** The objective of this research is to assess the short-term association between air pollution and mortality within different zones of an industrial city. The key hypotheses are that (1) risk patterns in the zones will differ from the aggregate citywide or regional estimates, and (2) zones with lower social status will have larger pollution effects than zones with higher social status.

**Methods:** Hamilton was divided into five zones based on Thiessen polygons that used the pollution monitors as the central nodal point. Within each zone, daily counts of non-trauma mortality and pollution estimates were combined. Generalized Additive Models were run to test associations between sulfur dioxide and particulate air pollution measured by the coefficient of haze, while controlling for the confounding influences of weather, temporal trends, and serial autocorrelation in the mortality data.

**Results and Conclusions:** Two areas of relatively high social status show no significant effects for particles, while the remaining zones have relative risks (RR) that are higher than the estimates derived from a citywide model. The zone with the highest pollution effects has a significant RR of 1.17 for a multi-day lag evaluated at the regional mean of pollution. This is about three times greater than the RR of 1.06 for the citywide estimate for the most significant multi-day lag. Although these differences appear large, tests for heterogeneity using a maximum likelihood random effects model did not support the hypothesis of significant differences among the zones. The pooled effect from five zones roughly equals with citywide effect. The pollution effect, however, appears to be associated with the social characteristics of the zones. Manufacturing employment showed the strongest association, but smoking rates, access to emergency health care, and educational levels also correlate with the size of the zonal pollution effect. Thus, our findings support the second hypothesis of sociodemographic effect modification.

**Keywords:** air pollution, mortality, time series, social factors, spatial analysis, GIS, Hamilton

## 10847 - The Contribution of Combustion Source Particulate Air Pollution to the Global Burden of Disease

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As part of the World Health Organization's (WHO) Global Burden of Disease Comparative Risk Assessment, attempts will be made to quantify the worldwide effects of 20 major risk factors, including ambient air pollution. Over the last decade, epidemiologic studies have identified serious health effects, including mortality, from exposure to combustion-derived air pollution, at ambient concentrations currently experienced in cities in the wealthy, developed countries of Western Europe and North America. At the same time, the populations of the rapidly expanding mega-cities of Asia, Africa and Latin America are increasingly exposed to levels of ambient combustion-related pollution that are often two or three times the levels experienced in the developed countries. Therefore, the global health impacts of current exposure to air pollution are likely to be considerable. Quantifying these impacts presents substantial challenges due to limited information on both air pollution concentrations and concentration-response functions in many parts of the world. Impact estimation on a world scale requires that these limitations be addressed by estimation and extrapolation from existing data based on well-justified assumptions. An international working group is deriving such estimates in terms of premature mortality resulting from exposure to particulate matter from combustion sources (measured as PM<sub>10</sub>). This is the health outcome for which the worldwide evidence is most extensive, and for which baseline occurrence rates, which are necessary to generate global estimates, are available for all countries (not the case for other outcomes associated with air pollution). Mortality is also the endpoint that would be expected to exert the most influence on Disability Adjusted Life Years (DALYs), the impact estimator used in the WHO Risk Assessment. The group will develop estimates of annual average concentrations of PM<sub>10</sub> for all cities in the world with populations greater than 100,000, using both ambient air quality measurements and estimates based

on models of economic activity. Risk coefficients will be developed and applied to these data, based on evidence from a large US cohort study of adults, and from studies of respiratory disease mortality in developing countries, to estimate reductions in life expectancy for adults and children (<5 yr.), respectively. In addition, the global number of attributable deaths will be estimated from time-series studies of daily mortality, based on results of a meta-analysis of the world literature. We will also critically evaluate the assumptions we have made to derive our estimates including: (1) the ability to transfer concentration-response functions; (2) the truncation of the relevant range of PM10 concentrations; and (3) the use of PM10 as a general marker of combustion-source pollution.

10768 - Association between Air Pollution Exposure and Exhaled Nitric Oxide in an Eldery Panel

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Previous studies have shown that the measurement of nitric oxide (NO) concentrations in expired air may represent a noninvasive measure of lower airway inflammation. Specifically, exhaled NO (eNO) has been shown to be a marker of inflammation in chronic cough, COPD and asthma. To examine the potential role of air pollution exposure in contributing to lung inflammation, we investigated the relationship between air pollution exposure and eNO in a panel of 29 elderly non-smoking subjects (median age of 72) in Steubenville, Ohio between September and December 2000. Breath samples were collected once weekly for each of the subjects and analyzed using a chemiluminescence monitor. At each session, room air samples were also collected for NO analysis, to correct for possible breath sample contamination. Ambient air sampling was conducted at a central site in Steubenville and included continuous measurements for PM<sub>2.5</sub>, along with meteorological parameters. Longitudinal analyses were performed on the repeated eNO measures, adjusting for individual subject variation. After controlling for time trend, day of the week, hour of the day, nitric oxide in the study room, ambient barometric pressure, temperature and relative humidity, an interquartile range increase in the mean PM<sub>2.5</sub> concentrations during the prior 24 hours was associated with an increase in eNO of 1.46 ppb (95% Confidence Interval [CI]: 0.29 – 2.63 ppb). This represents approximately a 15 % change when compared to the mean eNO in the cohort. We also observed a significant association for a 4-hour moving average (1.05 ppb increase, 95% Confidence Interval [CI]: 0.22 – 1.87 ppb). The relative importance of these two exposure periods on eNO is unclear due to their comparable explanatory power. These results suggest that eNO may represent a useful marker of pulmonary inflammation in future epidemiological studies of air pollution. Acknowledgement: This work was supported by NIEHS ES-00002, NIH 1P01E-ES09825-01, EPA R82-6780-010 and the Harvard-EPA Particle Health Effects Center.

10728 - SHORT-TERM EFFECTS OF AIR POLLUTION ON HEALTH: ARE THOSE OLDER THAN 65 YEARS A SENSITIVE SUB-GROUP?

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Within the framework of the APHEA2 project (Air Pollution and Health: a European Approach), a thirty city study investigating short-term health effects of air pollution, we assessed the effects of ambient particles (PM<sub>10</sub> and Black Smoke) and gaseous pollutants (NO<sub>2</sub>, SO<sub>2</sub>, CO and Ozone) on mortality among those older than 65 years. Twenty nine cities provided the number of daily deaths for the elderly for at least 4 years in the 90's. All cities provided daily measurements for ambient particles, either as PM<sub>10</sub> or Black Smoke, and for NO<sub>2</sub>, SO<sub>2</sub>, CO and Ozone as available. Data on several confounders (including other pollutants and meteorological variables) and on effect modifiers (variables characterizing each city's population, climate, environment and geography) were also provided. For the analysis, a hierarchical modeling approach was adopted implemented in two stages: in the first stage, the data from each city were analyzed separately using generalized additive Poisson regression models. Adjustment was done for seasonality, temperature, humidity, influenza epidemics, day of the week, holidays and other important city specific events. In the second stage, regression models were applied to explore between city heterogeneity and to combine the effects. The results from the second stage analysis show that the daily number of deaths among the elderly increases by 0.8% (95% CI: 0.7-0.9%) per 10µg/m<sup>3</sup> increase in PM<sub>10</sub>; by 0.6% (95% CI: 0.5-0.8%) per 10µg/m<sup>3</sup> increase in Black Smoke; by 0.72% (95% CI: 0.59-0.85%) per 10µg/m<sup>3</sup> increase of SO<sub>2</sub>; by 0.37% (95% CI: 0.32-0.42%) per 10µg/m<sup>3</sup> increase of NO<sub>2</sub>; by 1.13% (95% CI: 0.96-1.31%) per 1mg/m<sup>3</sup> increase in CO; whilst for ozone, effects are only observed during the summer season when a 10µg/m<sup>3</sup> increase in ozone concentration is associated with 0.31% (95% CI 0.20-0.43) increase in the daily number of elderly deaths. Effect modifiers have been identified for the above associations. The effects of air pollutants on the elderly are higher than those observed for all age mortality and mortality among the younger age groups.

