Introduction

The NIEHS Annotated Environmental Health Economic Analysis Bibliography is a resource for environmental health researchers who are looking to learn about economic analyses and incorporate them into their research. This list summarizes key attributes from almost 70 environmental health science articles that include economic analyses. Researchers can search by exposures studied, health outcomes analyzed, economic analysis methods used, and economic data cited. Full references to the articles are provided.

This document contains information from selected publications, mostly from the US, that address environmental health and include an economic analysis component. The bibliography is not comprehensive – articles were curated to select those most in line with current NIEHS funded research. We plan to update these resources periodically. To nominate an article for review, contact: EHEA@niehs.nih.gov.

Suggested Citation:
Coding Details

Peer-reviewed articles and gray literature (e.g., government reports from NIH and EPA) were identified in PubMed and Web of Science from calendar years 1989-2015 using the following key words:

- Economic (economic analysis, economic evaluation, economic impacts, etc.)
- Cost-benefit OR cost benefit
- QALY
- Burden
- Cost-effective OR cost effective

Combined with environmental pollutant* OR environmental pollution OR environmental health OR air pollution OR air pollutant* OR mercury OR lead (Pb) or metal OR BPA OR pesticide* OR phthalate OR PCB OR cookstove (and other relevant exposures)

Response options for each of the coded categories are listed below.

<table>
<thead>
<tr>
<th>Article Type</th>
<th>General Information</th>
<th>Methodology and Analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Research article</td>
<td>Study specific population</td>
<td>Models Used</td>
</tr>
<tr>
<td>Review</td>
<td>Environmental agents</td>
<td>Models Used (Links or References)</td>
</tr>
<tr>
<td>Commentary</td>
<td>Health outcomes</td>
<td>Methods Used</td>
</tr>
<tr>
<td>Report/white paper</td>
<td>Location/Region specificity</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Type of Economic Evaluation</th>
<th>Economic Measures/Variables for Costs and Benefits</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cost analysis</td>
<td>Costs Measures/Variables Measured</td>
</tr>
<tr>
<td>Cost-effectiveness analysis</td>
<td>Potential Cost Measures/Variable Measures</td>
</tr>
<tr>
<td>Cost-utility analysis</td>
<td>Benefits Measures/Benefits Variables</td>
</tr>
<tr>
<td>Cost-benefit analysis</td>
<td>Potential Benefits Measures/Benefits Variables</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Data Sources, Funding, and Summaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sources of Data</td>
</tr>
<tr>
<td>NIEHS Funding</td>
</tr>
<tr>
<td>Summaries</td>
</tr>
</tbody>
</table>
Index of Topics

This index provides page numbers for key methods, exposures and outcomes that may be of interest to readers.

**Economic Analysis Method**

**Cost Analysis**

**Cost Benefit Analysis**

**Cost Effectiveness Analysis**
21, 29, 35, 55, 79, 85, 87, 95, 99, 123

**Cost Utility Analysis**
11, 79

**Environmental Exposures**

**Air Pollutants**
11, 23, 25, 27, 29, 31, 33, 35, 37, 41, 47, 53, 59, 61, 63, 71, 73, 75, 77, 79, 81, 83, 85, 91, 93, 95, 121

**Algal Blooms**
67

**Allergens**
35, 53, 79, 85, 95

**Endocrine Disruptors**
128

**Environmental Pollutants**
51, 89, 103

**Ionizing Radiation**
51

**Metals**
13, 15, 25, 39, 41, 43, 45, 57, 63, 65, 69, 79, 83, 87, 89, 103
Index of Topics (continued)

Organic Compounds
83

Pesticides
17

UV
51, 55

Health Outcomes

Birth Outcomes
13, 33, 41, 47, 63, 71

Cancer
6, 25, 29, 41, 47, 51, 55, 71, 79, 83, 89, 103

Cardiovascular
6, 13, 27, 31, 47, 51, 59, 75, 128

Metabolic Outcomes
19, 87, 128

Metals Poisoning
25, 63, 89, 103

Mortality
8, 11, 13, 27, 29, 31, 33, 37, 55, 61, 73, 75

Neurological/Cognitive Outcomes
25, 41, 51, 63, 87, 89, 103

Other
6, 47, 51, 63

Respiratory Outcomes
6, 8, 11, 21, 23, 25, 27, 29, 31, 33, 35, 37, 41, 47, 51, 53, 63, 67, 71, 75, 79, 81, 85, 87, 89, 93, 95, 103
### Health costs of occupational disease in New York State

#### Article #1

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Fahs MC, Markowitz SB, Fischer E, Shapiro J, and Landrigan P</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>American Journal of Industrial Medicine</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This cost analysis study of occupational illnesses in New York state estimated the partial economic cost of occupational disease to be approximately $600 million per year, and the greatest proportion of costs were associated with occupationally induced cancer. Results suggested that analysis of the true costs of occupational disease can help in planning public and private efforts toward prevention.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Adolescents and adults (≥ 15 years)</td>
<td></td>
</tr>
</tbody>
</table>

#### Health Outcomes
- Cancer outcomes (occupational cancer); respiratory outcomes (chronic respiratory disease, pneumoconiosis (asbestosis, silicosis, coal workers' pneumoconiosis)); cardiovascular outcomes (cardiovascular disease); kidney outcomes (end stage renal disease); cerebrovascular disease

#### Environmental Agents
- **List of Environmental Agents**
  - Not available
- **Source of Environmental Agents**
  - Not available

#### Economic Evaluation / Methods and Source
- **Type:**
  - Cost analysis (CA)
- **CostsMeasured:**
  - Healthcare costs (hospitalization, physicians' services, nursing home care); treatment costs; future loss earnings (value of the output of workers and retirees suffering premature death or disability)
- **Potential Cost Measures:**
  - Costs/wage losses incurred by retirees who are not currently in labor force; economic costs for market imperfections from inequitable distribution of wages and salaries for certain groups (e.g., women and minorities); pain and suffering of all victims and their families
- **Benefits Measures:**
  - Not available
Potential Benefits:
• Not available

Location:
• New York state

Models Used:
• Not available

Methods Used:
• The authors estimated the total costs of occupational disease in New York State. The authors — 1) used incidence and prevalence statistics, mortality records, and a variety of financial data; and 2) employed two methods of cost accounting strategies applicable to the human capital approach, the incidence method, and the prevalence method, to estimate the costs of four categories of occupational illnesses.

Sources Used:
• 0

Citation:
• Fahs MC, Markowitz SB, Fischer E, Shapiro J, and Landrigan P 1989 Health costs of occupational disease in New York State American Journal of Industrial Medicine 16 4

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/2610214

DOI:
• http://dx.doi.org/1002/ajim.4700160409

NIEHS Funding:
• Not available

Other Funding:
Controlling urban air pollution: a benefit-cost assessment

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

Authors: Krupnick AJ and Portney PR

Journal: Science

Summary: This cost-benefit analysis evaluated proposed air quality controls for the US and the Los Angeles metropolitan area, and determined that the costs of proposed new controls were found to exceed the benefits by a considerable margin. Study findings suggested that it may make economic sense to implement air pollution control greatly in some areas and less so in others.

Population: Not available

Health Outcomes:
- Mortality/morbidity; respiratory outcomes (asthma, coughing, shortness of breath)

Environmental Agents:

List of Environmental Agents:
- Air pollutants (ozone, particulate matter, carbon monoxide (CO), nitrogen oxides (NOx), sulfur oxides (SOx), volatile organic compounds (VOCs))

Source of Environmental Agents:
- VOC emissions in nonattainment areas

Economic Evaluation / Methods and Source:

Type:
- Cost-benefit analysis (CBA)

Costs Measured:
- Costs for VOC and ozone control/reduction (cost for reducing the volatility of gasoline); cost for use of alternative fuels (e.g., methanol) to power fleet vehicles; costs for the South Coast plan in Los Angeles (costs for application of pollution control technologies; cost for substitution of less polluting solvents in facilities; costs for implementation of new controls in electric power plants; costs for control/reduction of fuel consumption, vehicle usage, and dust blown from roads/parking lots; costs for programs that aim to eliminate hydrocarbons from solvents, coatings, and motor vehicles

Potential Cost Measures:
- Costs of the South Coast plan to residents (e.g., time losses and inconvenience); nonpecuniary costs (e.g., maintenance program costs)

Benefits Measures:
- Acute health benefits associated with reductions in ground level ozone (as a result of controlling VOC emissions), such as — reduced incidence of asthma attacks, coughing, chest discomfort, pain on deep
inspiration; reduced number of days of restricted activity; reduced acute morbidity; health benefits associated with the South coast plan, such as — reduced risk of premature mortality, reduced risk of acute morbidity, reduced illness, frequency of respiratory symptoms

Potential Benefits:
• Reduced damage to exposed crops and other vegetation; reductions in prevalence of chronic illness; improvements in forests or agricultural output in rural regions that might result from VOC control in urban areas; reductions in damage to rubber and other products exposed to ozone

Location:
• Urban/metropolitan nonattainment areas in the United States; Los Angeles, California

Models Used:
• EPA trajectory models (used for predictions of peak ambient concentrations of ozone); county-level model (used to determine the acute health benefits associated with estimated reductions in VOC emissions in nonattainment areas)

Methods Used:
• The authors presented point estimates of costs and benefits for proposed efforts of improving air quality (reducing ambient ozone concentrations) at the national level. The authors — 1) used VOC emissions data from the Office of Technology Assessment about predicted air quality changes, EPA trajectory models to predict peak ambient concentrations of ozone, and a county level model to determine the acute health benefits associated with the estimated VOC emission reductions in nonattainment areas; 2) combined area-specific data on air quality improvements and population with dose-response functions based on epidemiologic and clinical studies relating ambient ozone concentrations to various human health effects and estimated the reduced incidence of these health effects accompanying a 35% reduction in VOC, and aggregated these estimates to obtain national estimates; 3) used willingness to pay estimates to convert predicted changes in physical health into economic benefits; and 4) presented point estimates of costs and benefits for proposed efforts of the South Coast air quality plan for Los Angeles.

Sources Used:
• Catching our breath — next steps for reducing urban ozone (Office of Technology Assessment, 1989); Review of the National Ambient Air Quality Standards for Ozone — assessment of scientific and technical information (EPA OAQPS, 1987); Economic impacts of t

Citation:
• Krupnick AJ and Portney PR 1991 Controlling urban air pollution: a benefit-cost assessment Science 252 5005

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/1902322

DOI:
NIEHS Funding:
- Not available

Other Funding:
Valuing the health benefits of clean air

Table:

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA), Cost-utility analysis (CUA)</th>
</tr>
</thead>
</table>

**Authors**

Hall JV, Winer AM, Kleinman MT, Lurmann FW, Brajer V, and Colome SD

**Journal**

Science

**Summary**

An assessment of health effects due to ozone and particulate matter (PM10) suggested that among the 12 million residents of the South Coast Air Basin of California, individuals experienced ozone-related symptoms on an average of up to 17 days each year, and face an increased risk of death in any year of 1/10,000 as a result of elevated PM10 exposure. The estimated annual economic value of avoiding these effects was estimated to be nearly $10 billion. The authors concluded that attaining air pollution standards may save 1,600 lives a year in the region.

**Population**

Not available

**Health Outcomes**

- Mortality; respiratory outcomes (cough, chest discomfort, sore throat, eye irritation, headaches)

**Environmental Agents**

**List of Environmental Agents**

- Air Pollutants (ozone, particulate matter (PM10/coarse))

**Source of Environmental Agents**

- Indoor pollution; in-vehicle pollution

**Economic Evaluation / Methods and Source**

**Type:**

- Cost-benefit analysis (CBA), Cost-utility analysis (CUA)

**Costs Measured:**

- Minor restricted activity days; restricted activity days; economic value of attaining national ambient air quality standards (NAAQS)

**Potential Cost Measures:**

- Not available

**Benefits Measures:**

- Lives saved; reduced symptoms

**Potential Benefits:**

- Improvements in visibility; protection of materials or vegetation; prevention of chronic lung disease; reduced greenhouse gas; reduced ecosystem effects
Location:
- South Coast Air Basin in California, USA

Models Used:
- Regional Human Exposure (REHEX) model

Methods Used:
- The authors assessed the health effects due to ozone and particulate matter in the South Coast Air Basin in California. The authors — 1) characterized exposure and dose using the Regional Human Exposure Model which estimates a population’s typical indoor, outdoor, and in-vehicle exposures during the day; 2) estimated concentration of exposure to pollutants by corresponding district assigned locations in an ambient air monitoring network for each of nine demographic groups; 3) calculated the statistical value of lives saved; and 4) used three economic measures to value pollution related health effects — cost of illness (CO), willingness to pay (WTP), and willingness to accept (WTA).

Sources Used:
- Air quality monitoring data from the South Coast Air Quality Management District; Effects on human health of pollutants in the South Coast Air Basin (Kleinman et al., 1989); additional sources cited in publication

Citation:
- Hall JV, Winer AM, Kleinman MT, Lurmann FW, Brajer V, and Colome SD 1992 Valuing the health benefits of clean air Science 255 5046

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
Societal benefits of reducing lead exposure

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

Authors: Schwartz J

Summary: This study provided an introduction to cost-benefit analysis methods for reducing lead exposure and also presents an example analysis which found that for a 1 µg/dl reduction in blood lead concentrations a society can save $17 billion a year. The author highlighted major research gaps for cost effective control of lead toxicity, such as a better understanding of low-dose health effects, the molecular basis of lead toxicity, and better measurement techniques for both research and screening.

Population: Not available

Health Outcomes

- Neurological/cognitive outcomes (IQ deficits); cardiovascular outcomes (myocardial infarctions, hypertension, stroke); mortality; birth outcomes (low gestational age)

Environmental Agents

List of Environmental Agents

- Metal (lead)

Source of Environmental Agents

- Lead-based paint

Economic Evaluation / Methods and Source

Type:

- Cost-benefit analysis (CBA)

Costs Measured:

- Costs related to reduced IQ (reduced lifetime earnings, effect on schooling and educational achievement, special education); lost wages; mortality

Potential Cost Measures:

- Effects of lead on growth, balance, hearing, cancer, and metabolic disturbances; cognitive damage due to prenatal lead exposure; hyperactivity and attention disorders; low birth weight

Benefits Measures:

- Reduction in the number of children who require medical attention; reduced infant mortality; reduced cardiovascular outcomes such as stroke and hypertension in adults; reduced medical costs for cardiovascular disease; increased workplace participation; increased graduation rates
Potential Benefits:
- Not available

Location:
- Not available

Models Used:
- Not available

Methods Used:
- The author provided a brief overview of the basic methods and issues involved in calculating the social benefits of lead control policies. The author — 1) discussed a classical approach to derive a theoretical model of the benefits or utility that a person gains from possessions, including health; 2) examined value of lifetime earnings, estimates of the effects of lead on IQ and schooling, and estimates of the effect of IQ on work force participation and wage rates to examine costs of cognitive damage in children; 3) discussed conservative costs of fetal effects of lead from willingness to pay studies; and 4) estimated of health benefits in adults involving blood pressure and cardiovascular disease studies and adapted it to reflect advancements in medical technology.

Sources Used:

Citation:
- Schwartz J 1994 Societal benefits of reducing lead exposure Environmental Research 66 1

Pubmed:

DOI:
- http://dx.doi.org/10.1006/enrs.1994.1048

NIEHS Funding:
- Not available

Other Funding:
Updated estimates of earnings benefits from reduced exposure of children to environmental lead

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Salkever DS</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Environmental Research</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This reassessment study of the benefits of reducing environmental lead exposure suggested a significant increase in benefits than previously reported. Rapid economic change and additional epidemiological data highlighted the need for regular reassessment of social benefit estimates to ensure that decision makers have up-to-date information when setting priorities for protecting human health and the environment.</td>
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<tr>
<td><strong>Population</strong></td>
<td>Not available</td>
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<tr>
<td><strong>Health Outcomes</strong></td>
<td></td>
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<tr>
<td>• Neurological/cognitive outcomes (IQ deficits)</td>
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<tr>
<td><strong>Environmental Agents</strong></td>
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<tr>
<td><strong>List of Environmental Agents</strong></td>
<td></td>
<td></td>
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<tr>
<td>• Metal (lead)</td>
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<tr>
<td><strong>Source of Environmental Agents</strong></td>
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<td></td>
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<tr>
<td>• Not available</td>
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<tr>
<td><strong>Economic Evaluation / Methods and Source</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type:</strong></td>
<td>Cost-benefit analysis (CBA)</td>
<td></td>
</tr>
<tr>
<td><strong>Costs Measured:</strong></td>
<td>Considered costs assessed in a previous study — Societal benefits of reducing lead exposure (Schwartz, 1994)</td>
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<tr>
<td><strong>Potential Cost Measures:</strong></td>
<td>Not available</td>
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</tr>
<tr>
<td><strong>Benefits Measures:</strong></td>
<td>Averted effects of lead exposure and IQ loss (effects of enhanced IQ on educational attainment, workforce participation, and earnings)</td>
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<tr>
<td><strong>Potential Benefits:</strong></td>
<td>Not available</td>
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</tbody>
</table>
The authors made minor extensions to a previous approach (Schwartz et al. 1994) to explicitly estimate the direct effects of IQ on educational attainment and on participation. Three different relationships were estimated using regression techniques — 1) least-squares regression of highest grade on cognitive ability; 2) multiple pro-bit regression of positive earnings on highest grade and cognitive ability; and 3) a least-squares regression, for persons with positive earned income, of the logarithm of earnings on highest grade and cognitive ability. As a measure of cognitive ability, the Armed Forces Qualifying Test percentile score for each respondent was converted to IQ units by assigning a score to each percentile.
An economic evaluation of the environmental benefits from pesticide reduction

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**  
Brethour C and Weersink A

**Journal**  
Agricultural Economics

**Summary**  
This study examined the environmental benefits of pesticide risk reduction in Ontario, Canada, and determined that the reduction in external costs associated with changes in pesticide use between 1983 and 1998 was $188 per household and $711 million (in US dollars) for the province as a whole. These benefits were largely due to the reduction in the levels of high and moderate-risk pesticides.

**Population**  
Not available

**Health Outcomes**
- Not available

**Environmental Agents**

**List of Environmental Agents**
- Pesticides

**Source of Environmental Agents**
- Application of agricultural pesticides

**Economic Evaluation / Methods and Source**

**Type:**  
Cost-benefit analysis (CBA)

**Costs Measured:**  
- External costs of pesticide use (low-risk, moderate-risk, and high-risk)

**Potential Cost Measures:**  
- Not available

**Benefits Measures:**  
- Willingness to pay values for reduction in environmental risk incurred by pesticide uses; values of the changes in environmental risks posed by pesticides

**Potential Benefits:**  
- Not available

**Location:**  
- Ontario, Canada
Models Used:
- Not available

Methods Used:
- The authors evaluated the value of environmental benefits associated with changes in the levels and types of pesticides applied in Ontario agriculture. They used the physical risk assessment approach (Mullen et al. 1997) with an incorporated contingent valuation survey to determine consumers' willingness to pay (CWP) for reductions in pesticide risk to different components of the environment. Using this approach, the authors — 1) identified changes in pesticide risk to the environment; and 2) examined valuation of changes in environmental risk using previous estimates of respondents willingness to pay (WTP) to reduce risk within each environmental category.

Sources Used:
- Survey data from the Ontario Ministry of Agriculture Food and Rural Affairs; additional sources cited in publication

Citation:
- Brethour C and Weersink A 2001 An economic evaluation of the environmental benefits from pesticide reduction Agricultural Economics 25

Pubmed:

DOI:
- http://dx.doi.org/10.1111/j.1574-0862.2001.tb00202.x

NIEHS Funding:
- Not available

Other Funding:
Societal costs of exposure to toxic substances: economic and health costs of four case studies that are candidates for environmental causation

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

Authors: Muir T and Zegarac M

Journal: Environmental Health Perspectives

Summary: This review article estimated that 10-50% of the social and economic costs of four health outcomes (diabetes, Parkinson's disease, neurodevelopmental effects, and IQ deficits) are environmentally induced. The authors concluded that accounting for the economic and social costs can contribute to a better understanding of the real scope of the many issues raised by polluted environments.

Population: Not available

Health Outcomes:
- Reviewed publications that examined — metabolic outcomes (diabetes); neurological/cognitive outcomes (Parkinson's disease, IQ deficits, ADHD, autism); hypothyroidism

Environmental Agents:
List of Environmental Agents:
- Reviewed publications that examined persistent toxic substances

Source of Environmental Agents:
- Not available

Economic Evaluation / Methods and Source:
Type:
- Cost analysis (CA)

Costs Measured:
- Reviewed publications that examined the following costs — healthcare costs/expenditures (e.g., inpatient, outpatient, nursing home, hospice, home-health provider/assisted living, prescription drugs, treatment/therapy); costs of disability income subsidies; lost productivity/earnings; costs of special education; costs related to justice system (e.g., juvenile delinquency and prison); impacts on lifetime earnings and labor force participation; social impact costs (e.g., welfare); costs of low-weight births

Potential Cost Measures:
- Not available

Benefits Measures:
- Not available
Potential Benefits:
• Not available

Location:
• Not available

Models Used:
• Not available

Methods Used:
• The authors reviewed literature to determine the evidence that exposure to environmental agents (particularly persistent toxic substances) are plausible risk factors for the chosen health outcomes. The authors — 1) evaluated literature to assess the extent to which approaches and methodologies to measure economic costs and impacts of the chosen health outcomes are developed; and 2) used primary data sources in cases where no existing studies were found that evaluated costs for the selected effects/outcomes.

Sources Used:
• Economic consequences of diabetes mellitus in the US in 1997 (American Diabetes Association, 1999); US Consumer Price Index (US Census Bureau); Diabetes in Canada: national statistics and opportunities for improved surveillance, prevention and control (He

Citation:
• Muir T and Zegarac M 2001 Societal costs of exposure to toxic substances: economic and health costs of four case studies that are candidates for environmental causation Environmental Health Perspectives 109 Suppl 6

Pubmed:
• http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240624/

DOI:

NIEHS Funding:
• Not available

Other Funding:
Health economics of asthma and rhinitis. II. Assessing the value of interventions

**Authors** Sullivan SD and Weiss KB

**Journal** Journal of Allergy and Clinical Immunology

**Summary** In this review article, the authors described the elements of comparative economic evaluations for asthma and rhinitis in an attempt to critically evaluate studies from the perspective of one who might use data for decision making. The authors suggested that the quality of economic evidence for asthma and rhinitis is limited, and therefore, the allocation of resources for these diseases will continue to primarily rely on expert opinion rather than evidence-based literature.

**Population** Not available

**Health Outcomes**
- Reviewed publications that examined — respiratory outcomes (asthma, allergic rhinitis)

**Environmental Agents**

**List of Environmental Agents**
- Not available

**Source of Environmental Agents**
- Not available

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-effectiveness analysis (CEA)

**Costs Measured:**
- Reviewed publications that assessed costs associated with asthma and rhinitis, including — Healthcare costs (diagnostic testing); education costs (special education, asthma patient education); productive days lost; short-stay observation units

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available
The authors performed a concise review of studies of both asthma and allergic rhinitis that highlight the utility of economic evaluations for clinical and resource decision making.

