Health Effects of Ambient Particulate Matter

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Epidemiological Studies of PM and Daily Mortality – Associations with Short-term Exposures

- Studies of PM10 and mortality conducted in hundreds of cities world-wide, over a wide range of climates and seasonal patterns, mean PM concentrations, co-pollutants, background health conditions, housing stock, etc.
- Examine associations between daily concentrations of PM and daily death counts.
- Studies account for weather, seasonal effects, day of week, co-pollutants, and other factors

PM/Mortality Epidemiology Studies – Short-term Exposure Results

- **Consistent associations between daily averages of PM10 and PM2.5 and mortality**
- **Linear relationship: no good evidence of any threshold**
- **Most mortality studies show associations between 0.5 and 1.5% increments in daily** μορταλιτψ περ 10 ?γ/μ3 **PM10**
  - **Example - APHEA-2 – 43 million people in 29 European cities - 0.6% increase in daily total mortality; 0.7% for** χαρδιοϖασχυλαρ δεατησ περ 10 3??/μ

Coherence: If PM kills some people, it should hurt others

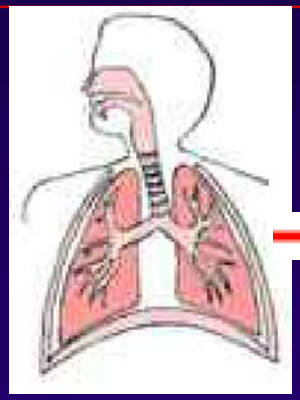
- Associations also reported between daily PM10 and multiple measures of illness
  - cardiorespiratory hospitalizations
  - emergency room visits
  - school absenteeism and work loss
  - asthma attacks
  - bronchitis other respiratory symptoms in children
  - decreased lung function

Low-Level PM Exposure and Cardiovascular Effects - Is this Believable?

- Numerous time-series studies link low-level ambient particulate matter (PM) with increased cardiac morbidity and mortality
- No good mechanistic explanations for this phenomenon until recently

PM - Potential Mechanisms of Action (Partial schematic)

PM ?



Pulmonary Inflammation

Systemic inflammation

Acute phase response

Autonomic effects

- C-reactive protein
- Fibrinogen
- Factor VII

- Heart rate
- Blood pressure
- Heart rate variability

Rupture of atherosclerotic plaque

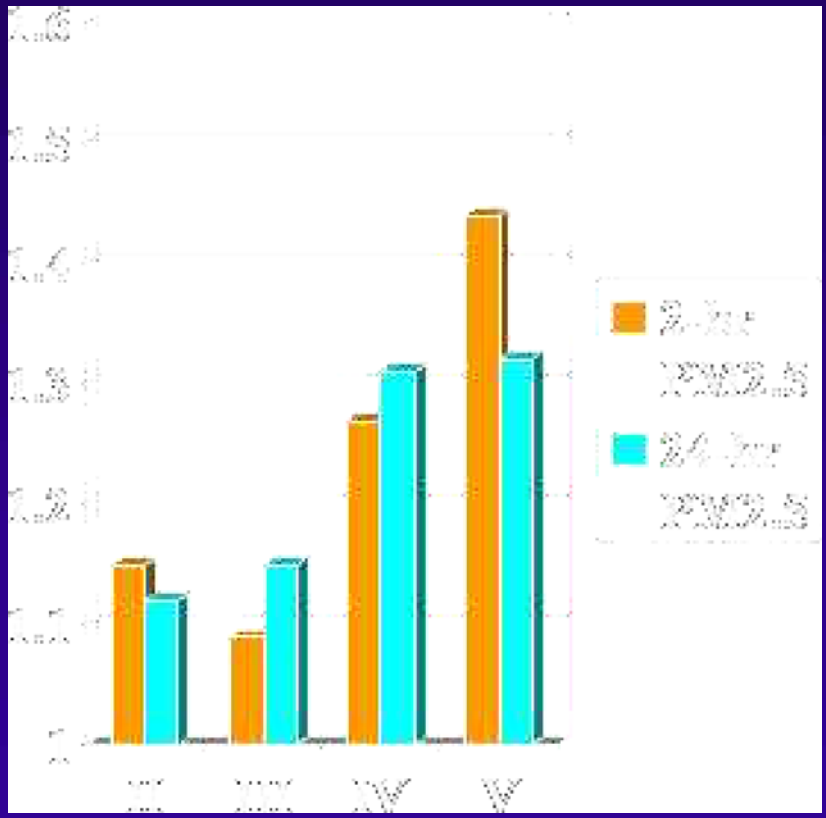
Thrombosis

Cardiac Ischemia

Arrhythmia

PM and Myocardial Infarction

- Boston study of 772 patients interviewed about onset of myocardial infarction symptoms
- PM10 and PM2.5 measured 2 and 24 hours before symptom onset both showed elevated odds ratios



Source Peters A et al. Circulation 2001:103

PM Epidemiology Studies – Long-term Exposures

- Several studies report associations between mortality and long-term exposure to PM10 and/or PM2.5.
- Analysis accounts for relevant individual-level factors (e.g., smoking, weight, alcohol, occupational exposure, gender, age, and others)
- In general, these studies show a markedly greater association of mortality with PM exposure than the time-series studies

American Cancer Society II Study

- 500,000 people in 151 cities followed for up to16 years.
- Controlled for age, sex, occupational exposure, obesity, alcohol and cigarette use, socioeconomic status
- Φορ ινχρεμεντ οφ 10 ?γ/μ 3 long-term average PM2.5:
  - 6% increase in all-cause mortality
  - 9% increase in cardiopulmonary
  - 14% increase in lung cancer
- Within the cardiopulmonary deaths:
  - 18% increase in ischemic heart disease
  - 12% increase in (arrhythmias+heart failure+cardiac arrest)
- *(Pope et al. AJRCCM 1995, JAMA 2002, Circulation 2004)*

Netherlands Cohort Study on Diet and Cancer

- Subcohort of 5,000 (ages 55-69) followed from 1986-94
- Controlled for age, smoking, second-hand smoke, education, occupation, weight, neighborhood socioeconomic status [alcohol and diet]
- Strongest pollutant predictor of mortality was living near a busy road (95% increased risk for cardiopulmonary mortality; 53% for all-cause [among long-term residents]).
- Too few deaths to examine relationship with lung cancer or other respiratory deaths, per se.

(Hoek et al. Lancet 2002)

Traffic and Non-fatal Myocardial Infarction

- 691 subjects in Germany interviewed about activities prior to symptom onset
- Exposure to traffic within 1 – 2 hr prior to symptoms more than doubled the risk of MI
- Could be a mix of effects: pollutants, stress, noise; however, increased risk seen also for taking public transportation (lower stress?)
- Larger effect estimates for women, age > 60, diabetics and the unemployed

Peters et al. (NEJM 2004)

Reduced Exposures Linked with Clear Health Improvements

- Dublin, Ireland – ban on coal sales (9/1/90). Comparing 6 yr before and after the ban; all-cause, cardiovascular, and respiratory mortality fell by 5.7, 10.3, and 15.5%, respectively. (Effects much larger than predicted from time-series) *(Clancy et al. Lancet 2002)*
- Southern California -- In the Children's Health Study, those who moved to less polluted areas had improved lung function growth, while those who moved to more polluted areas had decreased growth rates. *(Avol et al. AJRCCM 2001)*