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## 10724 - Stationary measurements of air pollutants in two areas with different heating systems in Sweden

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**Introduction** Domestic wood burning is considered to make up for a considerable part of the emissions of particles and polycyclic aromatic hydrocarbons (PAHs). The guideline from WHO regarding benzo[a]pyrene is set to 0.12 ng/m<sup>3</sup> (excess lifetime cancer risk, 1/100 000). Phenanthrene and fluoranthene, being representative for all sources, are two of the more abundant PAHs in ambient air and thus of great importance for human exposure. Fluoranthene, less potent as a carcinogen but present at a higher level, has a proposed guideline value at 2 ng/m<sup>3</sup>.

**Methods** Stationary measurements were carried out on two different locations in the small town Hagfors, one district heating area and one where domestic wood burning is common. Particles were monitored continuously during three days for a period of six weeks (n=24). PM<sub>10</sub> and PM<sub>2.5</sub> were collected on filters using the IVL sampling method (18 L/min) and Kleinfiltergerät (38.3 L/min), respectively. The filters were weighed in a climate chamber and analysed for Black Smoke (BS) using reflectance analysis. Active PAH-sampling (2 L/min) was performed with a personal sampling equipment containing a glass fibre filter and polyurethane adsorbent, in order to include PAHs in both the particulate and gaseous phases. Sampling was carried out during three consecutive days (n=12). The PAHs were then determined by GC-MS in SIM mode.

**Results** Similar levels for PM<sub>10</sub>, median about 8 µg/m<sup>3</sup>, were found for both areas. The levels for PM<sub>2.5</sub> were, however, higher in all sampling periods in the wood burning area compared to the district heating area (p=0.0005). The median for PM<sub>2.5</sub> was 4.5 µg/m<sup>3</sup> (range 2.8-8.1) for the district heating area, and 6.2 µg/m<sup>3</sup> (range 3.9-10.1) for the wood burning area. For phenanthrene the median was 5.0 ng/m<sup>3</sup> (range 3.4-9.0) in the area with district heating, and 10.5 ng/m<sup>3</sup> (range 7.7-11.0) for the wood burning area. The corresponding values for fluoranthene were 1.6 ng/m<sup>3</sup> (range 0.9-2.3) and 3.4 ng/m<sup>3</sup> (range 2.6-4.0). For both these PAHs, levels were significantly higher (p<0.01) in the wood burning area. Benzo[a]pyrene was successfully monitored during two sampling periods only, and the levels were 0.036 and 0.066 ng/m<sup>3</sup> for the wood burning area and 0.033 and 0.034 ng/m<sup>3</sup> for the area with district heating. Analysis of BS as a supplementary indicator of particulate outdoor air pollution also revealed significantly higher levels in the wood burning area (p<0.01).

**Conclusions** Somewhat higher levels of fine particles (PM<sub>2.5</sub>) and about twice the levels for phenanthrene and fluoranthene were found in the area where wood burning is commonly practised compared to the area with district heating.

10671 - Short-term effects of air pollution on daily hospital admission in Pécs, Hungary

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Short-term effects of air pollutants: total suspended particles (TSP), NO<sub>2</sub>, SO<sub>2</sub> and CO on the daily respiratory and cardiac emergency hospital admission in the total population have been investigated in Pécs, a city with 157 000 inhabitants following the methodology of APHEA2 project. Emergency hospital admission morbidity data were collected for 1997-1999 years from the Centre of Health Care Information, Ministry of Health. The effect of a mean concentration of NO<sub>2</sub> and SO<sub>2</sub> measured at 4 points, CO and TSP measured at 2 points was studied. The data were analyzed using generalized additive models separately for the summer and winter periods using slightly different models for the 2 types of periods. In the models adjustment was done for years, months, days, daily mean temperature, humidity, day of the week using a smooth function of the confounders, and for influenza epidemics (days above the 98 percentile of respiratory admissions were excluded). The effect of air pollutants were studied on different lag days. Significant associations were found in the summer period for an interquartile increase in TSP (28 µg/m<sup>3</sup>) concentration on lag1 day with cardiac admissions (RR 1,11; 95 % CI: 1,01-1,22) and with respiratory admission on lag0 day (RR 1,08; 95 % CI: 1,01-1,15)-of NO<sub>2</sub> (interquartile range 15 µg/m<sup>3</sup>) cardiovascular morbidity on lag3 day (RR 1.13; 95 % CI: 1,03-1,24) and CO (interquartile range 0,65 mg/m<sup>3</sup>) with respiratory morbidity on lag0 day (RR 1,09, 95% CI 1,01-1,17). In the winter period, a significant effect of NO<sub>2</sub> and CO on lag3 days (RR 1.05; 95 % CI: 1,00-1,10) respectively (RR 1.06; 95 % CI: 1,01-1,08) was detected on respiratory morbidity. SO<sub>2</sub> concentration did not effect morbidity on a significant level.

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## 10663 - Trends in Short-Term Air Pollution Characteristics

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Recent air pollution epidemiology studies have suggested associations between certain adverse effects and short-term air pollution. While improvements have been seen in the long-term air pollution trends, it is not clear if the same conclusion applies with the short-term pollution characteristics. In this study, ambient monitoring data from a mid-sized city in Taiwan were examined for short-term air pollution characteristics. Hourly observations between 1994 and 2000 were calculated for daily and annual average concentrations for PM<sub>10</sub>, SO<sub>2</sub>, NO<sub>2</sub>, CO and O<sub>3</sub>. In addition, daily maximum 1-hour average concentrations for SO<sub>2</sub>, NO<sub>2</sub> and O<sub>3</sub>, and daily maximum 8-hour average concentrations for CO and O<sub>3</sub> were calculated. Short-term air quality standards were used to identify “high pollution” conditions. A high-pollution event is defined as a contiguous period with the hourly, 8-hour or daily average concentrations above the “threshold” value. Contiguous records above the threshold value were treated as one event, and each event duration was calculated and recorded. The results showed that for the study location, the ambient SO<sub>2</sub>, CO and NO<sub>2</sub> levels were far below the regulatory limits, and the annual average concentrations were decreasing over the years. The annual average PM<sub>10</sub> concentrations were also within the regulatory standard and decreasing slightly over the years. However, the daily average concentration limit for PM<sub>10</sub> (125 µg/m<sup>3</sup>) was exceeded on 52 days in 42 events. The maximum daily average PM<sub>10</sub> concentration increased from 167 mg/m<sup>3</sup> in 1994 to 198 mg/m<sup>3</sup> in 2000. The high PM<sub>10</sub> concentration events lasted only 1-2 days in earlier years, but a 3-day and a 4-day event was seen in 1998 and 1999, respectively. For O<sub>3</sub>, the average concentrations showed a small increase over time at an average rate of 0.65 ppb per year. The hourly O<sub>3</sub> concentrations exceeded the 1-hour standard of 120 ppb in 42 hours on 22 different days, with the maximum 1-hour concentration rising from 118 ppb to 161 ppb over the years. The number of hours with 1-hour O<sub>3</sub> concentration above the standard increased slightly over the years, and the maximum duration increased from 3 to 5 hours. The 8-hour average O<sub>3</sub> concentrations exceeded the 60 ppb standard 916 times on 184 days, with higher maximum values in later years. The maximum event duration with the 8-hour average O<sub>3</sub> concentrations above the standard was from 10 hours in 1993 to 16 hours in 2000. When considering only the daily maximum 8-hour average concentrations, the occurrences also increased in recent years and lasted longer in consecutive days. The results suggested that, despite the improving trend in long-term concentrations for most criteria air pollutants, the short-term O<sub>3</sub> and PM<sub>10</sub> concentrations might be increasing and the high-pollution conditions lasting longer. Whether and how these changes might have caused different adverse health effects warrant further explorations.

