Associated Health Benefits on Mortality of Reducing Particulate Matter (PM2.5) in Spain

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Introduction: SERCA Project

- The study was carried out in the framework of the Air Pollution Risk Assessment System (SERCA)

- 3-year project (2009-2011)

- Spanish network of environmental and public-health professionals
  - Coordinator: Laboratory of Environmental Modelling. Technical University of Madrid (UPM)
  - Institute of Environmental Assement and Water Research (IDAEA-CSIC)
  - National Center for Epidemiology (ISCIII)
Introduction: background and objective

- **Background**
  Positive associations between exposure to air pollutants at low concentrations (particularly PM2.5) and adverse health outcomes

- **Objective**
  To estimate the number of avoidable deaths associated with reducing PM2.5 levels in Spain
HIA methodology


Mortality

CRF

BenMap software

Attributable cases

Control conditions

Baseline conditions

CMAQ software

PM2.5

Methodology: Air Quality Change

- Air quality model tool: **CMAQ** (Community Multiscale Air Quality)
- Free software to provide baseline and control conditions (US EPA)
Methodology: Air Quality Change

Air quality modeling data:

- **Baseline conditions**: a baseline 2004 scenario based on Spain's National Emissions Inventory

- **Control conditions**: a projected 2011 scenario in which a reduction in PM2.5 was estimated if specific air quality policies were implemented
Methodology: HIA tool

- **BenMAP** (Environmental Benefits Mapping and Analysis Program)
- Free software to estimate health benefits from improvements in air quality (US EPA)
Methodology: Air Quality Change
Gridded information with 18 Km$^2$ spatial resolution

Input data for each grid cell:
1 baseline data + 1 control data

CMAQ software

BenMap software

Linking air quality modelling and human impact assessment through the BenMAP
Methodology: Health effects (mortality)

- Spanish National Statistics Institute (INE) provided population and mortality data for each town (8,109 municipal cores)

- 2004-2006 Crude all-cause mortality rates (ICD-10: A00-Y98) for the over-30 and 25-74 age groups

- 2004 population figures corresponding to these same age groups
Methodology: Mortality rate and population

Input data for each grid cell:

1 mortality rate data
+ 1 population data

BenMap software
Methodology: CRF

We used two CRFs linked to PM2.5 exposure (Laden et al., 2006; Pope et al., 2002)

<table>
<thead>
<tr>
<th>Author</th>
<th>Location</th>
<th>Study population (age groups)</th>
<th>Regression coefficient (β)</th>
<th>Study features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pope et al., 2002</td>
<td>51 US cities</td>
<td>500,000 (30-99 years)</td>
<td>5.8*10^-3</td>
<td>Mean estimate</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Std. Error</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.1*10^-3</td>
<td>β distribution</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Normal</td>
<td></td>
</tr>
<tr>
<td>Laden et al., 2006</td>
<td>6 US cities</td>
<td>8,096 (25-74 years)</td>
<td>14.8*10^-3</td>
<td>Mean estimate</td>
</tr>
<tr>
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<td>Std. Error</td>
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<tr>
<td></td>
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<td></td>
<td>4.1*10^-3</td>
<td>β distribution</td>
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<tr>
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<td>Normal</td>
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</tbody>
</table>

Pope CA 3rd, Burnett RT, Thun MJ, Calle EE, Krewski D, Ito K et al. Lung cancer, cardiopulmonary mortality, and long-term exposure to fine particulate air pollution. JAMA 2002; 287:1132-41

Results: Air Quality Change

Modeled PM2.5 change between baseline scenario (2004) and control scenario (2011)

Air quality improvement was defined as an average annual reduction of 0.7 mg/m^3 in PM2.5 levels
Results: assessing the health impacts
PM2.5: LONG-TERM HEALTH IMPACT ON ALL CAUSES MORTALITY IN SPAIN (SCENARIO 2004-2011)

HIA estimations according to Pope et al., 2002

Absolute number of annual avoidable deaths

Crude rates of avoidable deaths/ 100,000 population


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## Results: assessing the health impacts

Summary of long-term HIA findings in terms of potential reductions in the number of attributable deaths and rates per 100,000 population

<table>
<thead>
<tr>
<th>Exposure indicator</th>
<th>Health indicator</th>
<th>Population at risk (age group)</th>
<th>CRF</th>
<th>Number of avoidable deaths (50th percentile)</th>
<th>Range of avoidable deaths (5th–95th percentiles)</th>
<th>Number of avoidable deaths per 100,000</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long-term PM$_{2.5}$</td>
<td>All-cause mortality</td>
<td>27,327,894 (30-99 years)</td>
<td>Pope, 2002</td>
<td>1,718</td>
<td>673-2,760</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>27,581,475 (25-74 years)</td>
<td>Laden, 2006</td>
<td>1,447</td>
<td>780-2,108</td>
<td>5</td>
</tr>
</tbody>
</table>

1,718 all-cause deaths (6 per 100,000 population) in the over-30 age group and 1,447 all-cause deaths (5 per 100,000 population) in the 25-74 age group could be prevented annually.
Discussion

- The validity of HIA estimates depends on:
  - Quality of population and health data
  - Quality of exposure data
  - Risk estimates

- Our overall results are consistent with previous HIA studies undertaken in Europe and Spain

- BenMAP could be a suitable tool for future HIA in Spain and in other European countries
Summary

- Potential benefits in mortality if pollution control policies were successfully implemented by 2011

- First attempt to perform a national HIA of air pollution in Spain
Associated Health Benefits on Mortality of Reducing Particulate Matter (PM2.5) in Spain (109)

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