The cost-effectiveness of budesonide in severe asthmatics aged one to three years (Connett et al., 1993); Efficacy and cost benefit of inhaled corticosteroids in patients considered to have mild asthma in primary care (O'Byrne et al., 1996); Cost-effective...
**Cost-benefit analysis methods for assessing air pollution control programs in urban environments - a review**

<table>
<thead>
<tr>
<th>Details</th>
<th>Authors: Voorhees AS, Sakai R, Araki S, Sato H, and Otsu A</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Journal: Environmental Health and Preventive Medicine</td>
</tr>
<tr>
<td>Summary</td>
<td>This review article described conceptual approaches that could be useful in analyses of urban air pollution impacts and air pollution prevention policies. The history of cost-benefit analyses (CBA) for air pollution control programs was discussed. The authors identified benefits valuation techniques and approaches for estimating benefits and costs. CBA assumptions and results for several existing analyses of air pollution control in urban areas were presented, and the authors also summarized the importance of CBA in environmental policy studies.</td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
</tr>
</tbody>
</table>

### Health Outcomes
- Reviewed publications that examined — respiratory outcomes (asthma, lower respiratory illness)

### Environmental Agents
#### List of Environmental Agents
- Reviewed publications that examined — Air pollutants (nitrogen oxides (NOx, NO2))

#### Source of Environmental Agents
- Reviewed publications that examined — air pollution from motor vehicles; NOx sources combined; emissions from stationary sources

### Economic Evaluation / Methods and Source
#### Type:
- Cost-benefit analysis (CBA)

#### Costs Measured:
- Reviewed publications that assessed and described cost measurements related to air pollution impacts, including — private sector costs; societal costs; governmental regulatory costs

#### Potential Cost Measures:
- Addresses limitations in estimating — indirect costs incurred by regulated industries; indirect macroeconomic costs resulting from regulations

#### Benefits Measures:
- Reviewed publications that assessed benefits of reducing air pollution, including — human health; productivity (work output, crop yield, industrial equipment); amenity effects (visibility, odor, and noise)
Potential Benefits:
• Not available

Location:
• Not available

Models Used:
• Not available

Methods Used:
• The review article discussed several cost-benefit analysis methods for air pollution impacts.

Sources Used:
• An ex post cost-benefit analysis of the nitrogen dioxide air pollution control program in Tokyo (Voorhees et al., 2000)

Citation:
• Voorhees AS, Sakai R, Araki S, Sato H, and Otsu A 2001 Cost-benefit analysis methods for assessing air pollution control programs in urban environments - a review Environmental Health and Preventive Medicine 6 2

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/21432239

DOI:
• http://dx.doi.org/10.1007/BF02897948

NIEHS Funding:
• Not available

Other Funding:
Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities

### Details
<table>
<thead>
<tr>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

### Authors
Landrigan PJ, Schechter CB, Lipton JM, Fahs MC, and Schwartz J

### Journal
Environmental Health Perspectives

### Summary
This analysis estimated the economic costs associated with four categories of pediatric illness attributable to environmental factors (lead poisoning, asthma, cancer, and neurodevelopmental conditions) to be an annual total of $54.9 billion, or 2.8%, of total U.S. health care costs. This study represented the first comprehensive attempt to estimate the incidence, prevalence, mortality, and costs associated with pediatric disease of toxic environmental origin in the United States.

### Population
Children (≤ 5 years)

### Health Outcomes
- Lead poisoning; neurobehavioral outcomes; respiratory outcomes (asthma); cancer outcomes (childhood cancer)

### Environmental Agents

#### List of Environmental Agents
- Metals (lead); air pollutants (particulate matter)

#### Source of Environmental Agents
- Nonbiologic air pollutants (vehicle exhaust, emissions from stationary sources); source not available for metal (lead) exposure

### Economic Evaluation / Methods and Source

#### Type:
- Cost analysis (CA)

#### Costs Measured:
- Medical/healthcare costs (hospital care/hospitalization, physician services, medications, laboratory services; costs of long-term care (therapy/rehabilitation); indirect costs (lifetime earnings, lost productivity, lost school days, premature deaths, IQ reduction, loss of parental wages); investigators also considered effects of cranial irradiation on IQ reduction (treatment for childhood brain cancer)

#### Potential Cost Measures:
- Costs related to pain, suffering and/or late complications; costs for outcomes related to tobacco, alcohol or drug abuse

#### Benefits Measures:
- Not available
Potential Benefits:
- Not available

Location:
- Not available

Models Used:
- Environmentally Attributable Fraction (EAF) model; economic forecasting model

Methods Used:
- The authors estimated the contribution of environmental pollutants to the incidence, prevalence, mortality, and costs of pediatric disease in American children. The authors — 1) used disease-specific methodologies to estimate the costs for each type of health outcome; 2) estimated costs by calculating the environmentally attributable fraction (EAF) of each type of health outcome, multiplying by the disease rate and population size, and by the cost per case; 3) retrieved data on costs, prevalence, incidence, and morbidity for health outcomes from a variety of relevant sources; and 4) developed EAFs using a modified Delphi technique with a panel of experts.

Sources Used:
- US EPA; Asthma surveillance data (CDC, 1960-1995); Lead poisoning prevalence and blood lead levels data (CDC, 1991-1994); National Health Interview Survey (National Center for Health Statistic, 1994); SEER database (National Cancer Institute, 1995); US Ce

Citation:
- Landrigan PJ, Schechter CB, Lipton JM, Fahs MC, and Schwartz J 2002 Environmental pollutants and disease in American children: estimates of morbidity, mortality, and costs for lead poisoning, asthma, cancer, and developmental disabilities Environmental Health Perspectives 110 7

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
Economic evaluation of the benefits of reducing acute cardiorespiratory morbidity associated with air pollution

**Authors**
Stieb DM, De Civita P, Johnson FR, Manary MP, Anis AH, Beveridge RC, and Judek S

**Journal**
Environmental Health

**Summary**
This paper evaluated epidemiological studies estimating the costs and benefits of reducing acute cardiorespiratory morbidity associated with air pollution. The authors determined that decreases in particulate sulfate concentrations in Toronto between 1984 and 1999 resulted in annual benefits of $1.4 million in relation to reduced emergency department visits and hospital admissions for cardiorespiratory disease. The authors described an approach to estimating the value of avoiding morbidity effects of air pollution that addressed a number of the limitations of the current literature and is applicable to future assessments of the benefits of improving air quality.

**Health Outcomes**
- Mortality/morbidity; cardiorespiratory disease/illness; respiratory outcomes (asthma, chronic obstructive pulmonary disease, respiratory infections, non-specific respiratory symptoms); cardiovascular outcomes (congestive heart failure, cardiac dysrhythmias, myocardial infarction/angina)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (sulfates)

**Source of Environmental Agents**
- Not available

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Respiratory and cardiac hospital admissions; hospital utilization costs; costs of physician visits, medication use, equipment and out-of-pocket expenses; emergency department visits; restricted activity days; asthma symptom days; acute respiratory symptom days; cost of productivity losses (e.g., time lost by parents and caregivers)

**Potential Cost Measures:**
- Reduced work capacity
Benefits Measures:
- Benefits of reduced acute cardiorespiratory morbidity related to air pollution — reduced morbidity; reduced pain/suffering; reduced expenditures on mitigation of illness; reduced risk of lost productivity; reduced emergency department visits and hospital admissions for cardiorespiratory disease

Potential Benefits:
- Not available

Location:
- Saint John and Toronto, Canada

Models Used:
- Cost of treatment model

Methods Used:
- The authors estimated the benefits of avoiding a variety of acute cardiorespiratory morbidity outcomes related to air pollution. The authors — 1) used empirical data on the duration and severity of cardiorespiratory disease as inputs to complementary models of cost of treatment, lost productivity, and willingness to pay (WTP) to avoid acute cardiorespiratory morbidity outcomes linked to air pollution in epidemiological studies; 2) used a Monte Carlo estimation procedure to propagate uncertainty in key inputs and model parameters; and 3) illustrated application of their approach by examining the benefits associated with reduced cardiorespiratory emergency department visits and hospital admissions attributable to the decline in particulate sulfate concentrations observed in Toronto, Canada from the mid-1980s to the late 1990s.

Sources Used:
- Report of sulphur in gasoline and diesel fuels (Health and Environmental Impact Assessment Panel, 1997);
- Health and selected socioeconomic characteristics of the family: United States (Collins and LeClere, 1996);
- Sample design of the National Population H

Citation:
- Stieb DM, De Civita P, Johnson FR, Manary MP, Anis AH, Beveridge RC, and Judek S 2002 Economic evaluation of the benefits of reducing acute cardiorespiratory morbidity associated with air pollution Environmental Health 1 1

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
Fuels for urban transit buses: a cost-effectiveness analysis

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-effectiveness analysis (CEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Cohen JT, Hammitt JK, and Levy JI</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Environmental Science &amp; Technology</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This cost-effectiveness analysis estimated the benefits of alternative transit fuel technologies relative to conventional diesel (CD). The authors found that compressed natural gas (CNG) provided larger health benefits than emission-controlled diesel (ECD) buses, but ECD was more cost-effective than CNG. This study is the first to compute and compare aggregate incremental costs and health benefits for bus propulsion technologies.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
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</tbody>
</table>

**Health Outcomes**
- Mortality; cancer outcomes; respiratory outcomes (chronic asthma)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (ozone, nitrogen oxides (NO,NO2), sulfur dioxide, diesel exhaust)

**Source of Environmental Agents**
- Near and far-source exhaust and transit emissions (vehicle operation emissions or upstream emissions)

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-effectiveness analysis (CEA)

**Costs Measured:**
- Resource costs such as vehicle procurement, infrastructure development, and operations (vehicle maintenance, facility maintenance, and fuel); greenhouse gas emission damages; health losses (mortality and morbidity) due to environmental exposures measured as quality adjusted life years (QALYs) or health loss estimates

**Potential Cost Measures:**
- Health impacts/losses due to impact of ultrafine particles; quality of life impacts of alternative fuel technologies on noise/odor control; safety risks; maintenance failure costs; health risks to those living near bus depots where diesel buses are often left running throughout the night

**Benefits Measures:**
- Benefits and QALYs saved by the use of alternative transit fuel technologies relative to conventional diesel
Potential Benefits:

- Benefits measures and reductions in costs related to health impacts/losses due to impact of ultrafine particles; quality of life impacts of alternative fuel technologies on noise/odor control, maintenance, and other health risks

Location:

- Not available

Models Used:

- GREET model

Methods Used:

- The authors analyzed the costs and health benefits associated with the purchase of alternative bus propulsion technologies relative to conventional diesel (CD) engines. The authors — 1) used a series of simplifying assumptions to arrive at first-order estimates for the incremental cost-effectiveness of emission controlled diesel (ECD) and compressed natural gas (CNG) buses relative to CD engines; 2) calculated cost effectiveness using the cost-effectiveness ratio, where the numerator reflects acquisition and operating costs, and the denominator reflects health losses; 3) quantified health impacts using estimated relationships between exposure to particulate matter (PM) and ozone and QALYs lost; 4) evaluated emissions of PM, NOx, and SO2 considering mortality risks from primary and secondary PM exposure and mortality and chronic asthma risks from ozone exposure; 5) estimated exposures to PM and ozone using the "intake fraction" parameter; 6) estimated upstream emissions for CD and CNG using the GREET model; and 7) evaluated vehicle operation emissions generated by transit buses using the central business district (CBD) test cycle.

Sources Used:

- Intergovernmental Panel on Climate Change; Transportation Research Board; American Cancer Society (1995); National Morbidity, Mortality, and Air Pollution Study (2000); additional sources cited in publication

Citation:


Pubmed:


DOI:

- http://dx.doi.org/10.1021/es0205030

NIEHS Funding:

- Not available

Other Funding:
Particulate air pollution in urban areas of Shanghai, China: health-based economic assessment

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Kan HD and Chen BH</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Science of the Total Environment</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This cost analysis reported the estimated total economic cost of health impacts due to particulate air pollution in urban areas of Shanghai in 2001 was approximately $625.40 million US dollars. The results suggested that the impact of particulate air pollution on human health could be substantial in urban Shanghai in physical and economic terms.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Children and adolescents (&lt; 15 years); adults (≥ 15 years)</td>
<td></td>
</tr>
<tr>
<td><strong>Health Outcomes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Mortality/morbidity (premature death); cardiovascular outcomes; respiratory outcomes (chronic/acute bronchitis, asthma)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Environmental Agents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>List of Environmental Agents</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Air pollutants (particulate matter (PM 10/coarse))</td>
<td></td>
<td></td>
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<tr>
<td><strong>Source of Environmental Agents</strong></td>
<td></td>
<td></td>
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<tr>
<td>• Not available</td>
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<td></td>
</tr>
<tr>
<td><strong>Economic Evaluation / Methods and Source</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Type</strong>:</td>
<td>Cost analysis (CA)</td>
<td></td>
</tr>
<tr>
<td><strong>Costs Measured</strong>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Costs associated with premature death; healthcare costs (respiratory and cardiovascular hospital admissions); outpatient visits (internal medicine and pediatrics); costs associated with restricted activity days; costs associated with asthma attacks</td>
<td></td>
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</tr>
<tr>
<td><strong>Potential Cost Measures</strong>:</td>
<td></td>
<td></td>
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<tr>
<td>• Economic costs related to sub-clinical health symptoms</td>
<td></td>
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<tr>
<td><strong>Benefits Measures</strong>:</td>
<td></td>
<td></td>
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<tr>
<td>• Not available</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Potential Benefits</strong>:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Not available</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Location:
- Shanghai, China

Models Used:
- Not available

Methods Used:
- The authors assessed the health impact of particulate air pollution and estimated its social cost in the urban area of Shanghai. The authors — 1) used concentration-response coefficients derived from other studies to calculate the number of health outcomes attributable to particulate air pollution in urban areas of Shanghai in 2001; and 2) estimated the corresponding economic costs of the health damages based on willingness to pay (WTP), cost of illness (COI), and value of a statistical life (VOSL).

Sources Used:
- A survey on acute respiratory disease (Wang et al., 1994); The benefits and costs of the Clean Air Act 1990 to 2010, Appendix H 21–26 (US EPA, 1999); Willingness to pay for reducing the risk of death by improving air quality: a contingent valuation study

Citation:
- Kan HD and Chen BH 2004 Particulate air pollution in urban areas of Shanghai, China: health-based economic assessment Science of the Total Environment 332 1-3

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.scitote.2003.09.010

NIEHS Funding:
- Not available

Other Funding:
Assessing the health benefits of air pollution reduction for children

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**: Wong EY, Gohlke J, Griffith WC, Farrow S, and Faustman EM

**Journal**: Environmental Health Perspectives

**Summary**: This study estimated that the inclusion of child-specific data on hospitalizations, emergency department visits, school absences and low birth weight would add $1-2 billion to the predicted cost estimates of decreased morbidity and mortality derived from the US Clean Air Act (CAA). The results highlighted the need for environmental health policy analyses to include improved information for children’s health effects.

**Population**: Children and adolescents (≤ 18 years)

**Health Outcomes**
- Mortality (post-neonatal mortality); respiratory outcomes (asthma, upper respiratory symptoms, lower respiratory symptoms, shortness of breath, chest tightness, wheeze, acute bronchitis); birth outcomes (low birth weight, birth defects (ventricular septal defect))

**Environmental Agents**

**List of Environmental Agents**
- Air Pollutants (ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide, particulate matter (PM10 and PM2.5))

**Source of Environmental Agents**
- Not available

**Economic Evaluation / Methods and Source**

**Type**: Cost-benefit analysis (CBA)

**Costs Measured**: Hospital admissions and emergency department visits

**Potential Cost Measures**: Pain and suffering; lost leisure time

**Benefits Measures**: Reduced cases of post-neonatal mortality; reduced number of asthma hospitalizations, emergency department visits; avoided school absences; reduced number of low birth weight infants

**Potential Benefits**: Benefits of reduced birth defects (e.g., cardiac defects)
Models Used:
- Fast Environmental Regulatory Evaluation Tool (FERET)

Methods Used:
- The authors utilized a meta-analysis approach to assess child-specific health impacts derived from the US Clean Air Act (CAA). The authors — 1) surveyed the peer-reviewed air pollution literature for studies focused exclusively on children or presenting results for children ≤ 18 years of age in the US; 2) included 23 original studies examining the association between a considered health effect and an air pollutant; 3) used estimated expected average changes in annual air pollutant concentrations for the entire US on a national level through 2010 based on a previous analysis of the US EPA 1990 - 2010 study (Farrow et al. 2001) to allow comparability with previous studies; 4) estimated a projected 2010 US population ≤ 18 years old; and 5) analyzed health impacts using regression coefficients from different studies of the same health outcome that were combined to form a regression coefficient specific to each end point and pollutant.

Sources Used:
- International Classification of Diseases (US DHHS 1991); US Census Bureau (2002); additional sources cited in publication

Citation:
- Wong EY, Gohlke J, Griffith WC, Farrow S, and Faustman EM 2004 Assessing the health benefits of air pollution reduction for children Environmental Health Perspectives 112 2

Pubmed:

DOI:
- http://dx.doi.org/10.1289/ehp.6299

NIEHS Funding:
- 1P01ES09601

Other Funding:
Cost-effectiveness of a home-based environmental intervention for inner-city children with asthma

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)</th>
</tr>
</thead>
</table>

**Authors**

**Journal**
Journal of Allergy and Clinical Immunology

**Summary**
The authors of this study calculated the benefits of a home-based environmental remediation for young, asthmatic children. They determined that the intervention, which cost $1,469 per family, led to a statistically significant reduction in asthma-symptom days, unscheduled clinic visits, and use of beta-agonist inhalers. Findings indicated that the intervention is cost-effective when the aim is to reduce asthma symptom days and the associated costs.

**Population**
Children (6-11 years) enrolled in the Inner City Asthma Study (ICAS) with moderate-to-severe asthma

**Health Outcomes**
- Respiratory outcomes (asthma)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (tobacco smoke); indoor allergens (dust mite, cockroach, mold, pets, rodents)

**Source of Environmental Agents**
- Allergens from pests (cockroaches, rodents); cigarette smoke (secondhand smoke)

**Economic Evaluation / Methods and Source**

**Type**
- Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)

**Costs Measured**
- Healthcare use costs (scheduled/unscheduled medical visits, emergency department visits, inpatient hospital days, medications/pharmaceutical use); costs of the intervention which included skin tests, anti-allergen equipment (e.g., impermeable mattress and pillow covers, HEPA vacuum cleaner, HEPA air cleaner, vent filters); salary for environmental counselor; travel costs; pest management services

**Potential Cost Measures**
- School days lost; days on which caretaker had to change plans due to child's asthma

**Benefits Measures**
- Number of asthma-symptom free days; reduced healthcare costs
Potential Benefits:
- Reduction in health costs and asthma symptom-free days for other household members

Location:
- Cities within the United States — Boston; New York City; Chicago; Dallas; Seattle; Tucson

Models Used:
- Not available

Methods Used:
- The authors used incremental cost-effectiveness ratios (ICER) to assess the cost-effectiveness of a home-based environmental allergen and irritant remediation intervention among inner-city children aged 6-11 years with moderate-to-severe asthma over a two-year study period.

Sources Used:
- Inner-City Asthma Study (ICAS); National Cooperative Inner-City Asthma Study (NCICAS); Medicaid Reimbursement Survey; American Academy of Pediatrics (2001); The cost-effectiveness of an inner-city asthma intervention for children (Sullivan et al., 2002);

Citation:

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
NOx emissions from large point sources: variability in ozone production, resulting health damages and economic costs

Summary
This study examined health damages (e.g., mortality and morbidity costs) of ozone produced from nitrogen oxides that are emitted by large point sources in the eastern United States. The results showed that a shift of a unit of nitrogen oxide emissions from one place or time to another could result in large changes in resulting health effects due to ozone formation and exposure. The authors called for development of a system of fees to provide emitters incentives to reduce nitrogen oxides emissions at times and in locations where health damages are greatest.

Health Outcomes
- Mortality/morbidity; respiratory outcomes (respiratory morbidity)

Environmental Agents

List of Environmental Agents
- Air pollutants (ozone)

Source of Environmental Agents
- Ozone produced by NOx emitted by large, stationary point sources (power plants)

Economic Evaluation / Methods and Source

Type:
- Cost analysis (CA)

Costs Measured:
- Health damages/costs as a result of ozone exposures such as mortality costs (e.g., premature death); respiratory morbidity costs (e.g., respiratory hospital admissions)

Potential Cost Measures:
- Not available

Benefits Measures:
- Reductions in adverse health effects as a result of beneficial regulations/cap-and-trade programs that aim to shift fixed amount of NOx emissions from certain sources (i.e. quantities of ozone that are produced)

Potential Benefits:
- Not available
Location:
- Eastern region of the United States

Models Used:
- Comprehensive Air Quality Model with Extensions (CAMx)

Methods Used:
- The authors described a method for estimating the damages to human health due to exposure to ozone formed as result of nitrogen oxide emissions from individual large stationary sources in the eastern United States. The authors — 1) used a regional atmospheric model of the eastern United States (CAMx) to quantify the variable impact that a fixed quantity of NOx emitted from individual sources can have on the downwind concentration of surface ozone; and 2) examined the dependence of resulting ozone-related health damages on the size of the exposed population.

Sources Used:
- The benefits and costs of the Clean Air Act (US EPA, 1997, 1999 & 2003); Meta-analysis of time-series studies of air pollution and mortality: update in relation to the use of generalized additive models (Stieb et al., 2003); Gridded Population of the World

Citation:
- Mauzerall DL, Sultan B, Kim N, and Bradford DF 2005 NOx emissions from large point sources: variability in ozone production, resulting health damages and economic costs Atmospheric Environment 39

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
Public health and economic consequences of methyl mercury toxicity to the developing brain

Article #17

Details | Research article | Cost analysis (CA)

Authors | Trasande L, Landrigan PJ, and Schecter C

Journal | Environmental Health Perspectives

Summary | The cost of neurodevelopmental impacts (loss of intelligence) from methyl mercury of anthropogenic origin was estimated in this study to be $8.7 billion annually. Of this total, $1.3 billion each year was attributable to mercury emissions from American power plants. These data indicated an urgent need on economic grounds for regulatory intervention at the federal level to minimize mercury emissions.

Population | Infants and Children

Health Outcomes

- Neurodevelopmental outcomes (IQ deficit)

Environmental Agents

List of Environmental Agents

- Metals (methyl mercury)

Source of Environmental Agents

- American power plants

Economic Evaluation / Methods and Source

Type:

- Cost analysis (CA)

Costs Measured:

- Loss of earnings over lifetime due to decreased IQ

Potential Cost Measures:

- Cardiovascular impacts; costs of mercury exposure to children in the first two years of life; other societal costs beyond decreased lifetime earnings; non-cognitive impacts (e.g., criminality and antisocial behavior)

Benefits Measures:

- Not available

Potential Benefits:

- Not available

Location:

- Not available
Models Used:
- Environmentally Attributable Fraction (EAF) model; linear dose-response model; economic forecasting model

Methods Used:
- To assess the costs that may result from exposure of the developing brain to methyl mercury, the authors estimated the economic impact of anthropogenic methyl mercury exposure in the 2000 US birth cohort. The authors — 1) applied the EAF model to assess the neurodevelopmental impacts and costs due to methyl mercury exposure; 2) estimated the costs of the neurodevelopmental impacts and further parsed out the cost of anthropogenic methyl mercury exposure resulting from emissions of American electrical generation facilities; 3) conducted sensitivity analysis using a linear dose response model to set a reference dose for mercury exposure (i.e., to determine the economic costs and impact of lower/upper bounds of methyl mercury exposure on intelligence); and 4) used an economic forecasting model (Schwartz et al., 1995) that was applied to NHANES data on prevalence on mercury exposure in women of childbearing age to estimate the costs associated with IQ loss.