10658 - The lag structure of ambient air pollution on daily mortality in Seoul, KOREA.

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#### A b s t r a c t

**Objective:** To assess differences in the lag structure pattern between PM<sub>10</sub> and cause-specific mortality in Seoul, Korea from Jan. 1995 to Dec 1999, we performed a time series analysis.

**Methods:** We used a generalized additive Poisson regression model to control for time trends, temperature, humidity and the day of the week. The PM<sub>10</sub> effect was estimated based on the time series models using the 24 hour means and the quadratic distributed lag model using cumulative 6-day effect. To evaluate lag effect pattern in detail, we calculated 24 hour means starting from various time points. 0 hour lag starts from 0:00 on the corresponding day, 6 hour lag starts from 18:00 on the previous day, and 12 hour lag starts from 12:00 on the previous day,... etc. And they lasts for 24 hours. 6, 12, 18, ..., 72 hour lags were calculated and used to get the estimated effects and AIC's in the models.

**Results:** The maximum or comparatively large effects with small AIC were observed in the 12 hour lag for nonaccidental mortality (3.2%, 95% CI: 2.2, 4.1), - excess mortality is associated with 1 Inter Quartile Range (=43.12 micro gram per cubic meter) increase of PM<sub>10</sub>. -, 18hr lag for pneumonia (12%, 95% CI: 4.7, 19.7), 42hr lag for all cardiovascular deaths (3.1%, 95% CI: 0.2, 6.1), 6hr lag for stroke (3.1%, 95% CI: 1.0, 5.6). 1 IQR increase in the 6-day cumulative mean of PM<sub>10</sub> was associated with increase in deaths due to nonaccidental mortality (3.7%, 95% CI: 2.1, 5.4), pneumonia (17.1%, 95% CI: 4.1, 31.7), cardiovascular deaths (4.4%, 95% CI: -1.0, 9.0), and stroke

(6.3%, 95% CI: 2.3, 10.5). When the distributed lag was assessed, the patterns of lag effect were similar to them of series of time series models with 24 hour means.

Conclusions: Lag period of stroke was the shortest. And the lag of pneumonia was shorter than that of cardiovascular deaths. The lag pattern from the series of time series analyses was similar to that from distributed lag models. These results contribute to the efforts in understanding how exposure to air pollution causes adverse health effects.

**10652 - Climate, Traffic-related Air Pollutants, and Allergic Rhinitis Prevalence in Middle School Children in Taiwan**

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The prevalence of allergic rhinitis has been increased in the past decades. However, environmental factors associated with such increase are not clearly documented. This study was conducted to examine the effects of climate factors and air pollutants on the prevalence of allergic rhinitis in adolescents in Taiwan. A nation-wide survey in middle school students in Taiwan was conducted from 1995 to 1996. The lifetime prevalence of physician-diagnosed allergic rhinitis and of typical symptoms of allergic rhinitis were compared with air monitoring station data of month-average temperature, relative humidity, sulfur dioxide, nitrogen oxides, ozone, carbon monoxide, and particulate matter with aerodynamic diameter less than 10 micrometer (PM<sub>10</sub>). A total of 331,686 non-smoking children attended schools located within two kilometers of 55 stations. Prevalence rates of physician-diagnosed allergic rhinitis were 28.6% and 19.5% in boys and girls, respectively, with prevalence rates of questionnaire-determined allergic rhinitis 42.4% and 34.0%. After adjusted for age, history of atopic eczema, and parental education, prevalence rates of physician-diagnosed allergic rhinitis in both boys and girls were found to be associated with non-summer (September to May) warmth (Estimate = 2.30 and 1.71; 95% CI = 0.23-4.37 and 0.05-3.36) and traffic-related air pollutants

(Estimate = 2.92 and 2.21; 95% CI = 1.03-4.81 and 0.69-3.73), including carbon monoxide, nitrogen oxides, and ozone. However, prevalence rates of questionnaire-determined allergic rhinitis were only correlated with traffic-related air pollutants. Our results suggested that non-summer warmth and traffic-related air pollution were risk factors of allergic rhinitis in Taiwanese children.

10628 - EVALUATION OF A REFINED EXPOSURE ASSIGNMENT IN AN AIR POLLUTION TIME-SERIES STUDY.

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There is concern that current effect estimates in air pollution time-series studies may be biased downward or estimated with poorer precision due to exposure measurement error. This study investigated the extent to which a refined exposure assignment effected the magnitude and precision of associations of air pollutants and daily hospital admissions for ischemic heart disease (IHD). Spatial confounding in the resulting multiple time-series designs was also investigated. The study population consisted of members of a large health maintenance organization (HMO) in Southern California from 1988 to 1995. Residential address was known for all members. As many as 30 pollutant monitors in the South Coast air basin (SoCAB) were available to estimate daily exposures to ozone (O<sub>3</sub>), carbon monoxide (CO), nitrogen dioxide (NO<sub>2</sub>) and particulate matter (PM<sub>10</sub>). PM<sub>10</sub> was measured every 6<sup>th</sup> day. Each member was assigned to a 10 x 10 kilometer grid based on their residential zip code. Up to 3 stationary monitors were used with distance-weights to estimate daily exposures in each grid. Three exposure assignment methods, each with successively larger geographic areas, were compared. The most refined method included 57 geographic groups, each containing 1 to 3 grids. In another method, each grid was assigned to one of 7 regions based on its weather profile. The least refined exposure assignment assigned one daily exposure for the entire study area. In each case, exposures were weighted by the number of HMO subscribers in each grid. Both the group- and region-based assignments had multiple time-series which necessitated adjustment for spatial confounding. Both CO and NO<sub>2</sub> were associated with admissions with each method. Effect estimates for these pollutants increased as the geographic area over which exposure was averaged, increased. After adjustment for day of week, study year and smoothing splines for day of study, temperature and relative humidity and, in the group analysis, a fixed effects term for exposure group to adjust for spatial confounding, a 1 ppm increase in same-day CO was associated with a 1.11% increase in daily IHD admissions (95% CI=0.47-1.74) in the group analysis and a 2.79% increase (95% CI=2.09-3.50) in the analysis which used a single daily exposure. PM<sub>10</sub> was associated with admissions only when the study area was analyzed as a single time-series. There were no large differences in the precision of effect estimates for any of the pollutants. Furthermore, broad adjustments for spatial confounding resulted in severely biased estimates in the group-based analyses. In this study, refined exposure assignments did not result in greater magnitude of effect estimates and increases in precision were small.

