The Health and Related Economic Benefits of Attaining Healthful Air in the San Joaquin Valley

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2006 San Joaquin Valley Air Quality Symposium
December 6, Bakersfield, California
Study Objectives

- Determine who is exposed to poor air quality and how frequently.
- Quantify known adverse health effects that result from exposure.
- Assess the economic value of meeting health-based air quality standards.
Research Approach

• Closely integrated multidisciplinary research.

• Three essential elements:
  – Exposure
  – Health
  – Economics
Research Approach Schematic

Air Quality

Population

Exposures (REHEX)

Response Functions

Symptoms (SYMVAL)

Economic Data

Economic Valuation (SYMVAL)
Exposure

- Integrates air quality, spatial and demographic data.
- Represents who is exposed as well as frequency of exposure.
- Supports estimation of adverse health effects associated with exposure.
Adverse Health Effects

Include effects that:

- Are well established in the health literature.
- Are associated with ozone or PM$_{2.5}$.
- Can be quantified in economic terms.
• Attaches dollar values to adverse health effects resulting from exposure.
• Provides an easily understood measure of the cost of poor air quality.
• Is not the entire picture: equity.
Ozone-related:

- Respiratory-related hospital admissions.
- Emergency room visits.
- School absences.
- Asthma attacks.
- Days of restricted activity.
Health Endpoints

PM$_{2.5}$-related:

- Premature death (mortality).
- Acute bronchitis, children.
- Chronic bronchitis, adults.
- Work loss days.
- Days of restricted activity.
- Upper and lower respiratory symptoms, children.
- Non-fatal heart attacks.
- Respiratory and cardio hospital admissions.
- Children’s asthma ER-related visits.
Other Health Endpoints

- Ozone-related mortality.
- Neonatal PM-related mortality.
- Loss of lung function.
- Asthma hospital admissions.
- Adult asthma ER visits.
Scope of the Results

- Expected reduction in exposure by attaining the federal (and state) air quality standards.
- Expected improvements in health.
- Economic value gained from fewer adverse health effects.
Health Studies Criteria

• Are peer-reviewed.
• Account for potential confounders.
• Are based on similar populations.
• Are more recent, using more advanced analytical methods.
• Cover longer periods and larger populations.
• Have been used in previous peer-reviewed benefits assessments.
\[ \Delta C = -C_0 (e^{\beta \Delta P} - 1) \]

where:

- \( \Delta C \) = the change in the number of cases
- \( C_0 \) = the number of baseline cases
- \( \Delta P \) = the change in ambient pollution concentrations
- \( \beta \) = an exponential “slope” factor derived from the health literature

and

\[ \beta = \frac{(1 + \text{ Increased Odds})}{(\text{ Pollution})} \]
PM Mortality Studies Used

Pope et al. (2002)
- Large scale, longitudinal cohort study.
- 16-year follow up from 1979-1983.
- 61 U.S. cities, ages 30 and older.
- Controls for lifestyle and occupation.
- Increase in all-cause mortality: 6% per 10 ug/m³.

Jerret et al. (2005)
- Based on LA subset of Pope study.
- Controls for same confounders.
- Better represents LA population.
- Finds greater association between traffic and health effects.
- Increase in all-cause mortality: 17% per 10 ug/m³.
## Economic Values

<table>
<thead>
<tr>
<th>Condition</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>New case of chronic bronchitis</td>
<td>$374,000</td>
</tr>
<tr>
<td>Hospitalization</td>
<td>$32,000</td>
</tr>
<tr>
<td>MRAD</td>
<td>$61</td>
</tr>
<tr>
<td>Work loss day</td>
<td>$123-141</td>
</tr>
<tr>
<td>School absence</td>
<td>$65-79</td>
</tr>
<tr>
<td>Respiratory symptom day</td>
<td>$20-32</td>
</tr>
<tr>
<td>Acute bronchitis</td>
<td>$110</td>
</tr>
<tr>
<td>Asthma attack</td>
<td>$50</td>
</tr>
<tr>
<td>Emergency room visit</td>
<td>$325</td>
</tr>
</tbody>
</table>
Value of a Statistical Life

One VSL = $6,700,000

Consider this example:

- 1,000,000 people are at risk.
- Risk is reduced for each by 1/100,000 a year.
- Each values that reduction at $670, which totals $670,000,000.
- Ten lives are saved: valued at $6,700,000 each.
NAAQS Results – Annually

2004 Population

- 460 fewer premature deaths.
- 325 fewer new cases of chronic bronchitis.
- 334,000 fewer days of reduced activity in adults.
- 345 fewer hospital admissions.
- 23,300 fewer asthma attacks.
- 188,000 fewer days of school absence.
- 3,230 fewer cases of acute bronchitis in children.
- 68,680 fewer work loss days.
- 595 fewer non-fatal heart attacks
- 445 fewer children’s asthma ER visits
- Over 382,000 fewer days of respiratory symptoms in children.
Total Value

- $3.3 billion *per year*
- $1,000 per Valley resident *per year*
- Attaining California AQ standards would double the benefits
CAAQS Results

- 880 fewer premature deaths.
- 610 fewer new cases of chronic bronchitis.
- 322,400 fewer days of reduced activity in adults.
- 42,700 fewer asthma attacks.
- 262,600 fewer days of school absence.
- 5,920 fewer cases of acute bronchitis in children.
- Total Value: over $6 billion
- Nearly $2,000 per person per year
<table>
<thead>
<tr>
<th>Adverse Health Effect</th>
<th>NAAQS</th>
<th>CAAQS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Premature deaths</td>
<td>460</td>
<td>880</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>325</td>
<td>610</td>
</tr>
<tr>
<td>Hospital admissions</td>
<td>865</td>
<td>1,635</td>
</tr>
<tr>
<td>Asthma attacks</td>
<td>23,300</td>
<td>42,700</td>
</tr>
<tr>
<td>Days of school absence</td>
<td>188,000</td>
<td>262,600</td>
</tr>
<tr>
<td>Children’s acute bronchitis</td>
<td>3,230</td>
<td>5,920</td>
</tr>
</tbody>
</table>
## Effects of 24-hr PM$_{2.5}$ NAAQS Changes

<table>
<thead>
<tr>
<th>Adverse Health Effect</th>
<th>Benefits of Achieving</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Previous NAAQS</td>
</tr>
<tr>
<td>Upper Respiratory Symptoms in Asthmatic Children</td>
<td>16,000</td>
</tr>
<tr>
<td>Lower Respiratory Symptoms in Children</td>
<td>880</td>
</tr>
<tr>
<td>Respiratory Hospital Admissions in Elderly</td>
<td>7</td>
</tr>
<tr>
<td>Nonfatal Heart Attacks (18+ years)</td>
<td>27</td>
</tr>
<tr>
<td>Minor Restricted Activity Days (18-64 years)</td>
<td>17,000</td>
</tr>
<tr>
<td>Work Loss Days (18-64 years)</td>
<td>3,000</td>
</tr>
</tbody>
</table>
• SJV residents face significant risks from air pollution.
• There is no “clean” season (ozone in summer and PM in winter).
• As science advances, known risks grow.
• Impacts of air pollution are not distributed evenly.
• More exposures than average for Latinos and blacks; Fresno and Kern Counties.