Sources Used:
- Benchmark dose level (BMDL) for cord blood mercury dose concentration (US EPA); Toxicological effects of methyl mercury (NRC, 2000); NHANES (1999-2000); Societal benefits of reducing lead exposure (Schwartz, 1994); American birth cohort data (CDC, 2000);

Citation:
- Trasande L, Landrigan PJ, and Schecter C 2005 Public health and economic consequences of methyl mercury toxicity to the developing brain Environmental Health Perspectives 113 5

Pubmed:

DOI:
- http://dx.doi.org/10.1289/ehp.7743

NIEHS Funding:
- P42ES07384

Other Funding:
Economic costs of childhood diseases and disabilities attributable to environmental contaminants in Washington state, USA

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

**Authors**  
Davies K

**Journal**  
Ecohealth

**Summary**  
This cost analysis estimated that the costs of childhood diseases and disabilities (asthma, cancer, lead exposure, birth defects, and neurobehavioral disorders) attributable to environmental contaminants equaled $1.875 billion in 2004 in Washington State. This study argued for the need of an ecosystem approach to human health in which the condition of the environment, in terms of exposures to environmental contaminants, must be addressed using a systemic perspective.

**Population**  
Children and adolescents (≤ 18 years)

**Health Outcomes**

- Cancer Outcomes; respiratory outcomes (asthma); birth outcomes (birth defects); neurological/cognitive outcomes (IQ/intelligence deficits)

**Environmental Agents**

**List of Environmental Agents**

- Air pollutants (traffic pollutants); metal (lead)

**Source of Environmental Agents**

- Outdoor pollution; vehicle exhaust emissions; source of lead not available

**Economic Evaluation / Methods and Source**

**Type:**

- Cost analysis (CA)

**Costs Measured:**

- Healthcare/medical costs such as hospital care, physician services, prescriptions, inpatient/outpatient charges, radiological services, lab services, and medical treatment; lost school days and lost productivity; lost parental wages; risk of secondary cancer; effects on IQ; lost productivity later in life; lifetime costs associated with decrements in IQ from lead exposure; costs of developmental services; cost of special education; housekeeping expenses

**Potential Cost Measures:**

- Asthmatic costs due to household allergens, molds, secondhand smoke, infections or climatic conditions; costs due to metabolic and functional birth defects

**Benefits Measures:**

- Not available
Potential Benefits:
- Not available

Location:
- Washington state, USA

Models Used:
- National and State Cost of Illness (COI) models; environmentally attributable fraction (EAF) model

Methods Used:
- The author estimated the economic costs associated with childhood diseases and disabilities attributable to environmental contaminants in Washington state, USA. The author — 1) based estimates on cost of illness models that included direct healthcare costs and indirect costs; and 2) used an environmentally attributable fraction (EAF) model to quantify the proportions of each disease or disability that could reasonably be attributed to environmental contaminants.

Sources Used:
- US Census Bureau (2000); US Dept. of Labor, Bureau of Labor Statistics (1999); Centers for Disease Control & Prevention (1997 and 2000); Trust for America's Health (2001); US National Academy of Sciences Committee on Developmental Toxicology (2000); Washi

Citation:
- Davies K 2006 Economic costs of childhood diseases and disabilities attributable to environmental contaminants in Washington state, USA Ecohealth 3 2

Pubmed:

DOI:
- http://dx.doi.org/10.1007/s10393-006-0020-1

NIEHS Funding:
- Not available

Other Funding:
Applying cost analyses to drive policy that protects children - mercury as a case study

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
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</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Trasande L, Schecther C, Haynes KA, and Landrigan PJ</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Annals of the New York Academy of Science</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>The economic costs of adverse health effects associated with prenatal mercury/methyl mercury exposure were determined using cost analysis. The costs related to diminished intelligence was estimated to be $8.7 billion annually, and costs of excess mental retardation cases is $2.0 billion annually. These results suggest that more stringent mercury policy options would prevent thousands of mental retardation cases and save billions of dollars over the next 25 years.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Infants (≤ 1 year)</td>
<td></td>
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</tbody>
</table>

**Health Outcomes**

- Neurological/cognitive outcomes (IQ deficits, mental retardation)

**Environmental Agents**

**List of Environmental Agents**

- Metals (mercury/methyl mercury)

**Source of Environmental Agents**

- Industrial mercury emissions (American coal-fired power plants)

**Economic Evaluation / Methods and Source**

**Type:**

- Cost analysis (CA)

**Costs Measured:**

- IQ deficits associated with prenatal mercury exposure; economic costs associated with IQ deficits; costs of excess mental retardation (MR) cases; cost of caring for MR children

**Potential Cost Measures:**

- Not available

**Benefits Measures:**

- Not available

**Potential Benefits:**

- Policies (e.g., EPAs Clean Air Mercury Rule) will likely result in the following benefits — averted cases of mental retardation; dollars saved/costs averted related to lost economic productivity, special education, and healthcare.
Models Used:
- Environmentally Attributable Fraction (EAF) model; linear dose-response model used by the National Research Council (NRC) to set reference dose for mercury exposure

Methods Used:
- The authors assessed the impact of industrial mercury emissions on children's health. Using an environmentally attributable fraction (EAF) model, the authors — 1) reviewed the adverse effects of MeHg exposure; 2) estimated the costs of the adverse effects (IQ decrements and mental retardation) and subsequently applied a further fraction to parse out the cost of anthropogenic MeHg exposure resulting from emissions of American electrical generation facilities; 3) used previously published data to obtain estimates about mercury concentrations in women of child-bearing age and mental retardation cases/prevalence in US; and 4) conducted sensitivity analysis with lower bound and upper bounds for estimating the costs to children with estimated cord blood concentrations.

Sources Used:
- NHANES (1999 - 2000); CDC National Vital Statistics System (2004); additional sources cited in publication

Citation:
- Trasande L, Schecther C, Haynes KA, and Landrigan PJ 2006 Applying cost analyses to drive policy that protects children - mercury as a case study Annals of the New York Academy of Science 1076

Pubmed:
- http://dx.doi.org/10.1196/annals.1371.034

NIEHS Funding:
- P42ES07384-07S1
Economic implications of manganese neurotoxicity

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Weiss B</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>NeuroToxicology</td>
<td></td>
</tr>
</tbody>
</table>

**Summary**
This review discussed factors to consider for monetizing the economic costs associated with declining capacities in the context of manganese-induced neurodegenerative diseases (e.g., Parkinson's disease). The author suggested that slight elevations in airborne manganese may produce a small but economically significant shift to an earlier onset of neurodegenerative diseases, such as Parkinson's disease.

**Population**
Not available

**Health Outcomes**
- Reviewed publications that examined — neurological/cognitive outcomes (Parkinson's disease, other neurodegenerative diseases (Manganism))

**Environmental Agents**

<table>
<thead>
<tr>
<th>List of Environmental Agents</th>
<th>Source of Environmental Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reviewed publications that examined — metal (manganese)</td>
<td>Reviewed publications that examined — inhaled manganese (hazardous air pollutant)</td>
</tr>
</tbody>
</table>

**Economic Evaluation / Methods and Source**

<table>
<thead>
<tr>
<th>Type:</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

**Costs Measured:**
- Reviewed publications that examined — costs associated with Parkinson's disease, such as annual medical costs

**Potential Cost Measures:**
- Costs of institutionalization; costs related to remedial care and/or education; decline in functional capacity

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available
Methods Used:

- The author reviewed previous literature to analyze how manganese neurotoxicity elevates Parkinson's risk and explored the influence of aging along with the economic implications of these risks.

Sources Used:

- Rate of cell death in Parkinsonism indicates active neuropathological process (McGeer et al., 1988); Ageing and Parkinson's disease: substantia nigra regional selectivity (Fearnley and Lees, 1991); additional sources cited in publication

Citation:

- Weiss B 2006 Economic implications of manganese neurotoxicity NeuroToxicology 27 3

Pubmed:


DOI:

NIEHS Funding:

- P01ES001247; P50ES001247; P30ES001247

Other Funding:
The economic impact of clean indoor air laws

**Article #21**

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**
Eriksen M and Chaloupka F

**Journal**
CA: A Cancer Journal for Clinicians

**Summary**
This review article presented evidence that clean indoor air laws are easily implemented, well accepted by the public, reduce nonsmoker exposure to secondhand smoke, and contribute to a reduction in overall cigarette consumption. Economic analyses indicated that clean indoor policies do not have negative economic impacts on the hospitality industry, contrary to fears raised by the tobacco industry.

**Population**
Not available

**Health Outcomes**
- Reviewed publications that examined — cancer outcomes (lung cancer, cervical cancer); respiratory outcomes (asthma, chronic obstructive pulmonary disease); otitis media; cardiovascular outcomes (coronary heart disease); birth outcomes (low birth weight, sudden infant death syndrome)

**Environmental Agents**

**List of Environmental Agents**
- Reviewed publications that examined — air pollutants (tobacco smoke)

**Source of Environmental Agents**
- Reviewed publications that examined — cigarette smoke

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Reviewed publications that examined the following costs — costs and impacts on business/industry revenues (e.g., employment, openings/closings); costs and impacts on tourism (e.g., retail revenues, hotel revenues, etc.); impacts to gaming establishments and businesses

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Reviewed publications that assessed benefits of clean indoor air laws, such as — reduced medical costs; reduced serum cotinine levels in nonsmokers; reduced cigarette smoking; protecting nonsmokers from exposure to tobacco smoke
Potential Benefits:
  - Not available

Location:
  - Not available

Models Used:
  - Not available

Methods Used:
  - The authors reviewed the spread of clean indoor air laws, along with their effects on public health and the scientific evidence of the economic impact of implementation of clean indoor air laws/policies.

Sources Used:
  - CDC Third National Report on Human Exposure to Environmental Chemicals (DHHS, 2007); Smoke-free laws and secondhand smoke exposure in US non-smoking adults (Pickett et al., 2006); Population based smoking cessation: proceedings of a conference on what wor

Citation:

Pubmed:

DOI:
  - http://dx.doi.org/10.3322/CA.57.6.367

NIEHS Funding:
  - Not available

Other Funding:
### The economic impact of attention-deficit/hyperactivity disorder in children and adolescents

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Pelham WE, Foster EM, and Robb JA</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Ambulatory Pediatrics</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>The economic impact of attention-deficit/hyperactivity disorder (ADHD) in childhood and adolescence was estimated to be $14,576 per individual for an annual societal estimate of $52.4 billion, according to this review article. The results highlighted the public health importance of ADHD, and the authors argued for expansion of and additional research on evidence-based interventions for ADHD.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Children and adolescents (≤ 17 years)</td>
<td></td>
</tr>
</tbody>
</table>

#### Health Outcomes
- Reviewed publications that examined — neurological/cognitive outcomes (ADHD)

#### Environmental Agents
<table>
<thead>
<tr>
<th>List of Environmental Agents</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Not available</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source of Environmental Agents</th>
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</thead>
<tbody>
<tr>
<td>• Not available</td>
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</tbody>
</table>

#### Economic Evaluation / Methods and Source

<table>
<thead>
<tr>
<th>Type:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Cost analysis (CA)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Costs Measured:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Reviewed publications that examined the following costs — healthcare costs (inpatient, outpatient); treatment costs (pharmacological treatment costs, psychosocial mental health treatment); educational costs (special education services); costs related to crime and delinquency (juvenile justice system utilization)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Cost Measures:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Impacts of ADHD children on parental and family function (e.g., distress depression, substance use); costs associated with disability/welfare for individuals within ADHD families; costs associated with substance abuse/use; costs associated with risky behaviors</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Benefits Measures:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Not available</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Potential Benefits:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Not available</td>
</tr>
</tbody>
</table>
Location:
- Not available

Models Used:
- Not available

Methods Used:
- The authors performed a review of aggregated data from recently published articles that studied the economic costs of ADHD. The authors — 1) selected thirteen studies based on their relevance to the economic costs associated with ADHD; and 2) provided a summed estimate of total ADHD costs across different sectors (e.g., health/mental health, education, crime and delinquency).

Sources Used:
- Utilization and cost of health care services for children with attention-deficit/hyperactivity disorder (Guevera et al., 2001); Use and costs of medical care for children and adolescents with and without attention-deficit/hyperactivity disorder (Leibson &

Citation:
- Pelham WE, Foster EM, and Robb JA 2007 The economic impact of attention-deficit/hyperactivity disorder in children and adolescents Ambulatory Pediatrics 7 Suppl 1

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.ambp.2006.08.002

NIEHS Funding:
- Not available

Other Funding:
How much disease burden can be prevented by environmental interventions

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Prüss-Ustün A and Corvalán C</td>
</tr>
<tr>
<td>Journal</td>
<td>Epidemiology</td>
</tr>
</tbody>
</table>

**Summary**
This commentary described the methods and key findings from a 2006 WHO report that estimated how much of the global burden of disease can be prevented by environmental management. Findings presented within this report suggested that creating healthier environments can prevent approximately one fourth of the disease burden globally in a way that is sustainable, and supported the case that interventions for healthy environments should be an important component of any strategy to improve global public health.

**Population**
Not available

**Health Outcomes**
- Reviewed publications that examined — respiratory outcomes (chronic obstructive pulmonary disease, asthma); gastrointestinal outcomes (diarrheal diseases); cancer outcomes; neurological/cognitive outcomes (neuropsychiatric disorders); cardiovascular outcomes; musculoskeletal outcomes

**Environmental Agents**

**List of Environmental Agents**
- Reviewed publications that examined — environmental pollution; ionizing radiation; non-ionizing radiation (UV)

**Source of Environmental Agents**
- Reviewed publications that examined — air; water; soil; built environment (housing and road design); occupation

**Economic Evaluation / Methods and Source**

**Type:**

**Costs Measured:**
- Not available

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available
Location:
- Not available

Models Used:
- Not available

Methods Used:
- The authors briefly describe the methods used in the 2006 WHO Environmental Burden of Disease report. The report — 1) enlarged the scope of previous studies to include most of the risks contained in the environment; 2) systematically reviewed diseases and injuries as to their environmental causes; 3) consulted experts to complete gaps in the evidence to obtain a more comprehensive estimate (using the attributable fraction approach/method) of the potential healthy environments to prevent disease; and 4) limited the environment to only the "reasonably modifiable environment" to improve the policy relevance of results.

Sources Used:

Citation:
- Prüss-Ustün A and Corvalán C 2007 How much disease burden can be prevented by environmental interventions Epidemiology 18 1

Pubmed:

DOI:
- http://dx.doi.org/10.1097/01.ede.0000239647.26389.80

NIEHS Funding:
- Not available

Other Funding:

NIEHS Environmental Health Economic Analysis Annotated Bibliography, February 2016  Page 52
Outcomes of a home-based environmental remediation for urban children with asthma

**Details**

<table>
<thead>
<tr>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Bryant-Stephens T and Li Y</td>
</tr>
<tr>
<td>Journal</td>
<td>Journal of the National Medical Association</td>
</tr>
</tbody>
</table>

**Summary**

This study examined the effectiveness of a home-based intervention for reducing environmental asthma triggers, and determined that children experienced fewer asthma-related hospitalizations, emergency room visits, sick visits, and asthma symptoms with the intervention. Study findings suggested that low-cost in-home education and environmental remediation may improve outcomes for asthmatic children, and that lay educators can deliver effective asthma-specific education that results in improved asthma control.

**Population**

Children and adolescents living in urban areas (2-16 years)

**Health Outcomes**

- Respiratory outcomes (asthma, asthma symptoms (nighttime/daytime wheezing and coughing))

**Environmental Agents**

**List of Environmental Agents**

- Indoor allergens (cockroach, dust mite); air pollutants (tobacco smoke)

**Source of Environmental Agents**

- Allergens from pests (cockroaches, rodents); cigarette smoke (secondhand smoke)

**Economic Evaluation / Methods and Source**

**Type:**

- Cost-benefit analysis (CBA)

**Costs Measured:**

- Asthma-related inpatient hospitalizations (length of hospital stays); number of emergency visits related to asthma; number of sick visits related to asthma; cost for environmental asthma trigger intervention; salary for home visitor

**Potential Cost Measures:**

- Not available

**Benefits Measures:**

- Reduction in number of inpatient hospitalizations/visits; reduction in number of asthma-related emergency department visits and sick visits; reduction in frequency of daytime/nighttime asthma symptoms (wheezing, coughing, etc.); reduced reliance on asthma medications (beta-agonists and controller medicines (e.g., albuterol))
Potential Benefits:
• Not available

Location:
• Philadelphia, Pennsylvania

Models Used:
• Not available

Methods Used:
• The authors used a prospective, randomized controlled trial design to study the effectiveness of a low-cost asthma intervention using lay educators to promote control of asthma triggers in the bedrooms of children with asthma. The authors — 1) enrolled patients in the study who received primary care at The Children's Hospital of Philadelphia between 1999 and 2002; 2) randomly assigned patients to either the observation only (OBS) group or the home visitor education and environmental intervention (HVE) group; 3) delivered in-home education visits which covered asthma physiology, asthma trigger avoidance and asthma management and conducted environmental remediation with the caregiver; and 4) monitored groups for 12 months.

Sources Used:
• The authors collected the data used for the study described in this publication. No other existing datasets were used.

Citation:
• Bryant-Stephens T and Li Y 2008 Outcomes of a home-based environmental remediation for urban children with asthma Journal of the National Medical Association 100 3

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/18390024

DOI:

NIEHS Funding:
• Not available

Other Funding:
**Economic evaluation of the US Environmental Protection Agency's SunWise Program: sun protection education for young children**

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-effectiveness analysis (CEA), Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Kyle JW, Hammitt JK, Lim HW, Geller AC, Hall-Jordan LH, Maibach EW, De Fabo EC, and Wagner MC</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Pediatrics</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This cost-benefit and cost-effectiveness analysis examined the costs, effectiveness, and benefits of the EPA's SunWise program. The researchers estimated that for every dollar invested in the program, $2 to 4 are potentially saved in medical costs and productivity losses. The findings suggested that it is worthwhile to educate children about sun safety and that small to modest behavioral impacts may result in significant reductions in skin cancer incidence and mortality.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Children and adolescents (5-15 years)</td>
<td></td>
</tr>
</tbody>
</table>

**Health Outcomes**

- Cancer outcomes (skin cancer, basal cell carcinoma, squamous cell carcinoma, cutaneous malignant melanoma); premature death

**Environmental Agents**

**List of Environmental Agents**

- Non-ionizing radiation (UV)

**Source of Environmental Agents**

- Sunlight

**Economic Evaluation / Methods and Source**

**Type:**

- Cost-effectiveness analysis (CEA), Cost-benefit analysis (CBA)

**Costs Measured:**

- Skin cancer cases; program implementation costs (including the funding amount of the program)

**Potential Cost Measures:**

- Private costs; cost of teachers’ time spent on SunWise; community programs or parent influence

**Benefits Measures:**

- Averted premature deaths; averted skin cancer cases; quality adjusted life years (QALYs) saved; return per dollar spent; costs averted (equal to the cases averted multiplied by medical and productivity loss cost per case); medical care and productivity costs averted
Potential Benefits:
• Impacts of other program components (i.e., SunWise Cities/Communities Program); change in impact if students receive SunWise lessons more than once

Location:
• Not available

Models Used:
• Atmospheric and Health Effects Framework Model (AHEF)

Methods Used:
• The authors used standard cost/benefit and cost-effectiveness analysis methods to assess the health and economic benefits of the EPA’s SunWise School Program. The authors — 1) measured intervention costs as program costs estimated to be incurred by the US government using three funding scenarios; 2) measured health outcomes as skin cancer cases and premature mortalities averted and QALYs; 3) modeled health outcomes using an effectiveness evaluation of SunWise based on pretest and posttest surveys administered to students who participated in the program and the EPA’s peer-reviewed Atmospheric and Health Effects Framework model; 4) measured costs averted as direct medical costs and costs of productivity losses averted as a result of SunWise; and 5) measured net benefits as the difference between costs averted and program costs.

Sources Used:
• National Human Activity Pattern Survey; US Environmental Protection Agency; US Bureau of Labor Statistics; Medicare Current Beneficiary Survey (1999–2000); additional sources cited in publication

Citation:

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/18450850

DOI:
• http://dx.doi.org/10.1542/peds.2007-1400

NIEHS Funding:
• Not available

Other Funding:
### Monetary benefits of preventing childhood lead poisoning with lead-safe window replacement

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Nevin R, Jacobs DE, Berg M, and Cohen J</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Environmental Research</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>The authors used a cost–benefit analysis to quantify the health benefits, costs, market value benefits, and energy savings of lead-safe window replacement and suggested that the intervention would yield net monetary benefits of at least $67 billion and 15-25% reduction in energy costs. In addition, such a window replacement effort would reduce peak demand for electricity, carbon emissions from power plants, and associated long-term costs of climate change.</td>
<td></td>
</tr>
</tbody>
</table>

| **Population** | Children (1-5 years) |

### Health Outcomes
- Neurological/cognitive outcomes (IQ deficits, ADHD)

### Environmental Agents
#### List of Environmental Agents
- Metals (lead)

#### Source of Environmental Agents
- Lead-based paint in old windows/window panes

### Economic Evaluation / Methods and Source
#### Type:
- Cost-benefit analysis (CBA)

#### Costs Measured:
- Cost of lead-safe window replacement

#### Potential Cost Measures:
- Lead paint litigation; special property maintenance; stress on parents; premature mortality/memory loss from lead exposure in childhood; treatment of dental caries associated with lead exposure; hearing loss; liver, kidney and other diseases associated with lead exposure

#### Benefits Measures:
- Lifetime earnings

#### Potential Benefits:
- Benefits of avoided healthcare costs associated with neurobehavioral/developmental outcomes (e.g., ADHD, mental retardation); benefits of other avoided medical costs of childhood lead exposure (e.g., chelation, follow-up, monitoring, physician visits, etc.); benefits of avoided special education; housing
market value benefits; energy savings (e.g., reduction in peak demand for electricity, carbon emissions from power plants, long-term costs of climate change)

Location:
- Not available

Models Used:
- Not available

Methods Used:
- The authors quantified health benefits, costs, market value benefits, energy savings, and net economic benefits of lead-safe window replacement. The authors — 1) estimated trends in preschool blood lead and blood lead reduction from window replacement from NHANES and NSLAH data; 2) calculated lifetime earnings and other benefits from lead-safe window replacement per resident child in housing units; and 3) calculated lead-safe window replacement costs and energy savings from US Department of Housing and Urban Development data.