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10613 - A preliminary study to assess the role of PM<sub>2.5</sub> elemental composition and elemental carbon content on heart rate variability

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Introduction: Environmental exposure to PM<sub>2.5</sub> has been associated with acute reductions in heart rate variability (HRV), however it is currently unknown if such changes can be partly explained by particle composition. We therefore analyzed the changes in HRV of an elderly panel based on the element composition and elemental carbon (EC) content of environmental exposure to PM<sub>2.5</sub> Methods: Participants from two nursing homes, located in the northern and southern areas of the Mexico City Metropolitan Area (MCMA) participated in the study. Every participant underwent spectral analysis of HRV every other day at the nursing home. Simultaneously, 24 hr indoor and outdoor PM<sub>2.5</sub> averages were obtained. PM<sub>2.5</sub> elemental composition was obtained by XRF analysis and EC was determined by optical density. A random effects model adjusting for age, gender and hypertension was used to estimate the effects of PM<sub>2.5</sub> mass and EC content on HRV. Element composition effects on HRV-high frequency component (HF) were analyzed using principal component analysis. Results: A panel of 72 non-smoking participants 65 years or older underwent a total of 1742 HRV tests over a period of 6 months. The Concentrations of PM<sub>2.5</sub>, EC content and presence of metals in particulates were highest in the nursing home located in the north part of MCMA were the largest reductions in HRV were seen in association with PM<sub>2.5</sub> mass. Elemental carbon in PM<sub>2.5</sub> was independently associated with reductions in HF-HRV only for the nursing home in the south of the MCMA which is located less than 30 ft from a heavily transited avenue ( $\beta = -.44$  [-.81, -.063] for 10 $\mu\text{g}/\text{m}^3$  of PM<sub>2.5</sub>) The presence of metals (aluminum, zinc, lead & iron) was significantly associated with reductions in HRV in the North, and with borderline reductions in the South. Conclusions: The presence of certain metals and EC content in PM<sub>2.5</sub> may be associated with changes in HRV independently of the PM<sub>2.5</sub> mass.

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10602 - AUSTRALIAN STUDY: The impact of air pollution on daily mortality and morbidity in  
Brisbane

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**ABSTRACT**

This paper presents preliminary results from the project funded by the Australia Research  
Council for 2001-2002: *The assessment of the impact of air pollution on daily mortality and  
morbidity in Australian cities using a protocol based on international benchmarking.*

**Objectives:** The National Environment Protection Council (NEPC) has recently set national air quality health  
standards based primarily on overseas epidemiological studies; there were few Australian studies. This project  
has developed a research protocol, using international benchmarking with USA and European (APHEA) groups,  
to address these issues in estimating the associations between air pollution and daily mortality and morbidity in  
Australian cities. Here preliminary results for Brisbane are presented.

**Methodology:** The study uses a standardised time series methodology (using GAMs) for  
studies of the acute effects of air pollution on daily mortality and daily hospital admissions in  
Melbourne, Brisbane and Perth. Hospital admissions data have been categorized as respiratory  
admissions, admissions for asthma and cardiovascular admissions for the following age  
groups; 0-4, 5-14, 15-64, >65 and total. Mortality data will be aggregated into broad  
categories of respiratory mortality, cardiovascular mortality and total mortality, with broad  
age groups (<65, 65+, Total). The pollutants considered include particles (nephelometer,  
PM<sub>10</sub> and PM<sub>2.5</sub> data), ozone, nitrogen dioxide, and carbon monoxide. The confounding  
effects of meteorology will be modelled using various lags and transformations of  
temperature, dew point temperature, relative humidity and rainfall.

**Results:** Preliminary results for Brisbane indicate that particles in particular affect mortality  
and morbidity, with nitrogen dioxide having significant impacts. Ozone has impacts on  
respiratory admission, particular in summer. These results agree with earlier studies in  
Brisbane but are in contrast with the studies in some other Australian cities.

**Conclusions:** The results suggest that further studies on sub-tropical cities such as Brisbane  
comparing them with mid-latitude cities may be needed. Air pollution clearly has an impact  
on health outcomes but there appear to be regional differences for the impacts of different  
pollutants.

**PM<sub>2.5</sub> Assessment at 21 Study Centers of ECRHS II  
(European Community Respiratory Health Survey II)**

Hazenkamp-von Arx M. E. (1), Oglesby L. (1), Ackermann-Liebrich U. (1), Sunyer J. (2), Heinrich J. (2), Poli A. (2), Bono R. (2), Luczynska Ch. (2), Forsberg B. (2), Norbäck D. (2), Pfeifer A. (2), Soon A. (2), Künzli N. (1) on behalf of ECRHS II

(1) Institute of Social and Preventive Medicine, University of Basel, Switzerland

(2) On behalf of Working Group Air Pollution & Health of ECRHS II

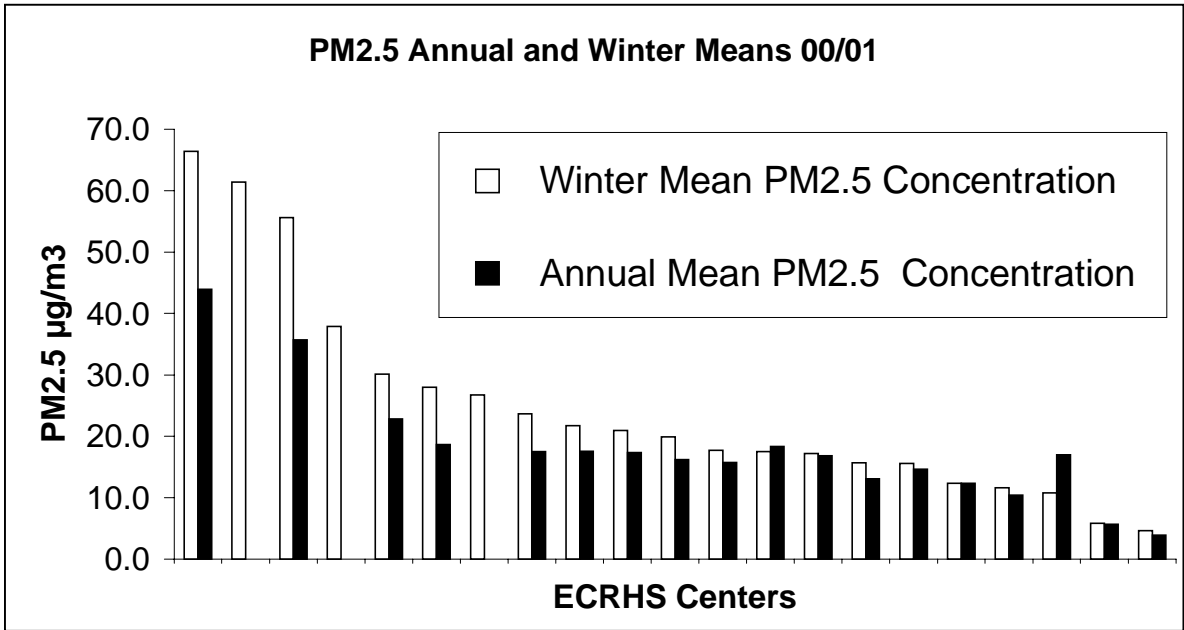
(contact: Marianne.Hazenkamp@unibas.ch)

The follow-up of cohorts of adults from 29 European centers of the former ECRHS I (1989-92) investigates long-term effects of exposure to ambient air pollution on incidence, course, and prognosis of respiratory diseases, in particular asthma and change of pulmonary function.

PM<sub>2.5</sub> is not routinely monitored in Europe. We measured PM<sub>2.5</sub> concentrations in 21 participating centers to estimate 'background' exposure in these cities. Winter (Nov. – Feb.) and annual mean (all months) values of PM<sub>2.5</sub> were determined from PM<sub>2.5</sub> measures made using the "Basel PM<sub>2.5</sub> Sampler" (EPA WINS impactor and PQ167 from BGI, [www.bgiusa.com](http://www.bgiusa.com)). Sampling was conducted for seven days per month for a year. A standardized protocol involving the weighing of filters in a single central laboratory was followed.