Sources Used:
- US EPA (1986, 2003); US Department of Housing and Urban development (1999); NHANES (1999-2002); National Survey of Lead and Allergens in Housing (NSLAH, 1999-2000); additional sources cited in publication

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.envres.2007.09.003

NIEHS Funding:
- Not available

Other Funding:
Smoke-free legislation and hospitalizations for acute coronary syndrome

Article #27

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**  

**Journal**  
New England Journal of Medicine

**Summary**  
This cost-benefit analysis performed in Scotland, Europe found that the number of hospital admissions for acute coronary syndrome decreased 17% overall and 21% among persons who had never smoked after enactment of smoke-free legislation. Study findings supported the legal treaty for improving public health outlined in the World Health Organization's Framework Convention on Tobacco Control.

**Population**  
Acute coronary syndrome patients — adults (men ≤ 55 years, women ≤ 65 years)

**Health Outcomes**

- Cardiovascular outcomes (acute coronary syndrome)

**Environmental Agents**

**List of Environmental Agents**

- Air pollutants (tobacco smoke)

**Source of Environmental Agents**

- Cigarette smoke (secondhand)

**Economic Evaluation / Methods and Source**

**Type:**

- Cost-benefit analysis (CBA)

**Costs Measured:**

- Not available

**Potential Cost Measures:**

- Not available

**Benefits Measures:**

- Reduction in acute coronary syndrome; related hospital admissions following smoke-free legislation

**Potential Benefits:**

- Not available

**Location:**

- Scotland
Models Used:
- Not available

Methods Used:
- The authors compared the number of admissions for acute coronary syndrome (ACS) before and after implementation of national legislation, overall, and according to smoking status. The authors — 1) collected data prospectively on all patients with ACS admitted to nine hospitals during the 10 months before implementation of the smoke-free legislation and during the same 10 months thereafter; 2) obtained case ascertainment for individuals with ACS by performing troponin assays for all patients admitted with chest pain; 3) obtained smoking status and exposure to secondhand smoke by self-reports and confirmed using cotinine assays; and 4) analyzed percentage reduction in the number of admissions, including subgroup analyses according to patients' sex and age group.

Sources Used:
- Acute myocardial infarction: trends in incidence 1996-2005 (NHS National Services Scotland, 2007); Hospital Episodes Statistics (Department of Health, 2007); Deaths: information and statistics (General Register for Scotland, 2007); additional sources cite

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1056/NEJMsa0706740

NIEHS Funding:
- Not available

Other Funding:

NIEHS Environmental Health Economic Analysis Annotated Bibliography, February 2016
**Local air pollution and global climate change: a combined cost-benefit analysis**

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Bollen J, Van Der Zwaan B, Brink C, and Eerens H</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Resource and Energy Economics</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This paper reports the first cost-benefit analysis that combines the damages resulting from global climate change and local air pollution. The authors found that the discounted benefits of local air pollution reductions significantly outweigh those of global climate change mitigation. However, the authors called for policies that simultaneously address reducing air pollution and greenhouse gas emissions, as their combination creates an additional climate change bonus.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Not available</td>
<td></td>
</tr>
</tbody>
</table>

**Health Outcomes**
- Mortality (premature death)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (particulate matter (PM2.5/fine))

**Source of Environmental Agents**
- Emissions from fossil fuel combustion (electricity/non-electricity sectors); greenhouse gas emissions; CO2 emissions

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Costs for implementing CO2, PM, and greenhouse gas abatement/reduction options or policies (costs of energy services and consumer goods); damages incurred by emissions; number of premature local air pollution-related deaths; years of life lost; costs related to premature death

**Potential Cost Measures:**
- Costs incurred by the implementation of end-of-pipe measures or the switch from fossil fuels to the use of alternative, cleaner forms of energy

**Benefits Measures:**
- Net global welfare benefits generated by integrated environmental policies (focused on reduction of air pollution and climate change damages); avoided number of premature deaths; avoided damages from CC and LAP
Potential Benefits:
• Not available

Location:
• Not available

Models Used:
• Modified/expanded version of the Model for Evaluating the Regional Global Effects (MERGE) model of greenhouse gas reduction policies

Methods Used:
• The authors performed a combined cost-benefit analysis of global climate change (GCC) and local air pollution (LAP) to investigate the benefits of technologies and environmental policies that simultaneously address GCC and LAP. The authors — 1) used a modified and expanded version of the MERGE model to estimate the costs and benefits from both GCC and LAP policies in a dynamic and multi-regional context; 2) used the ‘Value of a Statistical Life’ (VSL) and ‘Value Of a Life Year lost’ (VOLY) methods to value mortality incurred from PM exposure (Holland et al. 2004); and 3) used data from World Bank (2007) to estimate particulate matter concentrations across different urban and rural populations.

Sources Used:
• WHO (2002, 2004, 2006); The Regional Air Pollution Information and Simulation (RAINS) Model, Interim Report (Amann et al., 2004a); World Bank (2007); additional sources cited in publication

Citation:
• Bollen J, Van Der Zwaan B, Brink C, and Eerens H 2009 Local air pollution and global climate change: a combined cost-benefit analysis Resource and Energy Economics 31

Pubmed:

DOI:
• http://dx.doi.org/10.1016/j.reseneeco.2009.03.001

NIEHS Funding:
• Not available

Other Funding:
### The economic cost of environmental factors among North Carolina children living in substandard housing

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Chenoweth D, Estes C, and Lee C</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>American Journal of Public Health</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>The authors of this cost analysis study determined the cost of exposure to environmental hazards for children living in substandard housing in North Carolina. The costs exceeded $92 million in 2006 and $108 million in 2007. These findings suggest that more aggressive policies and funding are needed to reduce the substantial financial impact of childhood illnesses associated with substandard housing in North Carolina.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Children and adolescents in substandard housing (≤ 18 years)</td>
<td></td>
</tr>
</tbody>
</table>

### Health Outcomes
- Neoplasms; birth outcomes (congenital birth defects (anencephaly, cleft lip, cleft palate, cleft palate with cleft lip, heart defects, hypospadias, limb reduction, omphalocele, and spina bifida); lead or metal poisoning; neurological/cognitive outcomes (autism, cerebral palsy, mental retardation); respiratory outcomes (acute bronchitis, asthma)

### Environmental Agents

#### List of Environmental Agents
- Metal (lead); air pollutants

#### Source of Environmental Agents
- Substandard housing conditions

### Economic Evaluation / Methods and Source

#### Type:
- Cost analysis (CA)

#### Costs Measured:
- Medical care treatment; medications

#### Potential Cost Measures:
- School days lost; home modifications; developmental services; parental and lifetime wages lost; premature death; IQ reduction; lifetime earnings lost

#### Benefits Measures:
- Not available

#### Potential Benefits:
- Not available
Location:
• North Carolina

Models Used:
• Environmentally Attributable Fraction (EAF) model within a Proportionate Risk Factor Cost Appraisal (PRFCA) framework

Methods Used:
• The authors quantified the economic cost of selected environmental factors among North Carolina children living in substandard housing. They — 1) estimated direct costs by reviewing various cost analysis approaches by other research and obtaining relevant medical claims and cost data for children with targeted medical conditions; and 2) estimated indirect costs by obtaining data from previous work and applying it to the target population.

Sources Used:
• Medical claims and cost data (Division of Medical Assistance of the North Carolina Department of Health and Human Services, 2006 and 2007); medical claims data from BlueCross BlueShield of North Carolina; additional sources cited in publication

Citation:

Pubmed:
• http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2774188/

DOI:
• http://dx.doi.org/10.2105/AJPH.2008.141671

NIEHS Funding:
• Not available

Other Funding:
**Childhood lead poisoning: conservative estimates of the social and economic benefits of lead hazard control**

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Gould E</td>
<td></td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>Environmental Health Perspectives</td>
<td></td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This cost-benefit analysis of childhood lead poisoning determined that each dollar invested in lead paint hazard control resulted in a return of $17 - $221, or a net savings of $181-269 billion in health care, social, and behavioral costs. Results suggested there are substantial returns to investing in lead hazard control, particularly targeted at early intervention in communities most likely at risk.</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Children (≤ 6 years)</td>
<td></td>
</tr>
</tbody>
</table>

**Health Outcomes**
- Neurological/cognitive outcomes (IQ deficits, ADHD)

**Environmental Agents**

**List of Environmental Agents**
- Metal (lead)

**Source of Environmental Agents**
- Lead-based paint in housing

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Healthcare costs of screening and treatment (e.g., venipuncture, capillary blood sampling, lead assays, risk assessments/questionnaires, nurse-only visits, physician visits, environmental investigation/hazard removal, oral chelation, and intravenous chelation); social/behavioral costs (e.g., criminal activity/crime costs); lifetime earnings; special education costs; costs of lead-linked ADHD cases; tax revenue losses; costs of preventive measures resulting from criminal action

**Potential Cost Measures:**
- Healthcare costs later in life; costs related to neonatal mortality; costs related to community improvement; lead paint litigation; indirect costs to criminal activity; medical diagnostics; costs of treatment for those with blood lead levels < 10 μg/dL; treatment costs for children who didn't receive immediate treatment for lead poisoning

**Benefits Measures:**
- Study estimated the benefits of reducing lead-based paint in homes (i.e., household lead-based paint hazard
control) relative to the direct/indirect healthcare costs associated with lead exposure (e.g., increased IQ, higher lifetime earnings, tax revenues, reduced spending on special education, and reduced criminal activity)

Potential Benefits:
- Benefits of lead hazard control on property value and energy savings

Location:
- Not available

Models Used:
- Not available

Methods Used:
- The author quantified the social and economic benefits to household lead paint hazard control compared with the investments needed to minimize exposure to these hazards. This research updated estimates of elevated blood lead levels among a cohort of children ≤ 6 years of age. The author — 1) compared the composition of children with blood lead levels between 2 and 10 μg/dL with the demographic patterns of the entire cohort of children ≤ 6 years of age; 2) constructed an upper and lower bound cost-effectiveness of strategies to reduce lead exposure; 3) summed and compared the total benefits and costs of childhood lead level reduction; and 4) estimated the net benefit of lead-based paint hazard control in homes.

Sources Used:
- NHANES (CDC, 2003-2006); National Center for Environmental Health (CDC, 2007a); President's Task Force on Environmental Health Risks and Safety Risks to Children (2000); US Department of Housing and Urban Development (2002); US Census Bureau (2008); Feder

Citation:
- Gould E 2009 Childhood lead poisoning: conservative estimates of the social and economic benefits of lead hazard control Environmental Health Perspectives 117 7

Pubmed:

DOI:
- http://dx.doi.org/10.1289/ehp.0800408

NIEHS Funding:
- Not available

Other Funding:

The costs of respiratory illnesses arising from Florida gulf coast Karenia brevis blooms

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>Environmental Health Perspectives</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>The relationship between Karenia brevis algal blooms and the costs of respiratory illness-related visits to emergency departments in Sarasota County, Florida was the focus of this cost–benefit analysis. The authors found that the estimated marginal costs of illness ranged from $0.5 to $4 million, depending on bloom severity. Study results suggest blooms of K. brevis lead to significant economic impacts.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
<td></td>
</tr>
<tr>
<td>Health Outcomes</td>
<td>• Respiratory outcomes (pneumonia, bronchitis (chronic/acute), asthma, upper airway disease)</td>
<td></td>
</tr>
<tr>
<td>Environmental Agents</td>
<td>• Aerosolized toxicants (brevetoxins)</td>
<td></td>
</tr>
<tr>
<td>List of Environmental Agents</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Source of Environmental Agents</td>
<td>• Algal blooms of Karenia brevis</td>
<td></td>
</tr>
<tr>
<td>Economic Evaluation / Methods and Source</td>
<td>Type:</td>
<td>Cost analysis (CA)</td>
</tr>
<tr>
<td>Costs Measured:</td>
<td>• Marginal medical costs of emergency department (ED) visits for respiratory ailments due to aerosolized brevetoxins; lost productivity</td>
<td></td>
</tr>
<tr>
<td>Potential Cost Measures:</td>
<td>• Other costs of illness (shellfish poisoning); costs for accessing primary care physicians, allergists, or pulmonologists, as well as prescriptions and over-the-counter medications; non-market costs associated with pain and suffering</td>
<td></td>
</tr>
<tr>
<td>Benefits Measures:</td>
<td>• Not available</td>
<td></td>
</tr>
<tr>
<td>Potential Benefits:</td>
<td>• Not available</td>
<td></td>
</tr>
</tbody>
</table>
Location:
- Sarasota County, Florida

Models Used:
- Exposure-response model

Methods Used:
- The authors examined the relationship between K. brevis blooms and respiratory illness visits to hospital emergency departments and used this relationship to estimate the costs of illness associated with aerosolized brevetoxins. The authors — 1) developed an exposure-response model to express hypotheses about the relationship between respiratory illnesses, harmful algal blooms events, and other potential explanatory variables; 2) compiled total number of daily emergency department visits for respiratory diagnoses from October 2001 - September 2006; and 3) used in situ K. brevis cell counts as a proxy for aerosolized brevetoxin concentrations along the coast.

Sources Used:
- ED visits related to respiratory illness (Sarasota Memorial Hospital, 2001-2006); CDC; Sarasota Convention and Visitors Bureau; Florida Agency for Healthcare Administration; US Census Bureau (2008); National Allergy Bureau; MML Pass Weather Station (2009)

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1289/ehp.0900645

NIEHS Funding:
- P50ES12736; P01ES010594; P50ES012742

Other Funding:
The social costs of childhood lead exposure in the post-lead regulation era

Authors: Muennig P

Journal: Archives of Pediatrics and Adolescent Medicine

Summary: The authors estimated the benefits that might be realized if all children in the United States had a blood lead level of less than 1 μg/dL. This cost–benefit analysis estimated that policy changes to reduce childhood lead exposure would amount to societal benefits of $50,000 per child annually, and an overall savings of approximately $1.2 trillion for US society as a whole. The authors concluded that more aggressive programs aimed at reducing childhood lead exposure may produce large social benefits.

Population: Children (≤ 6 years)

Health Outcomes
- Neurological/cognitive outcomes (IQ deficits)

Environmental Agents

List of Environmental Agents
- Metals (lead)

Source of Environmental Agents
- Not available

Economic Evaluation / Methods and Source

Type:
- Cost analysis (CA), Cost-benefit analysis (CBA)

Costs Measured:
- IQ reduction; reduced lifetime earnings; crime costs; welfare costs; healthcare costs

Potential Cost Measures:
- Costs related to teen pregnancy; costs related to low-birth weight infants; costs related to intergenerational transmission of poverty; costs of child abuse and nonviolent criminal activity

Benefits Measures:
- Increase in high school graduation rates; quality adjusted life years (QALYs) gained; increase in lifetime earnings; reduction in administrative overhead for welfare costs; reduction in mortality; reduction in social costs of crime
Potential Benefits:
- Not available

Location:
- Not available

Models Used:
- Markov Model; mortality models; Health-Related Quality of Life (HRQL) models

Methods Used:
- The authors — 1) obtained data from published and electronic sources; 2) utilized a Markov model to project lifetime earnings, reduced crime costs, improvements in health, and reduced welfare costs; and 3) selected model inputs using a "levels of evidence" approach with inputs derived from randomized controlled trials given the highest priority.

Sources Used:
- NHANES (1999-2006); additional sources cited in publication

Citation:
- Muennig P 2009 The social costs of childhood lead exposure in the post-lead regulation era Archives of Pediatrics and Adolescent Medicine 163 9

Pubmed:

DOI:
- http://dx.doi.org/10.1001/archpediatrics.2009.128

NIEHS Funding:
- Not available

Other Funding:
The economic impact of exposure to secondhand smoke in Minnesota

**Summary**

This cost analysis study estimated the prevalence and costs of treated medical conditions related to secondhand smoke exposure (e.g., lung cancer and coronary heart disease) in Minnesota and found that the total annual cost of treatment was $228.7 million. The results presented a strong rationale for regulating smoking in public places and were used to support the passage of Minnesota's Freedom to Breathe Act of 2007.

**Population**

Nonsmokers — children and adolescents (≤ 17 years); adults (18 years +)

**Health Outcomes**

- Birth outcomes (low birth weight); respiratory outcomes (acute lower respiratory illnesses, asthma); ear infection; cancer outcomes (lung cancer); cardiovascular outcomes (coronary heart disease)

**Environmental Agents**

**List of Environmental Agents**

- Air pollutants (tobacco smoke)

**Source of Environmental Agents**

- Cigarette smoke (secondhand)

**Economic Evaluation / Methods and Source**

**Type:**

- Cost analysis (CA)

**Costs Measured:**

- Costs related to professional services; inpatient/outpatient hospital services; laboratory, radiology, and pathology services; costs of prescribed pharmaceuticals for all assessed outcomes

**Potential Cost Measures:**

- Medical costs related to sub conditions such as "cough, phlegm, wheeze, and breathlessness among schoolchildren" and "lower level of lung function during childhood" were excluded because they could not be clearly mapped to coded medical conditions with administrative claims data. Medical costs related to SIDS were excluded because the condition leads to immediate mortality instead of treatment. Investigators also excluded costs associated with health conditions the surgeon general identified as having a "suggestive but not sufficient" causal link with exposure to secondhand smoke.

**Benefits Measures:**

- Not available
Potential Benefits:
- Not available

Location:
- Minnesota

Models Used:
- Population Attributable Risk (PAR) equation; Episode Treatment Group methodology (ETG codes)

Methods Used:
- The authors estimated medical treatment costs related to exposure to secondhand tobacco smoke (SHS) in the state of Minnesota. To generate prevalence and cost estimates, the authors — 1) identified health conditions caused by secondhand smoke exposure; 2) determined the prevalence for each condition for Blue Cross members; 3) adjusted the treated prevalence to the state level; 4) determined the number of episodes attributable to secondhand smoke; and 5) determined the cost per episode. The authors used Episode Treatment Group (ETG) codes, applied to administrative claims data from Blue Cross, to identify individuals with an episode, and the average cost per episode, for each of the assessed health conditions for the year 2003.

Sources Used:
- Administrative claims data (Blue Cross Blue Shield of Minnesota); The Health Consequences of Involuntary Exposure to Tobacco Smoke: A Report of the Surgeon General (2006); Current Population Survey (Bureau of Labor Statistics, 2004); Health Insurance Cove

Citation:
- Waters HR, Foldes SS, Alesci NL and Samet J 2009 The economic impact of exposure to secondhand smoke in Minnesota American Journal of Public Health 99 4

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
Air pollution, health and economic benefits - lessons from 20 years of analysis

Summary
The authors compared two large-scale air quality benefit assessments that were completed for California’s South Coast Air Basin in 1989 and 2008. The authors concluded that there were dramatic improvements in air quality, and dramatic reductions in population exposures to particulate matter and ozone between the two time periods. The authors highlighted the continually evolving health literature, and in contrast, fairly constant real economic unit values assigned to adverse health outcomes.

Population
Adults (18-64 years)

Health Outcomes
- Reviewed publications that examined premature mortality

Environmental Agents

List of Environmental Agents
- Reviewed publications that examined — air pollutants (particulate matter (PM10/coarse and PM2.5/fine), ozone)

Source of Environmental Agents
- Not available

Economic Evaluation / Methods and Source

Type:
- Cost-benefit analysis (CBA)

Costs Measured:
- Reviewed publications that examined costs related to air quality, including — PM-related premature death/mortality (measured using value of a statistical life (VSL); ozone-related minor restrictions in activity days (MRADS)

Potential Cost Measures:
- Costs of asthma-related ER visits; respiratory hospital admissions; cardiopulmonary hospital admissions; cardiovascular outcomes; work days lost

Benefits Measures:
- Reviewed publications that examined benefits of improving air quality, including — reduced incidence of premature mortality; reduced/averted number of minor restricted activity days; improved air quality
**Potential Benefits:**
- Not available

**Location:**
- South Coast Air Basin in California, USA

**Models Used:**
- Regional Human Exposure Model (REHEX); linear rollback model

**Methods Used:**
- The authors reviewed and compared two large-scale air quality benefit assessments completed for California’s South Coast Air Basin for two different periods, 1989 and 2008. To determine which factors explain the differences in the two air quality assessments, the authors — 1) used an integrated approach to calculate reductions in adverse health outcomes by linking the severity of pollutant exposure of the affected population to the resulting health outcomes; and 2) assigned dollar values to each adverse health outcome/endpoint based on value of a statistical life (VSL).

**Sources Used:**
- Economic assessment of the health benefits from improvements in air quality in the South Coast Air Basin (Hall et al., 1989); The benefits of meeting federal clean air standards in the South Coast and San Joaquin Air Basins (Hall et al., 2008); Cross-sect

**Citation:**
- Hall JV, Brajer V, and Lurmann FW 2010 Air pollution, health and economic benefits - lessons from 20 years of analysis Ecological Economics 69 12

**Pubmed:**

**DOI:**
- http://dx.doi.org/10.1016/j.ecolecon.2010.08.003

**NIEHS Funding:**
- Not available

**Other Funding:**
## The economic cost of adverse health effects from wildfire-smoke exposure: a review

### Details

<table>
<thead>
<tr>
<th>Authors</th>
<th>Kochi I, Donovan GH, Champ PA, and Loomis JB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>International Journal of Wildland Fire</td>
</tr>
<tr>
<td>Summary</td>
<td>The economic costs of the adverse health impacts associated with wildfire smoke are discussed in this review article. The authors determined that there is a need for better understanding of the association between wildfire smoke and major/minor adverse health outcomes and suggested that quantifying the health-related costs of wildfire-smoke exposure will be an important consideration for wildfire management policy.</td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
</tr>
</tbody>
</table>

### Health Outcomes

- Reviewed publications that examined — morbidity/mortality (premature mortality); cardiovascular outcomes (heart failure); respiratory outcomes (acute bronchitis, asthma, chronic obstructive pulmonary disease, pneumonia)

### Environmental Agents

#### List of Environmental Agents

- Reviewed publications that examined — air pollutants (particulate matter)

#### Source of Environmental Agents

- Reviewed publications that examined wildfire smoke

### Economic Evaluation / Methods and Source

#### Type:

- Cost analysis (CA)

#### Costs Measured:

- Reviewed publications that examined economic costs associated with wild-fire smoke exposure, including — healthcare costs (hospital admissions inpatient/outpatient visits, emergency department visits); costs of premature mortality; number of excess deaths; morbidity related costs (work days lost, restricted-activity days, minor restricted-activity days); self-treatment costs; other overall costs reviewed included those that were estimated using the willingness to pay (WTP) and cost of illness (COI) method (medical costs, labor loss, averting costs, and utility loss)

#### Potential Cost Measures:

- Costs of relocating susceptible individuals from smoke-affected areas

#### Benefits Measures:

- Not available
Potential Benefits:
- The authors mention "prescribed burning" as a technique that would lead to reduction in health costs related to wildfires, reduction in fuel loads, reduction in future PM emissions

Location:
- Not available

Models Used:
- Not available

Methods Used:
- The authors reviewed and synthesized relevant literature related to health and economic costs of wildfire-smoke exposure. The authors focused on the following — 1) if wildfire-specific epidemiology studies found significant health effects associated with wildfire-smoke exposure; and 2) if the findings in wildfire-specific epidemiology studies are consistent with the findings in conventional PM studies. They then outlined potential reasons/causes for differences in observed health effects from conventional PM and wildfire smoke studies.

Sources Used:
- The economic costs of the use of fire in the Amazon (Cardoso de Mendonca et al., 2004); Indonesia's fires and haze — the cost of catastrophe (Shahwahid and Othman 1999); Smoke episodes emissions characterization and assessment of health risks related to d

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1071/WF09077

NIEHS Funding:
- Not available

Other Funding:
Cost analysis of impacts of climate change on regional air quality  

**Authors**  

**Journal**  
Journal of the Air & Waste Management Association

**Summary**  
Using a regional air quality model and a technology analysis tool, this cost-benefit analysis assessed the additional emission reductions required and associated costs to offset impacts of climate change on air quality. Overall, an annual cost of $9.3 billion was estimated for offsetting climate change impacts on air quality in the regions examined. Results suggested that additional emission controls and associated costs for offsetting climate impacts should be considered in developing control strategies for achieving air quality targets in the future.

**Population**  
Not available

**Health Outcomes**  
- Not available

**Environmental Agents**

**List of Environmental Agents**  
- Air pollutants (ozone, particulate matter (PM2.5/fine))

**Source of Environmental Agents**  
- Anthropogenic emissions of precursor air pollutants (SO2, NOx, VOCs)

**Economic Evaluation / Methods and Source**

**Type:**  
- Cost analysis (CA)

**Costs Measured:**  
- Costs of anthropogenic precursor emissions reductions; costs of offsetting impacts on climate change; annualized capital costs (calculated by taking into account interest rates, lifetime of the emission control equipment, and capital recovery factors); yearly operation and maintenance costs; implementation costs

**Potential Cost Measures:**  
- Control costs for reductions in primary PM2.5; interstate transport of precursors

**Benefits Measures:**  
- Not available

**Potential Benefits:**  
- Not available
Location:
- Six regions of the United States (West region, Central region, Great Lakes region, Northeast region, Mid-Atlantic region, and Southeast region); five metropolitan cities within the United States (Atlanta, Chicago, Houston, Los Angeles, New York City)

Models Used:
- The U.S. EPA's Models-3 Air Quality Modeling System—Fifth-Generation NCAR/Penn State Mesoscale Model (MM5); Sparse Matrix Operator Kernel Emissions (SMOKE); Community Multiscale Air Quality Model (CMAQ)

Methods Used:
- The authors assessed the additional emissions reductions required and associated costs to offset impacts of climate change on air quality. The authors — 1) implemented air quality modeling using current and future emissions scenarios for five metropolitan areas that experience high ozone and PM2.5 levels; and 2) used EPA’s control technology analysis tool (AirControlNET) to estimate the costs of emissions reductions of major ozone and PM2.5 precursors.

Sources Used:
- AirControlNET Version 4.1 Documentation Report (E.H. Pechan and Associates, 2006); National Emission Inventory (NEI) (1999); The decoupled direct method for calculating sensitivity coefficients in chemical-kinetics (Dunker, 1984); The decoupled direct met

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.3155/1047-3289.60.2.195

NIEHS Funding:
- Not available

Other Funding:
Estimates of costs for housing-related interventions to prevent specific illnesses and deaths

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
<th>Cost analysis (CA), Cost-effectiveness analysis (CEA), Cost-benefit analysis (CBA), Cost-utility analysis (CUA)</th>
</tr>
</thead>
</table>

**Authors**  
Mason J and Brown MJ

**Journal**  
Journal of Public Health Management and Practice

**Summary**  
An overview of economic analyses of housing-related interventions to address asthma, lead poisoning, carbon monoxide poisoning, and radon-related lung cancer was discussed in this review article. The authors stated that understanding both the strengths and limitations of economic evaluations will help decision makers interpret findings appropriately and make informed decisions about how best to allocate limited resources.

**Population**  
Not available

**Health Outcomes**
- Reviewed publications that examined — respiratory outcomes (asthma); cancer outcomes (lung cancer)

**Environmental Agents**

**List of Environmental Agents**
- Reviewed publications that examined — metals (lead); air pollutants (carbon monoxide (CO)); allergens/irritants; ionizing radiation (radon gas)

**Source of Environmental Agents**
- Reviewed publications that examined — home/residential exposures

**Economic Evaluation / Methods and Source**

**Type:**
- Cost analysis (CA), Cost-effectiveness analysis (CEA), Cost-benefit analysis (CBA), Cost-utility analysis (CUA)

**Costs Measured:**
- Reviewed publications that examined costs related to the following — asthma-related medical/healthcare costs; missed school days; productivity losses; lost lifetime earnings due to premature death; costs related to environmental/residential exposures to mold/dampness; costs for medications associated with comorbidities of asthma (e.g., allergic rhinitis); costs for asthma-related housing interventions (e.g., home-based interventions, integrated pest management, and reducing exposure to pesticides and allergens); lead-poisoning costs (e.g., productivity losses); costs related to radon exposure in homes/remediation (e.g., costs of lung cancer, radon mitigation costs, and costs for making new radon-resistant home)

**Potential Cost Measures:**
- Economic costs and burden of common housing-related injuries; direct medical costs of lead exposure in homes; costs associated with the effects of in utero lead exposure (reduced gestational age or lower birth
weight) or certain adult adverse outcomes (increases in blood pressure and cardiovascular disease); CO poisoning-related fatality costs; morbidity costs related to CO residential exposure; costs of CO exposure home interventions (e.g. CO detectors)

Benefits Measures:
- Reviewed publications that examined the following benefits — societal benefits from reduced lead exposures related to productivity gains; savings in energy costs and higher market values; benefits of preventing premature death caused by radon-induced lung cancer

Potential Benefits:
- Reduction in costs for ADHD, juvenile delinquency, criminal behavior, and special education as they are associated with lead exposures in young children; healthcare costs due to extended life expectancy; delayed lung cancer onset and prevention of nonfatal lung cancer; benefits to future generations that live in radon high-risk areas

Location:
- Not available

Models Used:
- Not available

Methods Used:
- The authors performed a review of economic articles on housing interventions, examined salient differences between studies, and discussed pertinent gaps in the literature. They provided an overview of key economic evaluation methods in relation to housing interventions pertaining to housing-related health issues/illness such as asthma, lead, carbon-monoxide poisoning and radon-related lung cancer.

Sources Used:
- Direct and indirect costs of asthma in school-age children (Wang et al., 2005); The Seattle-King County Healthy Homes Project: a randomized, controlled trial of a community health worker intervention to decrease exposure to indoor asthma triggers (Krieger

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1097/PHH.0b013e3181e28b2e

NIEHS Funding:
- Not available

Other Funding:
## School buses, diesel emissions, and respiratory health

### Article #38

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**
Beatty TK and Shimshack JP

**Journal**
Journal of Health Economics

**Summary**
This study estimated the benefits of the clean school bus program in Washington state, and determined that school bus retrofits induced statistically significant reductions in bronchitis, asthma, and pneumonia incidence for children and adults with chronic conditions. These results suggested that policies targeting localized air pollution may be particularly cost effective relative to ambient air pollution policies.

**Population**
At-risk populations with chronic respiratory conditions (children and adults)

**Health Outcomes**
- Respiratory outcomes (bronchitis, asthma, pneumonia, pleurisy)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants

**Source of Environmental Agents**
- Diesel emissions

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Healthcare costs per inpatient episode of bronchitis, asthma, and pneumonia; CCV retrofit costs (including parts, labor, and testing) per adopter school district

**Potential Cost Measures:**
- Indirect costs of school absences, pain and suffering, communicable disease transmission, and long-term welfare effects; Costs related to non-respiratory illnesses, long-term health effects, and health impacts on adults with chronic respiratory conditions

**Benefits Measures:**
- Reduced and/or avoided healthcare cost

**Potential Benefits:**
- Benefits calculations related to reduction in costs for non-respiratory illnesses, long-term health effects, suffering considerations, and impacts on adults with chronic respiratory conditions
Location:
- Puget Sound region, Washington

Models Used:
- Not available

Methods Used:
- The authors examined the impact of school bus emissions reductions programs on health outcomes. The authors — 1) performed a large-scale empirical assessment of the health outcomes stemming from school bus retrofit programs for Washington state districts; 2) used standard two-period difference-in-difference approach to examine differential trends in health outcomes for adopter districts and non-adopter districts over time using a regression model; and 3) combined empirical point estimates with cost-of-treatment health valuation estimates and observed retrofit costs to compute benefit-cost assessment of school bus retrofits.

Sources Used:
- Washington State Comprehensive Hospital Abstract Reporting System (CHARS); US Historical Climatology Network; Washington State Department of Ecology; Puget Sound Clean Air Agency; Washington State Department of Health; National Center of Educational Stati

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.jhealeco.2011.05.017

NIEHS Funding:
- Not available

Other Funding:
Meeting report: estimating the benefits of reducing hazardous air pollutants — summary of 2009 workshop and future considerations

<table>
<thead>
<tr>
<th>Details</th>
<th>Report</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>Environmental Health Perspectives</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This report summarized the 2009 EPA workshop to evaluate the uncertainties and research needs for many aspects of benefits assessment of reductions in air toxics. Key recommendations provide specific steps in advancing analysis of the benefits from air toxics reductions and suggest some future studies to inform many of the challenges in this field.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
<td></td>
</tr>
</tbody>
</table>

**Health Outcomes**
- Cancer outcomes; other serious health outcomes

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (acrolein); other organic compounds (toluene/xylene, benzene/ethyl benzene); metals (lead)

**Source of Environmental Agents**
- Stationary industrial facilities; automobiles

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Present value of lifetime loss in earnings per IQ point lost

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available

**Location:**
- Not available
Models Used:
- Not available

Methods Used:
- Not available

Sources Used:
- National Ambient Air Quality Standards (NAAQS) (US EPA); National Health and Nutrition Examination Survey (NHANES) (CDC); additional sources cited in publication

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1289/ehp.1002468

NIEHS Funding:
- Not available

Other Funding:
Article #40

Economic value of home-based, multi-trigger, multicomponent interventions with an environmental focus for reducing asthma morbidity a community guide systematic review

Details

Review (systematic)

Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)

Authors

Nurmagambetov TA, Barnett SB, Jacob V, Chattopadhyay SK, Hopkins DP, Crocker DD, Dumitru GG, Kinyota S, and Task Force on Community Preventive Services

Journal

American Journal of Preventive Medicine

Summary

This systematic review identified the effectiveness and economic value of home-based interventions to reduce childhood asthma morbidity. The researchers found that the benefits of interventions with an environmental focus can match or even exceed program costs. Results of this review showed that home-based programs can provide a good value for dollars spent on the interventions.

Population

Nine studies included children and adolescents (≤ 19 years) with asthma; three studies included participants of all ages with asthma

Health Outcomes

- Reviewed publications that examined — respiratory outcomes (asthma)

Environmental Agents

List of Environmental Agents

- Reviewed publications that examined — air pollutants; indoor allergens

Source of Environmental Agents

- Not available

Economic Evaluation / Methods and Source

Type:

- Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)

Costs Measured:

- Reviewed publications that examined program costs (costs of resources required to implement intervention) which varied based on the following factors — home visitor type (e.g., nurse, sanitarian), number of home visits, remediation type (e.g., allergen impermeable pillow covers/mattresses, installation of air filters/dehumidifiers, pest management, repairs), and education content

Potential Cost Measures:

- Not available

Benefits Measures:

- Reviewed publications that examined benefits such as — symptom free asthma days; averted healthcare utilization; averted missed school and work days due to illness; averted productivity losses
Potential Benefits:
- Reduction of indirect costs such as costs related to quality of life and pain/suffering for asthma patients and caregivers

Location:
- Eleven studies in the United States; two studies in the United Kingdom

Models Used:
- Not available

Methods Used:
- The authors systematically assessed the economic efficiency of home-based, multi-trigger, multi-component interventions with an environmental focus to improve asthma-related morbidity outcomes. The authors — 1) conducted a systematic literature review to retrieve relevant studies; 2) vetted the results using inclusion/exclusion criteria; and 3) analyzed program costs and changes in symptom free days.

Sources Used:
- The Watcombe Housing Study: the short term effect of improving housing conditions on the health of residents (Barton et al., 2007); Housing and health: does installing heating in their homes improve the health of children with asthma? (Somerville et al.,

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.amepre.2011.05.011

NIEHS Funding:
- Not available

Other Funding:
### Economics of children's environmental health

#### Article #41

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Authors</strong></td>
<td>Trasande L</td>
</tr>
<tr>
<td><strong>Journal</strong></td>
<td>The Mount Sinai Journal of Medicine</td>
</tr>
<tr>
<td><strong>Summary</strong></td>
<td>This review article presented a selection of articles that used cost analyses, cost-effectiveness analyses, and cost-benefit analyses, and compared the relative merits of each approach as they apply to children's environmental health. The authors concluded that economic analyses in children's environmental health are highly important to inform public-health policy, and further attention and training in their appropriate use are needed.</td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>Children</td>
</tr>
</tbody>
</table>

#### Health Outcomes
- Reviewed publications that examined — respiratory outcomes (asthma); metabolic outcomes (obesity); neurodevelopmental outcomes (mental retardation)

#### Environmental Agents
- **List of Environmental Agents**
  - Reviewed publications that examined — metals (lead, methyl mercury)
- **Source of Environmental Agents**
  - Reviewed publications that examined — lead in gasoline; lead in paint; mercury from coal-fired power plants

#### Economic Evaluation / Methods and Source
- **Type**:
  - Cost analysis (CA), Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)
- **Costs Measured**:
  - Reviewed publications that examined costs related to the following — healthcare expenses; hospitalizations; prescription drugs; outpatient visits and emergency room visits; lost economic productivity; QALYs lost; cost of implementing interventions
- **Potential Cost Measures**:
  - Not available
Benefits Measures:
- Reviewed publications that assessed benefits of reducing children’s exposure to environmental agents, such as — quality adjusted life years (QALYs) or disability adjusted life years (DALYs) saved/gained; savings in healthcare expenses and educational costs; increased economic productivity; reduced incidence/prevention of illness (e.g., obesity, childhood lead poisoning, mental retardation)

Potential Benefits:
- Not available

Location:
- Not available

Models Used:
- Review described the environmentally attributable fraction (EAF) model

Methods Used:
- This review article compared three types of economic evaluations, described the strengths and weaknesses, and provided examples of each. The authors discussed data sources commonly used in economic health analyses and methodological gaps and issues.

Sources Used:
- Authors recommended several data sources for conducting environmental health economic analyses, such as — NHANES (to quantify environmental exposures); National Health Interview Survey (for disease prevalence and incidence attributable to environmental ex

Citation:
- Trasande L 2011 Economics of children's environmental health The Mount Sinai Journal of Medicine 78 1

Pubmed:

DOI:
- http://dx.doi.org/10.1002/msj.20234

NIEHS Funding:
- Not available

Other Funding:
Reducing the staggering costs of environmental disease in children, estimated at $76.6 billion in 2008

**Article #42**

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

**Authors**  
Trasande L and Liu Y

**Journal**  
Health Affairs

**Summary**  
This cost analysis found that diseases of environmental origin in US children cost $76.6 billion in 2008. The authors concluded that to prevent further increases in these costs, efforts are needed to institute premarket testing of new chemicals, conduct toxicity testing on chemicals already in use, reduce lead-based paint hazards, and curb mercury emissions from coal-fired power plants.

**Population**  
Children

**Health Outcomes**
- Cancer outcomes (childhood cancer); respiratory outcomes (asthma); neurological/cognitive outcomes (intellectual disability, autism, ADHD, developmental disabilities); lead poisoning; methyl mercury toxicity

**Environmental Agents**

**List of Environmental Agents**
- Environmental pollutants ("chemical substances of human origin in air, food water, and communities"); metals (lead, methyl mercury)

**Source of Environmental Agents**
- Not available

**Economic Evaluation / Methods and Source**

**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Medical care costs for lead poisoning; lost economic productivity due to reduced cognitive ability from lead exposure and methyl mercury toxicity; intellectual disability costs; autism costs; ADHD costs; economic costs of developmental disabilities; medical costs of asthma; work days lost caring for child with asthma; medical costs for children with malignancies (inpatient emergency room costs, prescription drug costs, outpatient costs)

**Potential Cost Measures:**
- Medical costs of obesity due to exposure to endocrine-disrupting chemicals; cardiovascular risks due to perinatal exposure to methyl mercury; criminal activity due to childhood lead exposure

**Benefits Measures:**
- Not available
Potential Benefits:
- Economic savings achieved by preventing methyl mercury contamination of fish

Location:
- Not available

Models Used:
- Environmentally Attributable Fraction (EAF) model

Methods Used:
- To update and expand a previous analysis of the costs of environmental disease in children, the study authors multiplied the environmentally attributable fraction by the prevalence or incidence of each condition examined, the population at risk, and the cost per case.

Sources Used:
- US Census Bureau (2008); National Survey of Children's Health (2007-2008); National Health and Nutrition Examination Survey (1999-2004); Medical Expenditure Panel Surveys; Nationwide Inpatient Sample; Nationwide Emergency Department Survey; National Hospi

Citation:
- Trasande L and Liu Y 2011 Reducing the staggering costs of environmental disease in children, estimated at $76.6 billion in 2008 Health Affairs 30 5

Pubmed:

DOI:
- http://dx.doi.org/10.1377/hlthaff.2010.1239

NIEHS Funding:
- Not available

Other Funding:
Cost of developmental delay from prenatal exposure to airborne polycyclic aromatic hydrocarbons

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Weiland K, Neidell M, Rauh V, and Perera F</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Journal of Health Care for the Poor and Underserved</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>The cost of preschool special education for children with PAH-related cognitive developmental delay was estimated to be over $13.7 million per birth cohort in New York City, according to this cost analysis. These findings support the role of policies aimed at reducing the level of PAHs in air in order to reduce the health impacts associated with PAH exposure.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Low-income, preschool children in NYC</td>
<td></td>
</tr>
</tbody>
</table>

Health Outcomes
- Neurological/cognitive outcomes (developmental delay)

Environmental Agents
List of Environmental Agents
- Air pollutants (polycyclic aromatic hydrocarbons (PAH))

Source of Environmental Agents
- Combustion of fossil fuels and other organic materials

Economic Evaluation / Methods and Source
Type:
- Cost analysis (CA)

Costs Measured:
- Annual costs of preschool special education services

Potential Cost Measures:
- Not available

Benefits Measures:
- Not available

Potential Benefits:
- Not available

Location:
- New York City
Models Used:
- Environmentally Attributable Fraction (EAF) model

Methods Used:
- Researchers used results from CCCEH NYC cohort (low-income women/children in NYC) to compute the rate of developmental delay due to PAH exposure for the NYC Medicaid population. The authors — 1) employed the environmentally attributable fraction method to calculate the costs of developmental delay due to prenatal exposure to PAHs; and 2) estimated the annual costs of PAH-related preschool education services by multiplying the rate of developmental delay by the size of the population at risk from exposure to PAH and the cost per case for preschool education.

Sources Used:
- Effect of prenatal exposure to airborne polycyclic aromatic hydrocarbons on neurodevelopment in the first 3 years of life among inner-city children (Perera et al., 2006); Early childhood outcomes data (New York State Education Department, 2007); New York

Citation:
- Weiland K, Neidell M, Rauh V, and Perera F 2011 Cost of developmental delay from prenatal exposure to airborne polycyclic aromatic hydrocarbons Journal of Health Care for the Poor and Underserved 22 1

Pubmed:

DOI:
- http://dx.doi.org/10.1353/hpu.2011.0012

NIEHS Funding:
- Not available

Other Funding:
- NIEHS Environmental Health Economic Analysis Annotated Bibliography, February 2016
Upgrading to cleaner household stoves and reducing chronic obstructive pulmonary disease among women in rural China — a cost-benefit analysis

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Aunan K, Alnes LWH, Berger J, Dong Z, Ma L, Mestl HES, Vennemo H, Wang S, and Zhang W</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Energy for Sustainable Development</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This cost-benefit analysis determined that replacing indoor biomass stoves with cleaner burning stoves in villages of Guizhou Province, China, could potentially avoid 0.6-3.2 annual incidences of COPD per 1000 households with the economic value being greater than the intervention costs. Results suggested that policy interventions to increase access to cleaner burning stoves may provide large net benefits to rural women and their families.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Adults (women ≥ 30 years)</td>
<td></td>
</tr>
</tbody>
</table>

Health Outcomes
- Respiratory outcomes (chronic obstructive pulmonary disease (COPD))

Environmental Agents

List of Environmental Agents
- Air pollutants (particulate matter (PM 2.5/fine))

Source of Environmental Agents
- Indoor biomass stoves

Economic Evaluation / Methods and Source

Type:
- Cost-benefit analysis (CBA)

Costs Measured:
- Costs for purchase, installation and maintenance of stove (including fuel costs); medical treatment expenses

Potential Cost Measures:
- Not available

Benefits Measures:
- Treatment expenses saved; avoided incidence of COPD

Potential Benefits:
- Convenience benefits from improved stoves; avoided incidence of COPD in men and children

Location:
- Guizhou Province, China
Models Used:
- Not available

Methods Used:
- The authors sought to estimate the costs and benefits among women of replacing current biomass stoves in a rural area of China with second generation improved stoves. The authors — 1) developed hypothetical intervention scenarios for two groups of households (chimney households and no-chimney households); 2) estimated the indoor PM2.5 exposure pre and post-intervention; 3) calculated health benefits of COPD incidences avoided based on change of indoor concentrations of PM2.5 and lung function after replacement of biomass stoves; 4) monetized benefits based on treatment expenses saved and value of statistical life (VSL) formulas; and 5) calculated costs based on direct intervention costs (e.g., costs of installation and maintenance).

Sources Used:
- An assessment of programs to promote improved household stoves in China (Sinton et al. 2004); National Bureau of Statistics (NBS) (2010, 2012); World Bank (2007a, 2007b)

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.esd.2013.06.002

NIEHS Funding:
- Not available

Other Funding:
Cost-consequence analysis of multimodal interventions with environmental components for pediatric asthma in the state of Maryland

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Jassal MS, Diette GB, and Dowdy DW</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Journal of Asthma</td>
<td></td>
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</table>

**Summary**

This study estimated the expenditures and savings of environmental interventions for asthma in the state of Maryland. The researchers found that single- and multi-component environmental strategies were cost-saving relative to the standard of care, with home environmental education using non-medical professionals yielding the highest net savings of $14.1 million. These results lend support for wider deployment of comprehensive management strategies that address environmental determinants of childhood asthma.

**Population**

Pediatric patients (children and adolescents ≤ 18 years)

**Health Outcomes**

- Respiratory outcomes (asthma)

**Environmental Agents**

**List of Environmental Agents**

- Home-based environmental asthma triggers

**Source of Environmental Agents**

- Not available

**Economic Evaluation / Methods and Source**

**Type:**

- Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)

**Costs Measured:**

- Healthcare costs such as hospitalizations, emergency room visits and asthma-related clinic visits; costs of lost work productivity; costs of travel incurred during the usage of healthcare services; educational costs for interventions; training costs for medical professionals; costs for follow-up visits (e.g., training supplies and transportation); costs for implementation of interventions (e.g., cost of allergen-impermeable covers, pest management, etc.)