Annual and winter mean concentrations vary substantially being lowest in Iceland and highest in centers in Northern Italy. Annual mean concentrations ranged from 4 µg/m<sup>3</sup> to 44 µg/m<sup>3</sup> and winter mean concentrations ranged from 5 µg/m<sup>3</sup> to 66 µg/m<sup>3</sup>. Seasonal variability did not follow the same pattern across all centers.

The range of PM<sub>2.5</sub> concentrations obtained in ECRHS II is larger than in other current cohort studies on long-term effects of air pollution, with the annual mean reaching a max/min-ratio of >10, and an 90<sup>th</sup>/10<sup>th</sup>-percentile ratio of 3.4. This substantial variation in PM<sub>2.5</sub> exposure will improve statistical power in future multi-level health analysis and to some degree may compensate for the lack of information on within-city variability.



**NO<sub>2</sub> Assessment and Comparison with PM<sub>2.5</sub> Measurements at 21 Study Centers of ECRHS II (European Community Respiratory Health Survey II)**

Götschi T. (1), Hazenkamp-von Arx M. E. (1), Burney P. (2) Jarvis D. (2), de Marco R. (2), Verlato G. (2), Villani S. (2), Vermeire P. (2), Maldonado Perez J. A. (2), Payo Losa F. (2), Torén K. (2), Sunyer J. (2), Heinrich J. (2) Künzli N. (1) on behalf of ECRHS II

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(2) On behalf of Working Group Air Pollution & Health of ECRHS II

(contact: Marianne.Hazenkamp@unibas.ch)

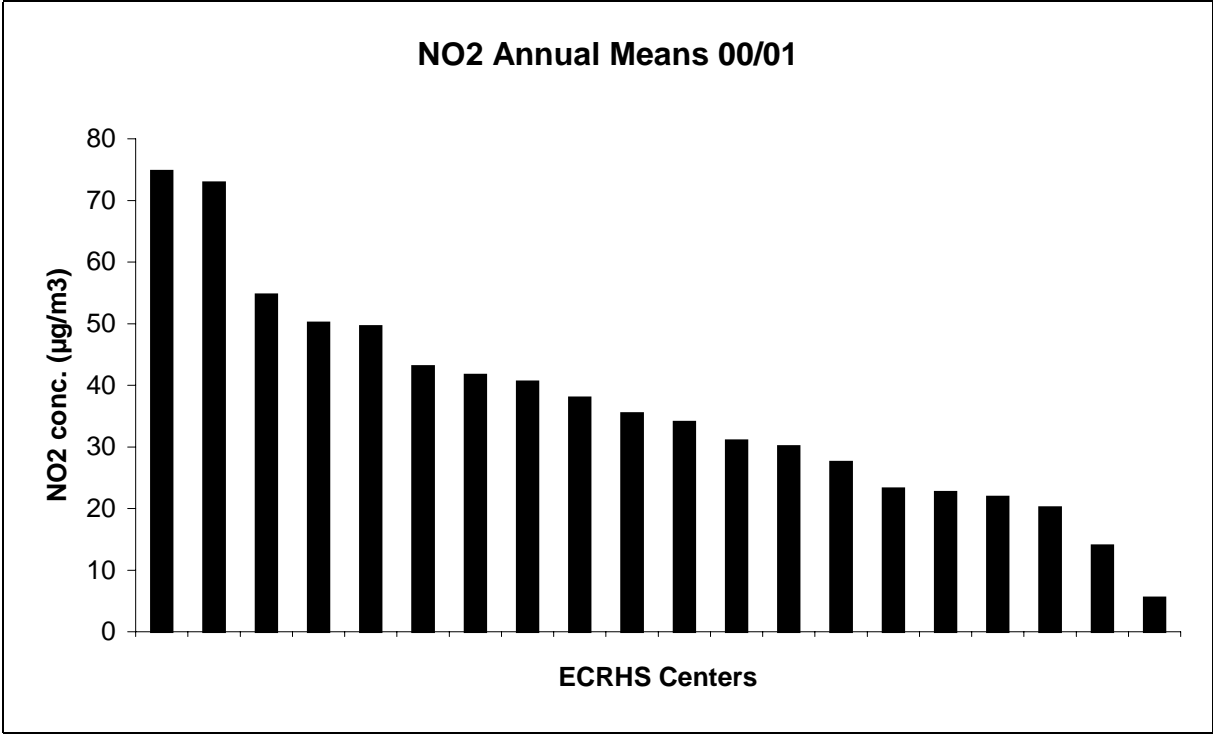
The follow-up of cohorts of adults from 29 European centers of the former ECRHS I (1989-92) investigates long-term effects of exposure to ambient air pollution on incidence, course, and prognosis of respiratory diseases, in particular asthma and change of pulmonary function.

Monitoring network data across Europe are incomplete. Therefore, we measured NO<sub>2</sub> and PM<sub>2.5</sub> concentrations in 21 study centers to estimate ‘background’ exposure in these cities. Annual means of NO<sub>2</sub> concentrations were determined by passive sampling (Palmer tubes, passam AG/Switzerland) for fourteen days each month, at the same sites PM<sub>2.5</sub> (EPA WINS impactor and PQ167 from BGI, www.bgiusa.com) was measured.

First results show a wide range for the calculated annual mean concentrations of almost 70µg/m<sup>3</sup> between the very low levels in Iceland (5.5µg/m<sup>3</sup>) and those in southern European cities (74.7 and 72.9 µg/m<sup>3</sup>, respectively). Over 20 study centers, the max/min ratio is 13.6 and the 90th/10th percentile ratio is 2.7.

Comparison between monthly NO<sub>2</sub> and PM<sub>2.5</sub> values within each center shows significant Pearson correlation coefficients in 8 out of 20 centers where data were available (min. 6 months included), reaching values between 0.72 and 0.94. In 12 centers correlation between NO<sub>2</sub> and PM<sub>2.5</sub> was not significant at 5% level. The identification of predictors for the strength of correlation between NO<sub>2</sub> and PM<sub>2.5</sub>, such as e.g. main characteristics of the measuring sites, will be subject of further investigations.

To assess within-city spatial variability of NO<sub>2</sub>, in some cities, outdoor NO<sub>2</sub> will be measured at 200 homes simultaneously .



## 10471 - Publication bias in studies of ambient particulate pollution and daily mortality

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There is a large body of evidence associating ambient particles at below guideline level with daily mortality. The consistency of positive associations has been important in the argument for causality, and pooled effect estimates are increasingly used for estimating health impact at city, regional, national and global levels. In evaluating this body of evidence, it is important to consider whether there has been publication bias. This might be expected in any emerging and contentious research findings but more so for these studies because analysis of routinely available data represents a modest investment in research time and the cost of not attempting to publish negative findings is low. The propensity of journals to favour the publication of positive findings is well known. From various bibliographic databases we have identified systematically all published time series studies of daily all cause all age mortality in all languages and countries up to the end of July 2001, and transferred coefficients and other information into a database. We calculated pooled estimates weighting according to the inverse of the variance. Random effects models were used, as all showed significant heterogeneity. We first looked at 42 separate studies of TSP and found some evidence of positive publication both from inspection of Begg's funnel plot and from Eggar's test ( $p=0.042$ ). We then examined the results for the 165 cities with results for  $PM_{10}$ . There was no evidence of publication bias on inspection of the funnel plot or on formal testing with Begg's or Eggar's tests; the pooled estimate for  $10\mu g/m^3$  was 1.006 (95%CI 1.005, 1.007). This evidence base is unusual in that it is possible to compare individual studies that might be subject to publication bias with two prospective multi-city studies (the European APHEA study and the US NMMAPS study), which are much more likely to have been published, whatever the result. The pooled estimate for the combined APHEA and NMMAPS cities ( $n=111$ ) was 1.005 (95% CI 1.004, 1.006) with no evidence of publication bias in the funnel plot or on statistical testing. For the 54 individual city studies, the funnel plot showed some evidence of bias which was supported by the Eggar's test which showed a slight positive bias ( $p=0.12$ ); the pooled estimate was 1.007 (95% CI 1.006, 1.008) but when adjusted for publication bias using Trim and Fill analysis, it was reduced to 1.006 (95% CI 1.004, 1.007), only slightly more than the pooled APHEA and NMMAPS estimates. It is concluded that there is little publication bias in the published literature on  $PM_{10}$  and daily mortality. This gives confidence in the consistency of positive results and in the use of pooled estimates for health impact assessment.