**Potential Cost Measures:**

- Incremental costs of acute and chronic asthma medications; cost of lost leisure time; employer friction costs; quality of life

**Benefits Measures:**
• Averted healthcare costs and parameters such as hospitalizations, emergency room and clinic/urgent care visits; averted costs related to lost worker productivity

Potential Benefits:
• Reduction of asthma medication use

Location:
• Maryland

Models Used:
• Not available

Methods Used:
• The authors performed a cost-consequence analysis of environmental strategies for asthma control using data from published studies. The authors — 1) used decision analysis to estimate all incremental costs and benefits, from a societal perspective, of selected environmental strategies for asthma control; 2) determined the appropriate study interventions, by performing a meta-analysis of studies describing environmental strategies for asthma control; 3) constructed a hypothetical study population using data on health encounters in 2009 within the state of Maryland from the 2011 Maryland Asthma Surveillance Report (MASR); and 4) calculated the costs parameters related to asthma and the implementation of the asthma control interventions.

Sources Used:
• Maryland Asthma Control Program, Maryland Asthma Surveillance Report (MASR) (Bankowski et al., 2011); CDC Behavioral Risk Factor Surveillance System (BRFSS); Youth Tobacco Surveys (YTS); Youth Risk Behavior Surveys (YRBS); Ambulatory Care and Hospital Dis

Citation:
• Jassal MS, Diette GB, and Dowdy DW 2013 Cost-consequence analysis of multimodal interventions with environmental components for pediatric asthma in the state of Maryland Journal of Asthma 50 6

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/23614791

DOI:
• http://dx.doi.org/10.3109/02770903.2013.792351

NIEHS Funding:
• Not available

Other Funding:
Cost savings associated with prohibiting smoking in U.S. subsidized housing

**Details**

<table>
<thead>
<tr>
<th>Authors</th>
<th>King BA, Peck RM, and Babb SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summary</td>
<td>This cost analysis is the first to assess costs that could be averted by prohibiting smoking in U.S. subsidized housing. The authors estimated cost savings would be $521 million per year, including $341 million in secondhand smoke-related healthcare expenditures, $108 million in renovation expenses, and $72 million in smoking-attributable fire losses. Prohibiting smoking in U.S. public housing alone would yield cost savings of approximately $154 million per year. These findings suggest that efforts to prohibit smoking in all U.S. subsidized housing would protect health and generate substantial cost savings to society.</td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
</tr>
</tbody>
</table>

**Health Outcomes**

- Not available

**Environmental Agents**

**List of Environmental Agents**

- Air pollutants (secondhand tobacco smoke)

**Source of Environmental Agents**

- Not available

**Economic Evaluation / Methods and Source**

**Type:**

- Cost Analysis (CA)

**Costs Measured:**

- Healthcare costs related to secondhand smoke; costs of renovation of units that permit smoking; smoking-attributable fire costs

**Potential Cost Measures:**

- Societal costs associated with smoking; long-term healthcare costs; time lost because of illness; costs associated with investment of money or staff time to implement and enforce smoke free policies

**Benefits Measures:**

- Not available

**Potential Benefits:**

- Benefits associated with smokers who quit due to smoke free policies
Location:
  • United States (excluding Alaska)

Models Used:
  • Not available

Methods Used:
  • The authors estimated annual cost savings associated with secondhand-smoke related health care, renovation of units that permit smoking, and smoking-attributable fires in all U.S. subsidized housing. The authors — 1) used residency estimates and previously reported national and state cost estimates for these indicators; 2) applied a price deflator to account for differential costs of living or pricing across states; and 3) performed a sensitivity analysis to develop a range around each cost estimate.

Sources Used:
  • National Health Interview Survey (CDC, 2009); Vital signs: current cigarette smoking among adults aged ≥18 years—U.S. 2009 (CDC 2010); Top 50 States. Cost of living by state (www.top50states.com/cost-of-living-by-state.html); Resident characteristic report

Citation:
  • King BA, Peck RM, and Babb SD 2013 Cost savings associated with prohibiting smoking in U.S. subsidized housing Am J Prev Med 44 6

Pubmed:
  • http://www.ncbi.nlm.nih.gov/pubmed/23683981

DOI:
  • http://dx.doi.org/10.1016/j.amepre.2013.01.024

NIEHS Funding:
  • Not available

Other Funding:
  • There were no sources of direct or indirect funding for the reported research.
Optimizing bulk milk dioxin monitoring based on costs and effectiveness

Details | Research article | Cost-effectiveness analysis (CEA)
--- | --- | ---
Authors | Lascano-Alcoser VH, Velthuis AG, Van Der Fels-Klerx HJ, Hoogenboom LA, and Oude Lansink AG | |
Journal | J Dairy Sci | |
Summary | Authors developed optimization models and used preselected contamination scenarios to estimate the costs and effectiveness of bulk milk dioxin monitoring in milk trucks as a means of optimizing sampling and pooling monitoring strategies. Results showed that detecting a dioxin incident with a high level of effectiveness is possible, but only at high cost; furthermore, low monitoring budgets are only highly effective when aiming to detect large incidences. These results suggested that taking a higher risk for not detecting the smallest detectable incident significantly reduces monitoring costs. This study developed decision-making models that risk managers of food industries and food safety authorities can use to evaluate the costs and effectiveness of dioxin monitoring in bulk milk. These models can be used to determine the minimum amount of resources required to accomplish a certain level of effectiveness or to calculate the achieved level of effectiveness at a certain monitoring budget. | |
Population | Not available | |

Health Outcomes
- Not available

Environmental Agents

List of Environmental Agents
- Chlorinated compounds (polychlorinated dibenzodioxins, polychlorinated dibenzofurans)

Source of Environmental Agents
- Dairy products (milk)

Economic Evaluation / Methods and Source

Type:
- Cost-effectiveness analysis (CEA)

Costs Measured:
- Monitoring costs (includes costs related to sampling, testing, labor for personnel, materials/equipment, transport, and storage); incident costs (includes costs related to tracing the source and concentration of dioxins through sampling and testing of suspected sources of contamination (trucks or farms)); screening test costs; confirmatory test costs

Potential Cost Measures:
- Losses of dairy farms or dairy processors related to mitigation strategies emplaced after an incident has been detected, such as cost of destroying contaminated milk; direct financial costs for implementation of
mitigation strategies; costs of monitoring for government, industries, and consumers

Benefits Measures:
- Reduced monitoring costs; increased effectiveness of monitoring

Potential Benefits:
- Benefits of monitoring for government, industries, and consumers

Location:
- European Union (hypothetical region (Dutch))

Models Used:
- Authors developed two optimization models using a linear programming methodology — MC optimization model (aimed at minimizing monitoring costs); ME optimization model (aimed at maximizing effectiveness of monitoring)

Methods Used:
- The authors estimated the costs and effectiveness of bulk milk dioxin monitoring in milk trucks to optimize sampling and pooling monitoring strategies aimed at detecting at least 1 out of 20,000 contaminated dairy farms at a target dioxin concentration level. The authors — 1) used a linear programming methodology to build two optimization models (MC and ME); 2) used the optimization models to evaluate a bulk milk dioxin monitoring plan in milk trucks covering 20,000 dairy farms located in an area of 40,000 km2, and randomly selected milk trucks at each sampling time; and 3) applied the optimization models to 8 preselected contamination scenarios representing different detectable incidents.

Sources Used:
- Results of the monitoring of dioxin level in food and feed (European Food Safety Authority (EFSA), 2010); Animal Health Economics, Principles and Applications, 1st Ed. (Dijkhuizen and Morris, 1997); Kaolinic clay derived PCDD/Fs in the feed chain from as

Citation:
- Lascano-Alcoser VH, Velthuis AG, Van Der Fels-Klerx HJ, Hoogenboom LA, and Oude Lansink AG 2013 Optimizing bulk milk dioxin monitoring based on costs and effectiveness J Dairy Sci 96 7

Pubmed:

DOI:
- http://dx.doi.org/10.3168/jds.2012-5898

NIEHS Funding:
- Not available

Other Funding:
- RIKILT-Institute of Food Safety, Wageningen University and Research Center, Wageningen, the Netherlands
Co-benefits of global greenhouse gas mitigation for future air quality and human health

This cost-benefit analysis simulated the co-benefits of global greenhouse gas (GHG) reductions on air quality and human health using a global atmospheric model and future scenarios via two mechanisms: 1) reducing co-emitted air pollutants, and 2) slowing climate change. The authors estimated that relative to a reference scenario, global GHG mitigation avoids 0.5 million, 1.3 million, and 2.2 million premature deaths in 2030, 2050, and 2100 respectively, and that global average marginal co-benefits of avoided mortality are $50–380 (ton CO2)−1. They concluded that air quality and health co-benefits provide strong additional motivation for transitioning to a low-carbon future.

Population

Adults (≥ 30 years)

Health Outcomes

- Mortality (premature deaths) due to cardiopulmonary disease, lung cancer, and respiratory outcomes

Environmental Agents

List of Environmental Agents

- Air pollutants (ozone, PM2.5)

Source of Environmental Agents

- Greenhouse gas emissions

Economic Evaluation / Methods and Source

Type:

- Cost-benefit analysis (CBA)

Costs Measured:

- Marginal costs of greenhouse gas reductions

Potential Cost Measures:

- Not available

Benefits Measures:

- Avoided mortality
Potential Benefits:
- Avoided cost of air pollution control; benefits to people younger than 30; benefits of avoided morbidity outcomes; ecosystem effects from reduced air pollution; benefits from reduced indoor air pollution; benefits from reduced fire and dust as result of slowing climate change

Location:
- Not available

Models Used:
- MOZART-4 global chemical transport model used to simulate ozone and PM2.5 air quality in future scenarios; AM3 model; MAGICC climate model

Methods Used:
- The authors estimated the co-benefits of global greenhouse gas (GHG) reductions on air quality and human health. The authors — 1) compared global GHG reductions for two future scenarios: a ‘no climate policy’ scenario and a second scenario with more aggressive GHG reduction policies; 2) used global atmospheric models to evaluate how these scenarios would affect air quality and human health in 2030, 2050, and 2100; and 3) monetized co-benefits of avoided air pollution mortality using high and low values of a statistical life and compared these values with the marginal costs of GHG reductions.

Sources Used:
- Extended follow-up and spatial analysis of the American Cancer Society study linking particulate air pollution and mortality (Krewski et al., 2009); Projections of global health outcomes from 2005 to 2060 using the International Futures integrated forecasts

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1038/NCLIMATE2009

NIEHS Funding:
- R21ES022600

Other Funding:
- U.S. Environmental Protection Agency STAR grant #834285; and the Integrated Assessment Research Program in the U.S. Department of Energy, Office of Science
**Economic impacts of environmentally attributable childhood health outcomes in the European Union**

**Summary**
This report is the first cost analysis of impacts of childhood environmental chemical exposures in the European Union (EU). The researchers estimated the combined environmentally attributable costs of lead exposure, methyl mercury exposure, developmental disabilities, asthma, and cancer to be $70.9 billion in 2008. Estimation of these costs was important for evaluating the impact of the implementation of the EU's chemical policy (REACH). These findings also highlight the importance of specifically considering the health effects in children when conducting analyses of the costs or benefits of environmental, health, and safety policies.

**Population**
Children and adolescents (< 18 years)

**Health Outcomes**
- Lead poisoning; methyl mercury poisoning; developmental disabilities (autism spectrum disorder, ADHD, conduct disorders, mental retardation); respiratory outcomes (asthma); pediatric cancer

**Environmental Agents**
**List of Environmental Agents**
- Environmental pollutants ("chemical substances of human origin in air, food water, and communities"); metals (lead, methyl mercury)

**Source of Environmental Agents**
- Not available

**Economic Evaluation / Methods and Source**
**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Direct health care system costs; costs of rehabilitation; lost productivity

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available
Location:
- European Union

Models Used:
- Environmentally Attributable Fraction (EAF) model

Methods Used:
- The authors evaluated the economic impacts of childhood environmental chemical exposures in the European Union. The authors — 1) used a cost-of-illness approach to estimate health care system costs; 2) used environmentally attributable fraction (EAF) modeling to estimate the proportion of childhood disease due to environmental exposures; and 3) analyzed data on exposures, disease prevalence, and costs at a country level, and then aggregated costs across EU member states to estimate overall economic impacts within the EU.

Sources Used:
- European Community Health Indicators (European Commission, 2008); Eurostat Harmonized Index of Consumer Prices; Global Burden of Asthma (Global Health Initiative for Asthma); GLOBOCAN database (WHO, 2008); additional sources cited in publication

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1093/eurpub/ckt063

NIEHS Funding:
- Not available

Other Funding:
Cost of near-roadway and regional air pollution-attributable childhood asthma in Los Angeles County

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

**Authors**

**Journal**
J Allergy Clin Immunol

**Summary**
This cost analysis study estimated the cost of childhood asthma attributable to residential near-roadway air pollution (NRP) exposure, regional ozone (O3), and nitrogen dioxide (NO2) in Los Angeles County by developing a novel approach to apportion the costs between these exposures under different pollution scenarios. They estimated that the annual cost of asthma for Los Angeles County in 2007 attributable to O3 and NO2 was approximately $441 million and $202 million, respectively, and that costs from increased NRP exposure may offset savings from reduced regional air pollution. The authors concluded that disaggregating the effects of regional air pollution and NRP exposure helps clarify the health co-benefits and cost savings that could be achieved by reducing these exposures.

**Population**
Children (≤ 17 years)

**Health Outcomes**
- Respiratory outcomes (asthma, asthma exacerbation-related outcomes such as bronchitis episodes, ear, and sinus infections)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (near-roadway air pollution, ozone (O3), nitrogen dioxide (NO2))

**Source of Environmental Agents**
- Residential near-roadway air pollution, regional ozone (O3), and nitrogen dioxide (NO2)

**Economic Evaluation / Methods and Source**

**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Costs of hospitalization; inpatient hospital stays; emergency room visits; doctor visits; asthma inhalers and drugs; caregiver’s time spent traveling, waiting, and receiving care for office visits, ER visits, and hospitalizations; medication use and treatment for asthma-related comorbidities (e.g., ear and sinus infections); school absences; antibiotics prescriptions

**Potential Cost Measures:**
- Lower lifetime earnings for caregivers of children with asthma; costs associated with adult asthma
Benefits Measures:
- Not available

Potential Benefits:
- Not available

Location:
- Los Angeles County, California

Models Used:
- Yes

Methods Used:
- The authors estimated the cost of childhood asthma attributable to residential near-roadway air pollution, regional ozone, and nitrogen dioxide in Los Angeles County. The authors — 1) used concentration response functions (CRF) to estimate the prevalence of asthma attributable to near-roadway air pollution; 2) integrated results from a study of willingness to pay to reduce the burden of asthma with studies of health care utilization and charges to estimate the costs of an asthma case and exacerbation; and 3) applied those costs to the number of asthma cases and exacerbations due to regional pollution in 2007 and to hypothetical scenarios of a 20% reduction in regional pollution in combination with a 20% reduction or increase in the proportion of families living in proximity to a major roadway relative to 2007 levels.

Sources Used:
- Southern California Children's Health Study (2007); Final 2012 Air Quality Management Plan (South Coast Air Quality Management District, 2013); Healthcare Cost and Utilization Project (Agency for Healthcare Research and Quality, 2011); American Academy of

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.jaci.2014.09.029

NIEHS Funding:
- R01ES016535, P01ES011627, P30ES007048, P01ES009581, 5R01ES014447

Other Funding:
- EPA grants: R826708, RD831861, R831845; South Coast Air Quality Management District; The Hastings Foundation
Household cooking with solid fuels contributes to ambient PM2.5 air pollution and the burden of disease


Journal: Environ Health Perspect

Summary: This cost analysis estimated the ill health effects associated with population-wide exposure to ambient PM2.5 caused by household cooking with solid fuels on the basis of the Global Burden of Disease (GBD) 2010 project for the years 1990, 2005, and 2010 in 170 countries. The study authors determined that exposure to ambient PM2.5 caused the loss of 370,000 lives and 9.9 million disability-adjusted life years (DALYs) globally in 2010. These results suggest that efforts to improve ambient air quality, especially in countries within South and East Asia (e.g., India and China, respectively), will be hindered if household cooking conditions are not addressed.

Population: Not available

Health Outcomes
- Mortality

Environmental Agents

List of Environmental Agents
- Air pollutants (particulate matter (PM 2.5/fine))

Source of Environmental Agents
- Household cooking with solid fuels

Economic Evaluation / Methods and Source

Type:
- Cost analysis (CA)

Costs Measured:
- Deaths; disability-adjusted life years (DALYs)

Potential Cost Measures:
- Not available

Benefits Measures:
- Not available

Potential Benefits:
- Not available
Location:
- 170 countries grouped by region

Models Used:
- Greenhouse Gas and Air Pollution Interactions and Synergies (GAINS) models were used to calculate proportion of household PM2.5 emissions that comes from cooking; Fast Scenario Screening Tool for Global Air Quality and Instantaneous Radiative Forcing pair

Methods Used:
- The authors estimated the proportion and concentrations of ambient PM2.5 attributable to household cooking with solid fuels for the years 1990, 2005, and 2010 in 170 countries, and examined ill health associated with exposures to ambient PM2.5. The authors — 1) used the GAINS and TM5-FASST models to estimate the proportion of ambient PM2.5 produced by households; 2) used the GAINS and TM5-FASST models to estimate the proportion of household PM2.5 emissions from cooking with solid fuels; and 3) estimated health effects using global burden of disease data from 2010 on ill health from ambient PM2.5 exposure.

Sources Used:
- Global burden of disease (GBD) 2010 project (IHME 2010); additional sources cited in publication

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1289/ehp.1206340

NIEHS Funding:
- Not available

Other Funding:
- Not available
QALY as evaluation tool in a health surveillance program

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

**Authors**
Esser A, Gube M, Schettgen T, Kraus T, and Lang J

**Journal**
Int J Hyg Environ Health

**Summary**
This study assessed whether PCB exposure can be associated with the quality adjusted life years (QALYs) of participants in an occupational exposure surveillance program. The authors found a significant effect of PCB exposure on QALY where PCB exposure reduced health-related quality of life (HRQL) in the remaining lifetime of surveillance program participants. The results supported the use of QALYs to monitor HRQL effects in surveillance programs and suggested that exposure to hazardous substances has an influence on QALYs.

**Population**
Participants in the Health Effects in High-Level Exposure to PCB (HELPcB) medical surveillance program

**Health Outcomes**
- Not available

**Environmental Agents**

**List of Environmental Agents**
- Chlorinated compounds (polychlorinated biphenyls (PCBs))

**Source of Environmental Agents**
- Occupational exposure via a capacitor and transformer recycling company

**Economic Evaluation / Methods and Source**

**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Quality adjusted life years (QALYs); health-related quality of life (HRQL)

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available
Location:
• Germany

Models Used:
• Linear calculation model to calculate Quality-Adjusted Life Year (QALY) using Health-Related Quality of Life (HRQL) and Remaining Life Expectancy (RLE); Complex Number Model as alternate method to calculate QALYs; Hierarchical linear regression models

Methods Used:
• The authors assessed whether PCB exposure can be associated with the quality adjusted life years (QALYs) of participants in an occupational exposure surveillance program. The authors — 1) determined internal PCB load of program participants using gas chromatography with mass spectrometry in plasma; 2) used a questionnaire to assess health related quality of life (HRQL) and generated an HRQL index value; 3) used a linear model that combined HRQL index value with remaining life expectancy of an individual to calculate QALY; 4) used a Complex Number Model as alternate method to calculate QALYs; and 5) used a hierarchical linear regression model with control variables to assess whether PCB exposure was associated with individual HRQL and QALYs.

Sources Used:
• Remaining life expectancy values via the mortality table 2010 for Germany (Federal Statistical Office, 2012); Biomonitoring data (PCB levels in plasmas) from surveillance program participants (Schettgen et al., 2011); HRQL data from surveillance program

Citation:
• Esser A, Gube M, Schettgen T, Kraus T, and Lang J 2014 QALY as evaluation tool in a health surveillance program Int J Hyg Environ Health 217 3-Feb

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/24054544

DOI:
• http://dx.doi.org/10.1016/j.ijheh.2013.07.014

NIEHS Funding:
• Not available

Other Funding:
• Institution for Statutory Accident Insurance and Prevention in the Energy, Textile, Electrical, and Media Industry (BGETEM), Cologne, Germany (unrestricted grant to the UK Hospital Aachen, RWTH Aachen University, grant number360328)
# A simulation model of building intervention impacts on indoor environmental quality, pediatric asthma, and costs

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**
Fabian MP, Adamkiewicz G, Stout NK, Sandel M, and Levy JI

**Journal**
J Allergy Clin Immunol

**Summary**
This cost-benefit analysis used a previously developed discrete event simulation model (DEM) of pediatric asthma to estimate differences in healthcare use costs comparing home-based interventions and intervention bundles for a simulated cohort of children in low-income multifamily housing in Boston, Massachusetts. The study authors determined that interventions, such as repairing kitchen exhaust fans and integrated pest management, led to 7% and 12% reductions in serious asthma events, respectively, with one- to three-year payback periods. This work increases the awareness of multi-intervention approaches to control asthma and highlights the cost-benefits of environmental home interventions.

**Population**
Simulated cohort of one million children living in low-income, multifamily housing consistent with public housing residents

**Health Outcomes**
- Respiratory outcomes (asthma, lung function)

**Environmental Agents**
**List of Environmental Agents**
- Air pollutants (nitrogen dioxide, particulate matter (PM2.5/fine), indoor allergens (cockroach, mold))

**Source of Environmental Agents**
- Sources of indoor air pollution, allergens from pests (cockroaches)

**Economic Evaluation / Methods and Source**
**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Healthcare costs related to pediatric asthma (medications/prescriptions); healthcare costs related to serious asthma events (e.g., clinic visits, ED visits, hospitalizations); asthma symptom days; medication use; intervention costs; energy costs

**Potential Cost Measures:**
- Lost work days; missed school days

**Benefits Measures:**
- Healthcare savings; reduction of indoor air pollutants and allergen concentrations resulting from interventions; reduction of pediatric asthma and poor lung function outcomes resulting from interventions;
energy savings

Potential Benefits:
- Not available

Location:
- Boston, Massachusetts

Models Used:
- Simulation models — Discrete event simulation model (DEM) of pediatric asthma; CONTAM model

Methods Used:
- Authors used a simulated cohort of children to evaluate the impact of building interventions on indoor environmental quality and pediatric asthma healthcare use, and conducted cost comparisons between intervention, healthcare costs, and energy savings. The authors — 1) used a previously developed and evaluated discrete event simulation model (DEM) of pediatric asthma to simulate health outcomes over a range of building interventions; 2) modeled indoor concentrations of four contaminants that potentially affect a child's lung function and asthma status (i.e., nitrogen dioxide, PM2.5, cockroach allergen, and mold); 3) evaluated several candidate interventions for improving indoor environmental conditions, and considered an intervention aimed at reducing energy costs; and 4) tested bundles of interventions that couple weatherization with interventions that can potentially offset indoor environmental effects.

Sources Used:
- 2007/2008 Massachusetts Medicaid Reimbursement Survey (American Academy of Pediatrics, 2008); Medical Expenditure Panel Survey (MEPS) (Barnett et al., 2011); 2006 Agency for Healthcare Research and Quality Healthcare cost and utilization project (Stranges

Citation:
- Fabian MP, Adamkiewicz G, Stout NK, Sandel M, and Levy JI 2014 A simulation model of building intervention impacts on indoor environmental quality, pediatric asthma, and costs J Allergy Clin Immunol 133 1

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.jaci.2013.06.003

NIEHS Funding:
- R21ES017522

Other Funding:
- Not available
# The human health effects of Florida red tide (FRT) blooms: an expanded analysis

**Details** | **Research article** | **Cost analysis (CA)**
---|---|---

**Authors** | Hoagland P, Jin D, Beet A, Kirkpatrick B, Reich A, Ullmann S, Fleming LE, and Kirkpatrick G

**Journal** | Environ Int

**Summary** | This cost-analysis estimated the human health risks and economic impacts associated with brevetoxin exposure from algal blooms of Karenia brevis in six southwest Florida counties. Specifically, these blooms were found to be significantly associated with human health and economic effects in older cohorts (≥ 55 years of age). The authors also found that the costs of illness associated with K. brevis ranged from $60,000 to $700,000 annually, but estimated that these costs could exceed $1 million per year for severe long lasting bloom events.

**Population** | Residents and tourists in six southwest Florida counties

**Health Outcomes**
- Respiratory outcomes; gastrointestinal outcomes

**Environmental Agents**

**List of Environmental Agents**
- Brevetoxins

**Source of Environmental Agents**
- Algal blooms of Karenia brevis

**Economic Evaluation / Methods and Source**

**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Number of emergency department visits; number of inpatient hospital admissions; treatment costs for respiratory and digestive illness; marginal emergency department costs for respiratory and digestive illness; marginal costs of hospital inpatient admissions for respiratory and digestive illness; lost income during treatment and recuperation

**Potential Cost Measures:**
- Non-market costs associated with pain and suffering; costs of self treatment; outpatient visits, costs of pharmaceutical utilized outside the emergency department of hospital inpatient environments; potential morbidities and mortalities from brevetoxin exposures; losses to local service businesses (e.g., restaurants and hotels); increased costs of beach cleanups; lost recreational opportunities; reduced fishery yields; mortalities of passively valued protected species
Benefits Measures:
- Not available

Potential Benefits:
- Not available

Location:
- Florida southwest or Gulf Coast counties — Hillsborough, Pinellas, Manatee, Sarasota, Charlotte, and Lee County

Models Used:
- Authors developed environmental exposure-response models (time-series, cross-section regression models) using monthly data at the county level to analyze the effects of algal blooms on human health

Methods Used:
- The authors estimated the human health risks and economic impacts in Florida Gulf Coast counties related to exposure to brevetoxins from algal blooms of Karenia brevis. The authors — 1) developed exposure-response models to test the effects of K. brevis blooms on human health by using data on emergency department visits and hospital admissions, measures of K. brevis bloom events, and county level population and tourism data; and 2) used marginal costs of emergency department visits and hospital admissions to estimate costs of illness.

Sources Used:
- Data on emergency department visits and hospital admissions from Florida Agency for Health Care Administration; Harmful algal bloom (HAB) monitoring database (Fish and Wildlife Research Institute, 2013); NOAA harmful algal blooms observing system (Nationa

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.envint.2014.03.016

NIEHS Funding:
- Not available

Other Funding:
- National Science Foundation (NSF/CNH grant no. 1009106)
Household's willingness to pay for arsenic safe drinking water in Bangladesh

Details

<table>
<thead>
<tr>
<th>Authors</th>
<th>Khan NI, Brouwer R, and Yang H</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>J Environ Management</td>
</tr>
<tr>
<td>Summary</td>
<td>This study implemented a survey to examine the public willingness to pay (WTP) for arsenic safe drinking water by investing in communal deep tubewells (DTW) across different arsenic-risk zones in areas of rural Bangladesh. Results showed that most survey respondents were willing to pay in principle for a communal DTW to secure access to arsenic safe drinking water; important factors that were found to influence WTP included household income, where respondents lived, awareness of water source contamination, and others. These results are consistent with other studies that have shown that WTP for arsenic safe drinking water increases as the baseline risk exposure levels increase, when controlling for other factors.</td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
</tr>
</tbody>
</table>

Health Outcomes

- Arsenicosis

Environmental Agents

List of Environmental Agents

- Metals (arsenic)

Source of Environmental Agents

- Groundwater, drinking water

Economic Evaluation / Methods and Source

Type:

- Cost analysis (CA)

Costs Measured:

- Willingness to pay (WTP) for arsenic safe drinking water; capital costs; operation costs; maintenance costs; cost of medical treatment; loss of income

Potential Cost Measures:

- Not available

Benefits Measures:

- Not available

Potential Benefits:

- Not available
Location:
• Bangladesh

Models Used:
• Not available

Methods Used:
• Authors used a double bound discrete choice valuation elicitation approach to estimate the public willingness to pay (WTP) for arsenic safe drinking water by investing in communal deep tubewells (DTW) across different risk zones in rural Bangladesh. The authors — 1) developed an extended questionnaire with contingent valuation questions; 2) collected information about sociodemographics and other factors for households; 3) implemented survey in thirteen villages located in three districts (Comilla, Munshiganj, and Pabna) in Bangladesh following a stratified random sampling procedure for households; and 4) characterized villages at high, medium, or low risk for groundwater arsenic exposure.

Sources Used:
• Value of arsenic-free drinking water to rural households in Bangladesh (Ahmad et al., 2005); A ‘natural experiment’ approach to contingent valuation of private and public UV health risk reduction strategies in low and high risk countries (Bateman et al.,

Citation:
• Khan NI, Brouwer R, and Yang H 2014 Household's willingness to pay for arsenic safe drinking water in Bangladesh J Environ Management 143

Pubmed:

DOI:
• http://dx.doi.org/10.1016/j.jenvman.2014.04.018

NIEHS Funding:
• Not available

Other Funding:
• Eawag, Swiss Federal Institute of Aquatic Science and Technology
The global burden of disease for skin, lung, and bladder cancer caused by arsenic in food

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
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</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Oberoi S, Barchowsky A, and Wu F</td>
</tr>
<tr>
<td>Journal</td>
<td>Cancer Epidemiol Biomarkers Prev</td>
</tr>
<tr>
<td>Summary</td>
<td>This quantitative risk assessment study estimated the global burden of disease for bladder, lung, and skin cancers attributable to inorganic arsenic exposures in food. They estimated that each year, 9,129 to 119,176 additional cases of bladder cancer, 11,844 to 121,442 of lung cancer, and 10,729 to 110,015 of skin cancer worldwide are attributable to inorganic arsenic in food. The authors conclude that risk estimates are valuable for informing and supporting policies to reduce the global burden of disease from arsenic exposures in food.</td>
</tr>
<tr>
<td>Population</td>
<td>Not available</td>
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</tbody>
</table>

### Health Outcomes
- Cancer outcomes (skin cancer, lung cancer, bladder cancer)

### Environmental Agents

#### List of Environmental Agents
- Metal (inorganic arsenic)

#### Source of Environmental Agents
- Diet

### Economic Evaluation / Methods and Source

#### Type:

#### Costs Measured:
- Not available

#### Potential Cost Measures:
- Not available

#### Benefits Measures:
- Not available

#### Potential Benefits:
- Not available

#### Location:
- Not available
Models Used:
- Dose-response model with a linear function of dose and quadratic function of age; exposure assessment model

Methods Used:
- The authors estimated the global burden of disease for bladder, lung, and skin cancers attributable to inorganic arsenic in food. The authors — 1) established dose response estimates by converting dose response estimates for water exposure to human dose; 2) estimated exposure using data on a common range of arsenic content for food crops grown in different parts of the world and dietary patterns in different parts of the world; 3) multiplied the dose-response slope factor with the estimated range of daily dietary inorganic arsenic exposure to characterize cancer risk; and 4) summed across different populations to estimate the global burden of a particular arsenic-induced cancer.

Sources Used:
- Global Environment Monitoring System-Food Contamination Monitoring and Assessment Programme (GEMS/Food) (World Health Organization 2006); Risk of internal cancers from arsenic in drinking water (Morales et al., 2000); United States Environmental Protection

Citation:
- Oberoi S, Barchowsky A, and Wu F 2014 The global burden of disease for skin, lung, and bladder cancer caused by arsenic in food Cancer Epidemiol Biomarkers Prev 23 7

Pubmed:

DOI:
- http://dx.doi.org/10.1158/1055-9965.epi-13-1317

NIEHS Funding:
- R01ES0138781

Other Funding:
- WHO Foodborne Disease Burden Epidemiology Group; National Cancer Institute (R01CA153073)
Hidden cost of U.S. agricultural exports: particulate matter from ammonia emissions

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Paulot F and Jacob DJ</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Environ Sci Technol</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This cost analysis quantified the cost of NH3 and resulting PM2.5 emissions associated with agricultural food exports in the United States. The authors found that NH3 emissions associated with food export increases the exposure of the U.S. population to PM2.5, and they estimated the valuation of increased premature mortality associated with PM2.5 from food export to be $36 billion per year (in US dollars). These findings suggest that eliminating NH3 emissions from food export would achieve greater health benefits than the reduction of the National Ambient Air Quality Standards for PM2.5 from 15 to 12 μg/m-3.</td>
<td></td>
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<tr>
<td>Population</td>
<td>Not available</td>
<td></td>
</tr>
</tbody>
</table>

Health Outcomes
- Mortality (premature mortality)

Environmental Agents
**List of Environmental Agents**
- Air pollutants (ammonia (NH3), particulate matter (PM2.5/fine))

**Source of Environmental Agents**
- PM2.5 and NH3 emissions via agricultural food exports

Economic Evaluation / Methods and Source
**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Mortalities; annual health costs of PM2.5 from food export; direct gross revenue associated with agricultural exports

**Potential Cost Measures:**
- Other agricultural impacts such as: eutrophication, loss of biodiversity, greenhouse gas emissions from production and transportation

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available
Location:
- United States

Models Used:
- MASAGE model was used to calculate agricultural emissions of NH3; GEOS-Chem global chemical transport model (CTM) was used to calculate the impact of a change in ammonia emissions on PM2.5

Methods Used:
- The authors quantified the costs of NH3, and resulting PM2.5 emissions, associated with US food export by coupling a model of agricultural sources of NH3 with a chemical transport model. The authors — 1) used a chemical transport model (GEOS-Chem global CTM) to calculate the sensitivity of PM2.5 to NH3 emissions from agricultural exports; 2) used the MASAGE model to calculate agricultural emissions of NH3; 3) used commodity-specific export fraction by weight to estimate the NH3 emissions associated with food export; and 4) estimated the annual health costs of PM2.5 from food export using the willingness to pay (WTP) and value of a statistical life (VSL) method.

Sources Used:

Citation:
- Paulot F and Jacob DJ 2014 Hidden cost of U.S. agricultural exports: particulate matter from ammonia emissions Environ Sci Technol 48 2

Pubmed:

DOI:
- http://dx.doi.org/10.1021/es4034793

NIEHS Funding:
- Not available

Other Funding:
- Not available
Prenatal exposure to airborne polycyclic aromatic hydrocarbons and IQ: Estimated benefit of pollution reduction

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Perera F, Weiland K, Neidell M, and Wang S</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Journal of Public Health Policy</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This study examined the benefits of a modest decrease in PAH exposure to children in New York City, and estimated a $215 million gain in lifetime earnings due to IQ increase for a single year. These results suggested that a modest reduction in ambient concentrations of PAH is associated with substantial economic benefits as measured by lifetime earnings for exposed children.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Children (0-5 years) — Columbia Center for Children's Environmental Health NYC cohort (low-income, Medicaid recipients)</td>
<td></td>
</tr>
</tbody>
</table>

Health Outcomes

- Neurological/cognitive outcomes (IQ deficits)

Environmental Agents

List of Environmental Agents

- Air pollutants (Polycyclic aromatic hydrocarbons (PAHs))

Source of Environmental Agents

- Combustion of fossil fuels and other organic materials

Economic Evaluation / Methods and Source

Type:

- Cost-benefit analysis (CBA)

Costs Measured:

- IQ deficits/loss associated with PAH exposure

Potential Cost Measures:

- Costs of controlling emissions from PAH from diverse sources

Benefits Measures:

- Estimated increase in IQ and related lifetime earnings

Potential Benefits:

- Reduction of asthma and cancer risk

Location:

- New York City, New York (Washington Heights, Harlem, and South Bronx)
Models Used:
- Not available

Methods Used:
- Researchers utilized previous data from the CCCEH cohort study to estimate the increase in IQ and related lifetime earnings in a low-income urban population as a result of reduced ambient PAH concentrations. The researchers — 1) calculated the cost of PAH-related IQ reduction using methods outlined in previous literature (Grosse et al. 2002 and Trasande et al. 2005); 2) estimated the gain in IQ corresponding to the hypothesized reduction in ambient PAH exposure of 0.25 ng/m³; 3) used monitoring data from CCCEH cohort study and city-wide monitoring data to obtain estimates of PAH exposure; and 4) used previous methodologies (Weiland et al. 2011) and selected Medicaid births in NYC which shared basic socioeconomic characteristics of the CCCEH cohort to estimate the size of the population at risk in NYC.

Sources Used:
- Summary of Vital Statistics 2002: NYC Department of Health and Mental Hygiene (Li et al., 2003); Prenatal airborne polycyclic aromatic hydrocarbon exposure and child IQ at age 5 years (Perera et al., 2009); additional sources cited in publication

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1057/jphp.2014.14

NIEHS Funding:
- 5P01ES09600; 5R01ES08977

Other Funding:
Forecast-based interventions can reduce the health and economic burden of wildfires

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Rappold AG, Fann NL, Crooks J, Huang J, Cascio WE, Devlin RB, and Diaz-Sanchez D</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Environ Sci Technol</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>This study simulated public health forecast-based interventions using a wildfire smoke episode/case study in rural North Carolina to demonstrate the potential for use of modeled smoke forecasts to reduce the human health burden and estimated the resulting economic benefits of reducing smoke exposures. The authors estimated that the economic benefit of effective interventions exceeded $1 million in excess emergency department visits for asthma and heart failure, $2 million in loss of productivity, $100,000 in respiratory conditions in children, and $42 million due to excess mortality. They concluded that wildfire smoke forecasts can be used as a tool to protect public health, and have the potential to yield large economic benefit.</td>
<td></td>
</tr>
<tr>
<td>Population</td>
<td>Adults (≥ 18 years); children (7–14 years)</td>
<td></td>
</tr>
</tbody>
</table>

**Health Outcomes**

- Respiratory outcomes (asthma, acute bronchitis, lower respiratory symptoms, asthma exacerbations, asthma attacks, upper respiratory symptoms in asthmatics); cardiovascular outcomes (congestive heart failure, nonfatal heart attacks); mortality (premature death)

**Environmental Agents**

**List of Environmental Agents**

- Air pollutants (particulate matter (PM2.5/fine))

**Source of Environmental Agents**

- Wildfire smoke

**Economic Evaluation / Methods and Source**

**Type:**

- Cost-benefit analysis (CBA), Cost-effectiveness analysis (CEA)

**Costs Measured:**

- Costs of emergency department visits and hospital admissions related to asthma and congestive heart failure attributable to smoke-based PM2.5 exposure; costs of illness (premature deaths, nonfatal heart attacks, chronic cardiovascular conditions, acute bronchitis, lower respiratory symptoms, upper respiratory symptoms, aggravated asthma); costs of lost productivity (days of work lost, minor restricted activity days)

**Potential Cost Measures:**

- Cost of protective measures to mitigate individual smoke exposure (e.g., HEPA filters and personal masks); impacts on quality of life
Benefits Measures:

- Avoided healthcare costs from emergency department visits and hospital admissions related to asthma and congestive heart failure attributable to smoke-based PM2.5 exposure; avoided loss of productivity; avoided cases of premature mortality attributable to smoke exposure

Potential Benefits:

- Not available

Location:

- 31 counties in eastern North Carolina

Models Used:

- Benefits Mapping and Analysis Program - Community Edition (BenMAP-CE) tool (v0.63)

Methods Used:

- The authors simulated forecast-based interventions using a wildfire smoke episode/case study in rural North Carolina to demonstrate the potential for using modeled smoke forecasts to reduce the human health burden and estimated the resulting economic benefits of reduced smoke exposures. The authors — 1) established a baseline risk model without any intervention to build county level forecast-based interventions; 2) simulated forecast-based intervention scenarios that vary based on the levels of smoke-based PM2.5 used to trigger advisories; 3) simulated three adherence levels for each of the three smoke-based PM2.5 interventions; 4) estimated relative risk of adverse health outcomes for each of the interventions; 5) evaluated the association between asthma and congestive heart failure related to emergency department visits and smoke-based PM2.5 for each intervention; and 6) quantified the economic value of non-avoidance of smoke in these outcomes as well as in a number of general health outcomes.

Sources Used:

- Peat bog wildfire smoke exposure in rural North Carolina is associated with cardiopulmonary emergency department visits assessed through syndromic surveillance (Rappold et al., 2011); NOAA Smoke Forecasting System for the 2008 Evans Road wildfire in North Carolina

Citation:

- Rappold AG, Fann NL, Crooks J, Huang J, Cascio WE, Devlin RB, and Diaz-Sanchez D 2014 Forecast-based interventions can reduce the health and economic burden of wildfires Environ Sci Technol 48 18

Pubmed:


DOI:

- http://dx.doi.org/10.1021/es5012725

NIEHS Funding:

- Not available
Other Funding:

- Internal funding by US Environmental Protection Agency
Pesticides and health: a review of evidence on health effects, valuation of risks, and benefit-cost analysis

<table>
<thead>
<tr>
<th>Details</th>
<th>Review</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Tago D, Andersson H, and Treich N</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Adv Health Econ Health Serv Res</td>
<td></td>
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</tbody>
</table>

**Summary**
This review article presented findings on the health effects of pesticide exposure, and preference valuation of health risks related to pesticides. The authors discussed policies related to pesticides, and provided an overview of benefit-cost analyses applied to pesticide regulatory measures. This review highlighted the need to clarify rationale for regulating pesticides, the role of risk perceptions in benefit-cost analysis, and the importance of inter-disciplinary research in this area.

**Population**
Reviewed publications that examined: 1) individuals with direct exposure to pesticides (e.g., farmers and producers, people who spray pesticides, mix and load pesticides, sow pesticide-seeds, weed and harvest sprayed crops, and clean and dispose of pesticide)

**Health Outcomes**
- Reviewed publications that examined cancer outcomes; neurological/cognitive outcomes (neurological deficits, children's IQ scores, Parkinson's disease); behavioral outcomes (depression, suicides); metabolic outcomes (diabetes, body mass index); respiratory outcomes (rhinitis, asthma, bronchitis, farmer's lung, wheeze, dyspnea); cardiovascular outcomes (myocardial infarction); reproductive outcomes (premature/delayed menopause, delayed conception, sperm quality); mechanistic outcomes (endocrine performance, women-specific hormonal disorders); thyroid dysfunction; liver outcomes (hepatitis); birth outcomes (birth weight, fetal growth); other general health outcomes (hearing loss)

**Environmental Agents**

**List of Environmental Agents**
- Reviewed publications that examined pesticides (e.g., chlorinated pesticide compounds, organophosphates, insecticides, and fumigants), and pesticide residues

**Source of Environmental Agents**
- Reviewed publications that examined agricultural sources of pesticide exposure, and water or food products contaminated with pesticides (e.g., vegetables, fish, seafood, and dairy products)

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Reviewed publications that examined preference elicitation to reduce pesticide risks (i.e., individuals' willingness to pay (WTP) to reduce or eliminate pesticides use (e.g., WTP for pesticide-free food products, WTP to reduce or eliminate health risks associated with pesticide exposure); indirect costs for farmers such as loss of natural enemies, pesticide resistance, and crop losses; environmental losses; costs for monitoring
and cleaning pesticide-polluted groundwater; health costs including those for hospitalization due to poisoning, outpatient-treatment of poisonings, pesticide-related cancers and fatalities

Potential Cost Measures:
• Not available

Benefits Measures:
• Reviewed publications that examined private benefits for farmers (e.g., improved productivity; self-insurance against pest uncertainty), private benefits for consumers

Potential Benefits:
• Not available

Location:
• Not available

Models Used:
• Not available

Methods Used:
• The authors performed a review of existing literature published from 2000 to 2013 to present the following — 1) health effects of pesticide exposure; 2) preference valuation of health risks related to pesticide use; and 3) discussion of policies related to pesticides and difficulties of evaluating them.

Sources Used:
• Agricultural Health Study Cohort data (Alavanja et al., 2003; 2004); Cancer incidence among glyphosate-exposed pesticide applicators in the Agricultural Health Study (De Roos et al., 2005); Depression and pesticide exposures among private pesticide applic

Citation:
• Tago D, Andersson H, and Treich N 2014 Pesticides and health: a review of evidence on health effects, valuation of risks, and benefit-cost analysis Adv Health Econ Health Serv Res 24

Pubmed:
• http://www.ncbi.nlm.nih.gov/pubmed/25244910

DOI:

NIEHS Funding:
• Not available

Other Funding:
• Agence de l'Eau Adour-Garonne (AEAG); Institut d'Economie Industrielle (IDEI)
Further limiting bisphenol a in food uses could provide health and economic benefits

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**  
Trasande L

**Journal**  
Health Affairs

**Summary**  
Researchers used a cost-benefit analysis to assess the social costs of childhood obesity and adult coronary heart disease attributable to BPA exposure, and estimated them to be $2.98 billion in 2008. Results suggested that regulatory action to reduce BPA exposure could result in large health and economic benefits.

**Population**  
Children (12 years); adults (40-74 years)

**Health Outcomes**
- Cardiovascular outcomes (coronary artery disease); metabolic outcomes (obesity/aberrant body weight)

**Environmental Agents**

**List of Environmental Agents**
- Hormonal mimics (bisphenol A (BPA))

**Source of Environmental Agents**
- Metal-based food containers; beverage containers

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Healthcare costs/expenditures associated with additional cases of obesity (during childhood and adulthood); healthcare costs/expenditures associated with additional cases of incident coronary heart disease; cost of QALYs lost

**Potential Cost Measures:**
- Cost for use of alternative lining for containers (e.g., oleoresin) or replacing BPA; costs for removing BPA from food uses (e.g., costs for premarket testing to rule out toxicity)

**Benefits Measures:**
- Cases of BPA-attributable childhood obesity prevented; costs of BPA-associated childhood obesity saved; cases of BPA-attributable adult coronary heart disease prevented; costs of BPA-associated adult coronary heart disease saved

**Potential Benefits:**
- Not available
Models Used:
- Environmentally Attributable Fraction (EAF) model

Methods Used:
- The author quantified the potential social costs of childhood obesity and adult coronary heart disease attributable to BPA exposure in the United States in 2008 and models the potential health and economic benefits associated with replacing BPA in all food uses. The author — 1) quantified both increased rates of coronary heart disease in adults and increases in children’s BMIs attributable to BPA exposure; 2) used pre-existing burden of disease cost-estimates to quantify costs from exposure; and 3) used data from previous BPA intervention study to estimate reductions in both disease and costs if BPA was removed from food uses.