## 10455 - An investigation into the potential health effects of a sulphur dioxide air pollution episode

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### Abstract

**Introduction:** On 2 September 1998, a sulphur dioxide (SO<sub>2</sub>) air pollution episode occurred in the Midlands and South Yorkshire regions of the UK. The Environment Agency conducted an investigation into the episode and found that air quality standards for SO<sub>2</sub> were exceeded across a large part of the Midlands and South Yorkshire. Together with the Trent Public Health Observatory, the Environment Agency commissioned an investigation into the potential health effects of the episode using routinely collected health data. **Methods:** Emergency hospital admissions and deaths in the week in which the episode took place (2–8 September 1998) were compared with those in a control week (26 August to 1 September 1998) using odds ratios (ORs) and 95% confidence intervals (95% CIs). Similar comparisons were made for control years (1995–1997 and 1999). The primary study area was the city of Nottingham (population 658000) where the highest concentrations of SO<sub>2</sub> were recorded during the episode. The county of Leicestershire (population 934000) was much less affected by the episode and was used as a control area. **Results:** In Nottingham, there was a small but statistically significant increase in emergency admissions for all respiratory diseases during the week in which the episode occurred (OR=1.40, 95% CI=1.00–1.94). Ten of the 25 excess admissions were for asthma, although the increase for asthma alone was not statistically significant (OR=1.90, 95% CI=0.87–4.15). Five of the excess admissions for asthma were among 0–14 year olds. There were no statistically significant changes in emergency admissions for cardiovascular diseases, nor in deaths from respiratory or cardiovascular diseases. In Leicestershire, there were no statistically significant changes in emergency admissions or deaths from respiratory or cardiovascular diseases in the week in which the episode occurred. **Conclusions:** The increase in emergency admissions for respiratory diseases in Nottingham could have been caused by exposure to SO<sub>2</sub> or one of the other pollutants (particulates and nitrogen dioxide) that were present in elevated concentrations during the episode. The increase is unlikely to be explained by the rise in childhood admissions for asthma that tends to occur when schools reopen after the summer holidays because schools in Nottingham reopened towards the end of the week in which the episode occurred. The fact that humidity and rainfall were higher and barometric pressure lower in the week in which the episode occurred might, however, explain some of the excess admissions for asthma. This study has demonstrated the feasibility of using routinely available health data to provide a relatively quick assessment of the health effects of an air pollution episode. Local authorities could use a similar approach to investigate health effects of future pollution episodes.

### **10453 - THE EVALUATION OF VEHICULAR RESTRICTION ON ATMOSPHERIC POLLUTANTS LEVELS IN SÃO PAULO CITY, BRAZIL.**

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A huge automotive fleet is the main source of air pollutants in São Paulo. In the last decade polices have been adopted in order to reduce the amount of air pollutants emitted by cars, trucks and buses. Investments on fleet renovation and technological improvements of the vehicles were the main adopted procedures. This study was developed in order to estimate the impact of a specific program, the vehicular restriction, which prohibited the circulation of 20% of the fleet per day, according to the plate's final number, in the São Paulo Metropolitan Region from 1995 to 1998, during wintertimes. However, the program was adopted in full, with mandatory restriction and for a longer period of time, only in the winter of 1998. Daily levels of PM<sub>10</sub>, SO<sub>2</sub>, O<sub>3</sub>, CO, and NO<sub>2</sub> were obtained from the São Paulo State Sanitary Agency and daily levels of minimum temperature and relative humidity were provided by the Institute of Astronomy and Geophysics of the University of São Paulo. Covariance analyses were done to estimate possible differences in the mean levels of pollutants during the wintertimes of the period, controlling for temperature, humidity, and number of thermal inversions. The honest significant differences test (HSD-TUKEY) was used to identify the years with differences. The same approach was adopted to analyze temperature, humidity, and the number of thermal inversions of each analyzed period. Although the levels of primary pollutants had dropped consistently from 1995 to 1998 and the covariance analysis had showed statistically significant differences, the decreases of PM<sub>10</sub>, SO<sub>2</sub> and CO in the winter of 1998 were more evident (p<0.001). In 1999 and 2000, years where there was not restriction of vehicles circulation, levels of air pollutants were similar to those observed in 1998. The analysis of weather characteristics showed no differences between 1997 and 1998 wintertimes. Based on this analysis it is possible to infer that the vehicular restriction reduced the mean levels of primary pollutants during the winter of 1998 in São Paulo besides the expected. This abstract was funded by: LIM05-FMUSP, UNISA, and FAPESP.

## **10447 - Modelling the association between mortality and long term exposure to air pollution**

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(3) Departments of Statistics and Biostatistics, University of Washington, USA

Compared to acute effects of air pollution on health, rather less attention has been given to the investigation of chronic effects of air pollution, i.e. the association between health outcomes and long-term exposures to air pollution, possibly over several years. This is primarily due to the lack of availability of suitable data (including potential confounders), and it is uncertain to what extent, if at all, findings from studies of short-term effects can be extrapolated to longer term (chronic) effects. The majority of the studies of the chronic effects of air pollution have focused only on concurrent exposures: that is, on the associations between health outcome and pollution levels measured in the same, or very recent, years. As such, these studies take no account either of possible latency effects (e.g. due to exposures earlier in life), or of the effects of cumulative exposures over many years. The approach presented here is novel in that it addresses both of these issues at a much higher level of geographical resolution that has been possible before, and additionally allows the effects to vary over calendar time. This is achieved by using health outcomes from distinct time periods, each of which is associated with previous exposure over a number of years. By considering sub-divisions of these exposure periods, the effects of different lags can be examined. This is implemented within a Bayesian framework and applied to ward-level mortality data (respiratory deaths) from Great Britain during the period 1981-96 with associated exposures from ambient concentrations of sulphur dioxide from 1966-81 measured in the same wards. The effects of unmeasured confounders is considered, both in terms of possible over-dispersion and, as a number of the wards may be common to more than one of the time periods, in the possibility that the outcomes may not be considered independent. The effects of socio-economic deprivation, using a census based index are also taken into account. The study has shown consistent associations between long-term SO exposure and respiratory mortality, with increased risks of similar magnitude to those previously observed in studies in the USA, suggesting that the long term health risks of exposure to air pollution merit continued attention.

**Publication bias in studies of PM<sub>10</sub> and children’s lung function**

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Topic : air quality outdoor

It is well known that, in general, statistically significant findings are more likely to reach publication than non-significant results for a variety of reasons. In synthesising the evidence for adverse effects of particles on children’s lung function, it is important to investigate if there is any evidence for publication bias. We have systematically identified all peer-reviewed published papers of panel studies indexed in Medline, Embase and Web of Science. We created a database containing regression estimates and all relevant data to standardise the results prior to pooling. Up to August 2001 there were 121 studies of daily lung function and symptoms in panels of subjects providing 39 estimates of effects of PM<sub>10</sub> on PEFR in symptomatic children. We have investigated publication bias in the whole data set (39 estimates) and in two subsets, the estimates from the PEACE studies (28 estimates) and estimates from ‘single location’ studies (11 estimates). The PEACE study group has conducted panel studies in 14 European centres using a standard protocol. This group had a prior policy to publish results regardless of the findings. Hence their findings should not be subject to publication bias. We calculated pooled estimates using fixed and random effects models weighting inversely according to the variance.

Figure : Funnel plot for studies of PM<sub>10</sub> on PEFR in symptomatic children (N=39)

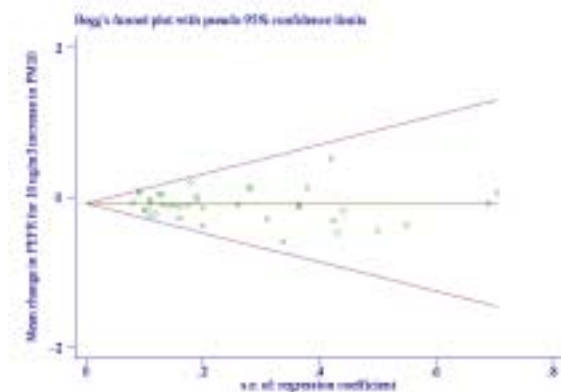


Table : Pooled estimates of effects of PM<sub>10</sub> on PEFR in children in various study subgroups

Study group	Pooled estimate <sup>1</sup>	95% CI	No. of studies
Symptomatic including PEACE studies	-0.080	-0.129,-0.031	39
..... without PEACE studies	-0.143	-0.259,-0.027	11
..... only PEACE studies	-0.067	-0.121,-0.013	28

<sup>1</sup> regression coefficient l/min/10µg/m<sup>3</sup>

The funnel plot for all estimates (figure) showed no evidence of publication bias (estimates randomly distributed about the mean effect) and the Begg and Eggar tests confirmed this lack of evidence for publication bias. Funnel plots for the sub-groups containing only PEACE estimates and non-PEACE estimates were also symmetrical. There was no significant statistical heterogeneity in any group and so fixed effects estimates have been presented. There was a significant negative relationship between PM<sub>10</sub> and PEFR in each group but the effect sizes were relatively small, being equivalent to about 0.02% decline in PEFR for a 10µg/m<sup>3</sup> increase in PM<sub>10</sub>. The pooled estimate for the non-PEACE studies was double that for the PEACE studies. This difference does not appear to be explained by publication bias.

10354 - Air pollution and bronchitic symptoms in children: Between-community and within-community effects

R McConnell, K Berhane, F Gilliland, J Molitor, E Avol, WJ Gauderman, JM Peters

The association of air pollution with the prevalence of chronic lower respiratory tract symptoms among children has been examined previously in cross sectional studies comparing communities with different levels of pollutants. We examined the change over time within communities in prevalence of chronic cough, phlegm, or bronchitis among asthmatic children participating in the Children's Health Study in 12 Southern California communities. Average ambient annual exposure to nitrogen dioxide (NO<sub>2</sub>), ozone, particulate matter (PM<sub>10</sub>, PM<sub>2.5</sub>, and PM<sub>10-2.5</sub>), and inorganic and organic acid vapor was estimated from monitoring stations in each community. The year-to-year deviation in symptom prevalence from the 5-year mean in each community was modeled as a function of year-to-year deviations from a multi-year average for each pollutant. Significant associations were observed between bronchitic symptoms and NO<sub>2</sub>, ozone, PM<sub>2.5</sub> and inorganic acid. There were only modest changes in the magnitude of the effect of PM<sub>2.5</sub> when other pollutants were included in two pollutant models, but the effect of other pollutants was markedly diminished in models including PM<sub>2.5</sub>. The relative risk of chronic bronchitic symptoms associated with within-community changes in air pollution (per ppb or  $\mu\text{g}/\text{m}^3$ ) was three to four times larger than the effect of between-community differences in air pollution. There was no increased risk of symptoms either within- or between-communities in children with no history of asthma. These results are consistent with previous studies showing an increase in chronic symptoms associated with air pollution in children with asthma. However, one possible explanation for the large within-community effects, compared with between-community cross sectional comparisons, is less confounding by unmeasured ecologic factors. If this is the correct explanation, between-community comparisons may have under-estimated the impact of air pollution on bronchitic symptoms in children with asthma.

10316 - Loss of Survival in Relation to “Frailty” and Air Pollution in a Cohort of Respiratory Clinic Patients.

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**Objectives:** Studies from around the world have found an association between daily mortality rates and measures of increased air pollution. Most of these studies have been ecologic time series analyses, and there is little information about the individuals who die. It is controversial whether mortality is advanced by a brief interval (harvesting) or whether there is a more substantial loss of life expectancy among individuals who die on high pollution days. The aim of this study was to directly examine loss of survival in a cohort of patients who underwent lung function testing at a respiratory diseases clinic.

**Methods:** Subjects were 5228 individuals aged 40 years or more who entered follow-up at the time of lung function testing between January 1, 1992 and the end of 1999. Subjects were linked to the Ontario Mortality Database and 632 deaths were observed. Cox regression analysis was used to model survival time in relation to age, sex, Forced Vital Capacity, Forced Expiratory Volume, Body Mass Index, diagnosis of asthma or other chronic pulmonary disease, and neighbourhood income. The “Risk Score” was defined to be the linear predictor in the Cox model. Expected survival was computed for each subject by integrating the area under the survival curve. Loss of Survival was defined to be the difference between observed and expected survival. Daily measures of PM10 were obtained from Ministry of Environment sampling stations. The relations between daily PM10 and loss of survival were examined in linear regression models adjusted for “Risk Score”.

**Results:** Loss of survival was significantly associated with the risk score and with the PM10 level on the date of death. There was also a significant interaction between PM10 and the Risk Score. When stratified on place of death, there was a relation between PM10 and loss of survival among subjects who died outside of hospital, but none among those who died in hospital. Among the most frail, death on a day with an increase in PM10 of  $10 \mu\text{g}/\text{m}^3$  was associated with a loss of survival of about 40 days.

**Conclusions:** Loss of survival in relation to elevations of PM10 pollution was related to the underlying frailty of subjects.

10304 - Air Pollution Exposures for an Acute Epidemiological Study of Respiratory Effects in Children in Durban, South Africa.

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The Settlers School is located amidst two major petroleum refineries, a paper mill and a wastewater treatment plant in the South Durban Industrial Basin in Durban, South Africa. Odor complaints and exceedences of national air quality guidelines have been common for many years. The 860 students and 28 staff at this elementary school (grades 1 - 7) appear at risk due to exposures to sulfur dioxide, particulate matter and other air pollutants. An investigation of air pollution exposures and health symptoms for children and staff was initiated in early 2001. Questionnaires and methacholine challenge pulmonary function tests (PFTs) administered to approximately 275 children indicated very high rates of asthma (~50%). PFTs and symptom/activity logs were completed bi-hourly during the school day, and daily diaries were maintained by parents over a three-week period. Statistically significant associations were found between both upper and lower respiratory symptoms and several exposure measures. This paper reports on these exposure measures, which were derived from continuous measurements of sulfur dioxide (SO<sub>2</sub>), nitrogen oxides (NO<sub>x</sub>, NO<sub>2</sub>, NO), particulate matter (PM<sub>10</sub>), carbon monoxide (CO), total reduced sulfur (TRS), and surface meteorological variables taken at the school. Integrated samples of particulate matter and speciated volatile organic compounds were also collected. For the continuous variables, data were reduced to 15-min averages, and the autocorrelation, trends, distributions, and directional patterns (by wind direction) were evaluated. Due to its coastal location and nearby mountains and plateaus, the area has somewhat complex circulation patterns. The 3-week study period had lower levels of SO<sub>2</sub> (8.2 ppb average, 144 ppb 15-min maximum) than the annual average, but typical levels of CO (0.9 ppb average, 5.5 ppb maximum), NO<sub>x</sub> (20.8 ppb average, 226 ppb maximum) and PM<sub>10</sub> (average 36 µg/m<sup>3</sup>, 193 µg/m<sup>3</sup> maximum). All pollutants showed regular, but different diurnal patterns. For pollutants primarily emitted by local point sources, e.g., SO<sub>2</sub> from refineries, etc., pollutant distributions were non-normal, trends were 'spiky' and erratic, and concentrations were strongly affected by wind direction and atmospheric stability. For pollutants emitted by more dispersed area sources, e.g., CO, NO, and NO<sub>2</sub> from vehicles, concentrations were more normally distributed, and trends were typically smoother. PM<sub>10</sub> showed both effects, indicating both local and urban sources. A factor analysis corroborated this classification, with two main factors, i.e., NO, NO<sub>x</sub>, and CO; and SO<sub>2</sub> alone; TRS and PM<sub>10</sub> were separate, but weak factors. Pollutant measures were derived to represent average and peak exposures during different periods during the day, corresponding to the times of symptom assessment, playtime outdoors, etc. Due to source and meteorological factors, the various pollutant measures are autocorrelated, but interpollutant correlation is relatively low. These and other issues affecting the use of high temporal resolution exposure measures in acute health effects studies are discussed.

## **10286 - RESPIRATORY DISEASES AND PARTICULATE AIR POLLUTION IN THE SÃO PAULO METROPOLITAN REGION (SPMR), BRAZIL.**

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Many studies have showed the influence of particulate air pollution on respiratory morbidity. Our group has developed studies in São Paulo City and this study is the first one to focus on the particulate respiratory effects in nine cities of the SPMR. For the period ranging from January 1<sup>st</sup> 1997 to December 31<sup>st</sup> 1998, daily records of total respiratory hospital admissions for all ages in Osasco, São Bernardo do Campo, São Caetano do Sul, Santo André, Taboão da Serra, São Paulo City, Diadema, Mauá, and Guarulhos were obtained from the Public Health System. Daily levels of PM<sub>10</sub> were obtained from the São Paulo State Sanitary Agency. City-specific analysis was carried out using generalized additive robust Poisson regression, adjusting for time trend, temperature, humidity and day of the week. When necessary, autorregressive terms were incorporated in the models. PM<sub>10</sub> was positively associated with respiratory admissions in eight cities and the effect was observed mainly in the concurrent day, although association could be seen with pollutant levels until 3 days before. The most robust effect was observed in São Paulo City where a 10 µg/m<sup>3</sup> increase in 3-day moving average of PM<sub>10</sub> was associated with an increase of 1.5% (95% CI 0.9 - 2.1) in total respiratory admissions. The overall effect of PM<sub>10</sub> in the nine cities was 1.2% (95% CI 0.78 – 1.62) per 10 µg/m<sup>3</sup>. This study showed that the association between PM<sub>10</sub> and respiratory disease is a problem that affects inhabitants of many cities of SPMR and that any police to control air pollutant emission must be adopted for the whole region.

## 10251 - AIR POLLUTION - A RISK FACTOR IN ISCHEMIC STROKE MORTALITY

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<sup>2</sup>Institute of Environmental and Industrial Medicine, Hanyang University, Seoul, Korea

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<sup>4</sup>Department of Preventive Medicine, Dankook University College of Medicine, Cheonan, Korea

**Background and Purpose** - Air pollution is known to be associated with cardiovascular disease, but little is known about the occurrence of stroke in relation to air pollution. The authors investigated the association between acute stroke mortality and air pollution over a 7-year period (January 1991 to December 1997) in Seoul, Korea.

**Methods** - A generalized additive model was used to regress daily stroke death counts for each air pollutant, controlling for time trends, day of the week, and meteorological influences such as temperature, relative humidity, and atmospheric pressure. Ischemic and hemorrhagic stroke deaths were examined separately.

**Results** - The effects of air pollutants on ischemic stroke mortality were statistically significant, whereas this was not the case for hemorrhagic stroke mortality. We observed estimated relative risks of 1.03 (95% confidence interval, 1.00 to 1.06) and 1.04 (95% confidence interval, 1.01 to 1.08) for ischemic stroke mortality for each interquartile range increase in total suspended particulates and sulfur dioxide concentrations on the same day. We also found significantly increased relative risks of 1.04 (95% confidence interval, 1.01 to 1.07) for nitrogen dioxide with a 1-day lag, of 1.06 (95% confidence interval, 1.02 to 1.09) for carbon monoxide with a 1-day lag, and of 1.06 (95% confidence interval, 1.02 to 1.10) for ozone with a 3-day lag for each interquartile range increase.

**Conclusions** - These findings indicate that air pollutants are significantly associated with ischemic stroke mortality, which suggest an acute pathogenetic process in the cerebrovascular system induced by air pollution.

## 10240 - Air Pollution Increases Mortality Among Persons with Diabetes

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We conducted a mortality time series study in Montreal, Quebec, to investigate the relationship between ambient air pollution and underlying causes of death as well as conditions that subjects had before their death. Using data from the universal Quebec Health Insurance Plan, we identified individuals who had a diagnosis of diabetes (ICD-9 250). We classified a subject as having diabetes one year before death according to the following algorithm: 1) two or more physician billings coded as diabetes; 2) certain treatment codes for insulintherapy that clearly indicated diabetes; 3) at least one physician billing for diabetes and certain other treatments that were possibly indicative of diabetes; 4) for subjects 65 years and over, at least one physician billing for diabetes and at least one blood glucose monitoring; and 5) for subjects 65 years and over, filled prescriptions for any oral antihyperglycemic agent or insulin. Among the subgroup of persons with diabetes, we estimated the association between daily mortality, ignoring the underlying cause of death, and daily concentrations of ambient particles and gaseous pollutants, 1984-1993. We regressed the logarithm of daily counts of mortality on the daily mean levels of each pollutant, after accounting for seasonal and subseasonal fluctuations in the mortality time series, non-Poisson dispersion, and weather variables. The analyses of diabetes from the medical record, ignoring the underlying cause of death, showed significant increases in the mean percent change (MPC) in daily mortality with almost all pollutants except ozone, as follows:

3-day mean for pollutant	MPC (%) across interquartile range of pollutant	95%CI MPC (%)
Ozone	1.72	-0.93-4.44
SO2	4.58	2.30-6.92
CO	4.29	2.12-6.51
NO2	3.22	0.79-5.71
Coefficient of haze	3.86	1.43-6.35
Extinction coefficient	2.38	0.19-4.62
Predicted PM2.5	3.72	1.39-6.09
Predicted sulphates from PM2.5	2.76	0.99-4.56

These data are consistent with some prevailing hypotheses and may also be consistent with recent toxicologic data implicating endothelins. Some other recent epidemiologic studies have also shown these associations, and other studies are required to confirm these findings.