Sources Used:
- NHANES (2003-2008); Incidence and prevalence: 2006 chart book on cardiovascular and lung diseases (National Heart, Lung and Blood Institute); Center for Disease Control and Prevention; American Heart Association (Heidenreich et al., 2011; Russell et al.,

Citation:
- Trasande L 2014 Further limiting bisphenol a in food uses could provide health and economic benefits Health Affairs 33 2

Pubmed:

DOI:
- http://dx.doi.org/10.1377/hlthaff.2013.0686

NIEHS Funding:
- Not available

Other Funding:
**Healthy homes: in-home environmental asthma intervention in a diverse urban community**

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**  
Turcotte DA, Alker H, Chaves E, Gore R, and Woskie S

**Journal**  
Am J Public Health

**Summary**  
This cost-benefit analysis demonstrated that implementing an in-home environmental asthma intervention for the Lowell, Massachusetts community resulted in a significant health improvement from baseline to follow-up. The cost of the interventions (not including personnel) was $36,240, whereas the estimated savings due to reductions in asthma-related hospitalizations, emergency department visits, and doctor visits over a 4-week assessment period was $71,162, resulting in an estimated annual savings of about $821,304. The authors concluded that low-cost, multicomponent interventions decrease all measures of asthma severity and health care utilization in this diverse population of urban children.

**Population**  
Children with asthma (< 15 years)

**Health Outcomes**
- Respiratory outcomes (asthma attacks, wheeze, rhinitis, eczema, cough, phlegm)

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (tobacco smoke); environmental asthma triggers, such as pests (roaches and mice), mold, dust mites, furry pets, outdoor allergens

**Source of Environmental Agents**
- Allergens from pests (roaches and mice), combustion sources, moisture, dust, pets

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Cost of the in-home intervention

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Savings resulting from reductions in hospitalizations, emergency department visits, and doctor visits

**Potential Benefits:**
- Not available
Location:
- Lowell, Massachusetts

Models Used:
- Not available

Methods Used:
- The authors evaluated health care cost savings resulting from individualized interventions focused on reducing indoor allergen levels and asthma triggers. The authors — 1) used a questionnaire tool to conduct a pre-intervention health assessment; 2) used a questionnaire and collected floor dust samples to conduct pre-intervention environmental assessment; 3) implemented customized home and education intervention; 4) followed-up 11 to 12 months post-intervention to evaluate impact of the intervention on the child’s health; 5) determined reduction in urgent care costs resulting from intervention; 6) analyzed change in medication use pre- and post-intervention using a test of proportion.

Sources Used:
- Data on costs of asthma-related hospitalizations, emergency department visits, and doctor visits from Massachusetts Department of Public Health; Massachusetts Emergency Department Discharge Database (2012)

Citation:
- Turcotte DA, Alker H, Chaves E, Gore R, and Woskie S 2014 Healthy homes: in-home environmental asthma intervention in a diverse urban community Am J Public Health 104 4

Pubmed:

DOI:
- http://dx.doi.org/10.2105/ajph.2013.301695

NIEHS Funding:
- Not available

Other Funding:
- US Department of Housing and Urban Development, Office of Healthy Homes and Lead Hazard Control (grant MALHH0171-8)
Effect of occupational polychlorinated biphenyls exposure on quality-adjusted life years over time at the HELPcB surveillance program

Authors: Esser A, Gaum PM, Schettgen T, Kraus T, Gube M, and Lang J

Journal: J Toxicol Environ Health A

Summary: This cost analysis examined the longitudinal impact of occupational PCB exposure on health-related quality of life (HRQL) and quality-adjusted life years (QALY) for participants enrolled in the Health Effects in High-Level Exposure to PCB (HELPcB) medical surveillance program. Findings revealed that PCB exerts an influence on QALY, where individuals with a higher PCB exposure show a decline in QALY over time, especially for higher chlorinated PCBs. These results suggest that further investigations are needed to analyze the impact of lower chlorinated PCB congeners on the development of HRQL and QALY to explain the lack of longitudinal findings for these chemicals in the present study.

Population: Participants in the Health Effects in High-Level Exposure to PCB (HELPcB) medical surveillance program

Health Outcomes
- Not available

Environmental Agents

List of Environmental Agents
- Chlorinated compounds (polychlorinated biphenyl compounds (PCBs))

Source of Environmental Agents
- Occupational exposure via a capacitor and transformer recycling company

Economic Evaluation / Methods and Source

Type:
- Cost analysis (CA)

Costs Measured:
- Health-related quality of life (HRQL); quality-associated life years (QALYs)

Potential Cost Measures:
- Not available

Benefits Measures:
- Not available
Potential Benefits:
- Not available

Location:
- Germany

Models Used:
- Linear calculation model to calculate Quality-Adjusted Life Year (QALY) using Health-Related Quality of Life (HRQL) and Remaining Life Expectancy (RLE)

Methods Used:
- Authors examined the longitudinal impact of PCBs on health-related quality of life (HRQL) and quality-adjusted life years (QALYs) for participants enrolled in the Health Effects in High-Level Exposure to Polychlorinated Biphenyls (HELPcB) medical surveillance program. The authors — 1) included 118 participants for whom a complete data set in three cross-sections at three consecutive years was available; 2) used results from the EQ-5D-3L self-report instrument/questionnaire to determine the HRQL for participants; 3) calculated QALYs for participants using a linear calculation model; and 4) performed statistical analysis (repeated-measurement analysis of covariance) for each PCB congener and each PCB sum variable including potential confounders.

Sources Used:
- Health Effects in High-Level Exposure to PCB (HELPcB) medical surveillance program (Schettgen et al., 2011); EQ-5D-3L self-report instrument via the EuroQol Group (Rabin et al., 2013); Algorithm derived from time trade off (TTO) study (Greiner et al., 200

Citation:
- Esser A, Gaum PM, Schettgen T, Kraus T, Gube M, and Lang J 2015 Effect of occupational polychlorinated biphenyls exposure on quality-adjusted life years over time at the HELPCB surveillance program J Toxicol Environ Health A 78 2

Pubmed:

DOI:
- http://dx.doi.org/10.1080/15287394.2014.946165

NIEHS Funding:
- Not available

Other Funding:
- Institution for Statutory Accident Insurance and Prevention in the Energy, Textile, Electrical, and Media Industry (BGETEM), Cologne, Germany — Grant number 360328
The geographic distribution and economic value of climate change-related ozone health impacts in the United States in 2030

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost analysis (CA)</th>
</tr>
</thead>
</table>

**Authors**

**Journal**
J Air Waste Manag Assoc

**Summary**
This cost-analysis study estimated the influence of near-term climate change on ozone-related health impacts in the continental U.S. and the economic burden of those health impacts. The authors estimated that ozone levels will result in tens to thousands of additional ozone-related premature deaths and illnesses per year, as well as an economic burden of hundreds of millions to tens of billions of U.S. dollars.

**Population**
Not available

**Health Outcomes**
- Mortality (premature deaths); respiratory outcomes

**Environmental Agents**

**List of Environmental Agents**
- Ozone

**Source of Environmental Agents**
- Anthropogenic sources

**Economic Evaluation / Methods and Source**

**Type:**
- Cost analysis (CA)

**Costs Measured:**
- Respiratory emergency department visits; respiratory hospital admissions; cases of acute respiratory symptoms; lost school days

**Potential Cost Measures:**
- Not available

**Benefits Measures:**
- Not available

**Potential Benefits:**
- Not available

**Location:**
- Continental United States
Models Used:
- NASA Goddard Institute for Space Studies Model E2; National Center for Atmospheric Research/Department of Energy Community Earth System Model; Weather Research and Forecasting Model; Community Multi-scale Air Quality Model; GEOS-Chem global chemical tra

Methods Used:
- The authors estimated the influence of near-term climate change on ozone, and the resulting health impacts and economic burden of those health impacts. The authors — 1) used two general circulation models (GCM) driven by different greenhouse gas forcing scenarios to estimate changes in air quality due to climate change; 2) used a weather research and forecasting model to downscale GCM projections to the United States; 3) used Community Multi-scale Air Quality model to assess how climate-driven meteorological changes would impact near-surface ozone levels over continental U.S.; 4) used a health impact function to estimate health impacts associated with near-surface ozone levels; 5) used both cost of illness and willingness to pay measures to estimate the economic value of the health impacts of climate change on air quality; and 6) used value of statistical life to characterize the economic value of ozone-related premature deaths.

Sources Used:
- U.S. EPA estimates of 2030 ozone levels; Regulatory Impact Analysis for the Particulate Matter NAAQS (EPA, 2012); Integrated Climate and Land Use Scenarios (EPA, 2009; Bierwage et al., 2010); Wide Ranging OnLine Data for Epidemiologic Research (CDC Wonder

Citation:

Pubmed:

DOI:
- http://dx.doi.org/10.1080/10962247.2014.996270

NIEHS Funding:
- Not available

Other Funding:
- Not available
U.S. air quality and health benefits from avoided climate change under greenhouse gas mitigation

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Authors</td>
<td>Garcia-Menendez F, Saari RK, Monier E, and Selin NE</td>
<td></td>
</tr>
<tr>
<td>Journal</td>
<td>Environ Sci Technol</td>
<td></td>
</tr>
<tr>
<td>Summary</td>
<td>The authors evaluated the impact of climate change on U.S. air quality and health in 2050 and 2100 under three greenhouse gas (GHG) emission policy scenarios and performed a cost-benefit analysis to monetize health benefits due to reduced air pollution. When compared to a reference scenario that assumes no GHG mitigation efforts, the authors estimated the value of benefits associated with avoided mortality under one climate policy scenario at $150 billion and $1.3 trillion in 2050 and 2100 respectively; and $180 billion and $1.4 trillion (in US dollars) under a second, more stringent, policy scenario. These results suggest that increasing climate policy stringency beyond a certain degree may lead to diminishing returns relative to its cost. However, the authors conclude that air quality impacts of climate change are substantial and should be considered by cost-benefit climate policy analyses.</td>
<td></td>
</tr>
</tbody>
</table>

Population | Not available |

Health Outcomes

- Mortality (premature deaths)

Environmental Agents

List of Environmental Agents

- Air pollutants (ozone (O3), particulate matter (PM2.5/fine), which includes fine particulates such as sulfate (SO4), black carbon, organic aerosol, and ammonium nitrate (NH4NO3))

Source of Environmental Agents

- Not available

Economic Evaluation / Methods and Source

Type:

- Cost-benefit analysis (CBA)

Costs Measured:

- Costs of climate policy implementation

Potential Cost Measures:

- Not available

Benefits Measures:

- Mortalities avoided; years of life gained
Potential Benefits:

- Health benefits stemming from reductions of coemitted pollutants under greenhouse gas mitigation; benefits to other sectors, such as ecosystems, infrastructure, and agriculture

Location:

- United States

Models Used:

- Massachusetts Institute of Technology Integrated Global System Model linked to the Community Atmosphere Model (MIT IGSM-CAM); Community Atmosphere Model with atmospheric chemistry (CAM-Chem); Massachusetts Institute of Technology Emissions Predictions and

Methods Used:

- The authors evaluated the impact of climate change on U.S. air quality and health in 2050 and 2100 using a global modeling framework and integrated economic, climate, and air pollution projections. The authors —
  1) used earth system and human activity models to generate greenhouse gas emission and climate projections;
  2) simulated atmospheric pollution under three greenhouse gas emission policy scenarios; 3) used models to simulate and analyze the climate penalty on air quality across the contiguous United States;
  4) estimated change in mortality risk associated with pollutant levels in 2050 and 2100 for each policy scenario; 5) monetized reduced mortality risks using value of a statistical life and years of life saved; and 6) estimated climate policy costs as loss in GDP relative to a no-climate policy scenario in 2050 and 2100.

Sources Used:

- U.S. Environmental Protection Agency, Regulatory Impact Analysis for the Final Revisions to the National Ambient Air Quality Standards for Particulate Matter, Office of Air Quality Planning and Standards (2012); U.S. Environmental Protection Agency, Guide

Citation:


Pubmed:


DOI:

- http://dx.doi.org/10.1021/acs.est.5b01324

NIEHS Funding:

- Not available

Other Funding:

- U.S. Environmental Protection Agency’s Climate Change Division (Cooperative Agreement # XA-83600001-0)
Health impact metrics for air pollution management strategies

### Details

<table>
<thead>
<tr>
<th>Authors</th>
<th>Martenies SE, Wilkins D, and Batterman SA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Journal</td>
<td>Environ Int</td>
</tr>
<tr>
<td>Summary</td>
<td>Authors performed a literature review of health impact assessment (HIA) metrics pertaining to air quality management, developed evaluative criteria for selecting and using the metrics, and illustrated the metrics in a Michigan-based case study where PM2.5 concentrations were reduced from 10 to 8 μg/m3 in an urban area. Results from the case study showed that the total monetized health benefit of the 2 μg/m3 change in Wayne County, Michigan exceeded $1.9 billion annually, and the greatest number of avoided cases occurred for low severity morbidity outcomes such as, asthma exacerbations and minor restricted activity days. The authors concluded that quantitative metrics describing the direction, magnitude, and severity of expected health impacts can help inform decision makers and elevate health concerns to the level of other political and economic drivers into evaluations of projects, programs, and policies. They also made several recommendations for selecting metrics that are appropriate for air quality applications: metrics should be comprehensive, identify the number of people affected for each morbidity and mortality outcome, clearly communicate both direct and indirect impacts, use local data, incorporate outcomes of high public health importance, and represent spatial and temporal dimensions of impacts.</td>
</tr>
</tbody>
</table>

### Population

- Not available

### Health Outcomes

- Mortality (premature and infant mortality); respiratory outcomes (asthma exacerbations, pneumonia, COPD); cardiovascular outcomes (ischemic heart disease, stroke); cancer outcomes (lung, trachea, and bronchus cancers)

### Environmental Agents

#### List of Environmental Agents

- Air pollutants (particulate matter (PM 2.5/fine))

#### Source of Environmental Agents

- Industrial, commercial, area, and mobile emission sources

### Economic Evaluation / Methods and Source

#### Type:

- Cost-benefit analysis (CBA)

#### Costs Measured:

- Predicted number of cases of mortalities and morbidities attributable to changes in PM2.5 levels; disability-adjusted life years (DALYs); years of life lost (YLL); years living with disability (YLD)
Potential Cost Measures:
- Impacts related to other pollutants; impacts of PM2.5 on outcomes such as cancer and adverse birth outcomes; impacts of short-term exposure to PM2.5 on mortality outcomes; time lost to avoidance behaviors (e.g., not participating in recreational activities)

Benefits Measures:
- Avoided cases of premature mortality, all-cause deaths, and cause-specific deaths (COPD, lung, trachea, and bronchus cancers, ischemic heart disease, and stroke); avoided cases of asthma exacerbations; avoided cases of minor restricted activity days; avoided work lost days; avoided asthma emergency department visits; avoided hospitalizations for outcomes related to cardiovascular, pneumonia, COPD, and asthma; avoided cases of non-fatal myocardial infarction; avoided DALYs, YLL, and YLD; emissions-based reductions (i.e., monetized benefits per ton of PM2.5 emitted per year)

Potential Benefits:
- Co-benefits related to other pollutants; co-benefits of pollution control policies (e.g., transportation policies)

Location:
- Detroit, Michigan, and surrounding county (Wayne County)

Models Used:
- Population Attributable Fraction (PAF) method; Health impact function (HIF) method

Methods Used:
- Authors evaluated quantitative metrics used in health impact assessments (HIAs) and similar analyses that are relevant to air quality management at the urban and potentially regional scales. The authors — 1) performed a review of literature published between 2011 and 2015 to identify HIA metrics used for both project and policy applications; 2) evaluated and selected HIA quantitative metrics based on explicit criteria; and 3) demonstrated the formulation, use, strengths, and limitations of the selected metrics in a Michigan-based case study that focuses on PM2.5 concentrations being lowered from 10 to 8 μg/m3.

Sources Used:
- Population dynamics and air pollution: the impact of demographics on health impact assessment of air pollution (Flachs et al., 2013); Interpreting health statistics for policymaking: the story behind the headlines (Walker et al., 2007); National ambient a

Citation:
- Martenies SE, Wilkins D, and Batterman SA 2015 Health impact metrics for air pollution management strategies Environ Int 85

Pubmed:

DOI:
- http://dx.doi.org/10.1016/j.envint.2015.08.013
NIEHS Funding:
- R01ES022616, P30ES017885

Other Funding:
- Not available
The economic burden of exposure to secondhand smoke for child and adult never smokers residing in U.S. public housing

Authors: Mason J, Wheeler W, and Brown MJ

Journal: Public Health Rep

Summary: This cost-analysis used large-scale databases and biomarker data to estimate the public health and economic burden of secondhand smoke (SHS) exposure for child and adult non-smokers living in U.S. public housing. The authors estimated that the total annual economic burden of SHS-attributable illness and death of non-smokers in public housing ranged from $183 million to $267 million, depending on serum cotinine limit of detection. They concluded that implementing smoke-free policies in all U.S. public housing can improve the health of residents and reduce societal costs.

Population: Adult and child never smokers residing in public housing

Health Outcomes:
- Morbidity and mortality associated with: cancer outcomes (lung cancer); cardiovascular outcomes (ischemic heart disease); respiratory outcomes (asthma, lower respiratory infection – syncytial virus, pneumonia, bronchitis/bronchiolitis); birth outcomes (low birth weight); sudden infant death syndrome; otitis media

Environmental Agents:
- List of Environmental Agents
  - Air pollutants (secondhand smoke)
- Source of Environmental Agents
  - Secondhand smoke

Economic Evaluation / Methods and Source:
- Type:
  - Cost analysis (CA)
- Costs Measured:
  - Costs considered in source studies, including direct medical costs (e.g., hospitalizations, physician’s visits, medications); costs of productivity loss (e.g., caregiver time lost from work or school due to illness); nonmedical direct costs
- Potential Cost Measures:
  - SHS-attributable fire-related and apartment renovation costs; implementation costs of smoke-free policies; costs borne by society (e.g., long-term care, copayments, other nonmedical direct expenses); intangible cost of SHS-exposure related health effects (e.g., pain and suffering)
Benefits Measures:
- Not available

Potential Benefits:
- Lower out-of-pocket expenditures for medical care; lower apartment clean-up costs; fewer productivity losses for employers and society

Location:
- United States

Models Used:
- Not available

Methods Used:
- The authors estimated the public health and economic burden of secondhand smoke (SHS) exposure for child and adult never smokers living in U.S. public housing using large-scale databases, including biomarker data. The authors — 1) estimated the public health burden attributable to SHS for health outcomes by calculating a population-attributable fraction using WHO estimates of relative risk; 2) estimated annual societal economic burdens for each health outcome using published estimates for direct medical costs, nonmedical care costs, and the value of lost productivity; and 3) estimated the public health and economic burden for two serum cotinine limits of detection.

Sources Used:
- 2009 National Youth Tobacco Survey; 2010 National Health Interview Survey; National Health and Nutrition Examination Survey (2007-2008, 2009-2010); Second-hand smoke: assessing the burden of disease at national and local levels (Öberg et al./WHO, 2010); a

Citation:

Pubmed:

DOI:

NIEHS Funding:
- Not available

Other Funding:
- Not available
Application of a cost-benefit analysis model to the use of flame retardants

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
</thead>
</table>

**Authors**
Mcnamee MS and Anderson P

**Journal**
Fire Technol

**Summary**
This study applied a fire cost-benefit analysis (CBA) model in different scenarios of a 2003-based case study in Sweden comparing television (TV) sets containing/not containing flame retardants. For all tested scenarios, the benefits of a high level of fire performance in a TV set far outweighed the costs associated with obtaining that high level of fire safety, where the net benefit ranged from $49 to $1073 million US dollars per year. This study is the first attempt to establish monetary costs and benefits associated with the use of flame retardants in televisions.

**Population**
Not available

**Health Outcomes**
- Not available

**Environmental Agents**

**List of Environmental Agents**
- Brominated compounds (polybrominated diphenyl ethers (PBDEs, e.g., decaBDE))

**Source of Environmental Agents**
- Flame retardants in television (TV) sets

**Economic Evaluation / Methods and Source**

**Type:**
- Cost-benefit analysis (CBA)

**Costs Measured:**
- Calculated incremental costs associated with an increase in fire safety via the fire cost-benefit analysis model by considering the following: cost difference between resins used for TV manufacture; costs of lives saved; costs associated with treatment of fire victim injuries; societal losses and costs associated with fire victim deaths; cost of flame retardants; cost of recycling; value of statistical life (VSL); average cost per fire; cost for house construction; health costs: costs associated with disposal or inclusion of products in fire

**Potential Cost Measures:**
- Absolute costs associated with flame or non-flame retarded products, such as: environmental or eco-toxicological costs; costs of raw materials for production; costs associated with use; transport costs; cost of fire-fighting; cost of post-fire clean-up; costs for replacement of destroyed or damaged equipment

**Benefits Measures:**
- Calculated incremental benefits associated with an increase in fire safety via the fire cost-benefit analysis
model by considering the following: lives saved through the avoidance of TV fires; avoided injuries; avoided house fires; avoided TV fires; capital costs through fires averted

Potential Benefits:
- Absolute benefits associated with flame or non-flame retarded products, such as: environmental or eco-toxicological benefits

Location:
- Sweden, European Union

Models Used:
- Authors developed the fire cost-benefit analysis (CBA) model (which is analogous to the fire life cycle assessment (LCA) model)

Methods Used:
- Authors performed a cost-benefit analysis of effects associated with exposure to flame retardants in TV sets and fires. The authors — 1) developed a fire cost-benefit analysis (CBA) model; 2) applied the fire CBA model to a 2003-based case study comparing cathode ray tube television (CRT TV) sets containing flame retardants in the outer enclosure compared to those that did not; 3) tested nine scenarios for the CRT TV set application of the fire CBA model; and 4) performed several calculations to show the influence of different input parameters on the benefits of house fires saved.

Sources Used:
- Civil Contingencies Agency Incident Database (IDA) (http://ida.msb.se/ida2#page=a0087); Televisions by country, CIA World Factbook, Dec. 2003 (http://www.nationmaster.com/graph/med_tel-media-televisions); Swedish Insurance Federation (http://www.svenskfo

Citation:
- Mcnamee MS and Anderson P 2015 Application of a cost-benefit analysis model to the use of flame retardants Fire Technol 51 1

Pubmed:

DOI:
- http://dx.doi.org/10.1007/s10694-014-0402-9

NIEHS Funding:
- Not available

Other Funding:
- Bromine Science and Environmental Forum (BSEF)
Factors influencing the acquisition and correct and consistent use of the top-lit updraft cookstove in Uganda

**Details**

**Authors**

**Journal**
J Health Commun

**Summary**
This study examined the effects of select behavior change interventions on the purchase and use of a top-lit updraft (TLUD) stove in Uganda, and assessed the commercial viability of the stove in the study area. The authors found that community cooking demonstrations, training, and promotion of stove use by village health teams were the most influential factors for purchase, correct, and consistent use of the TLUD, and that access to and cost of processed fuel were the greatest reported barriers. However, commercial viability analyses showed that the TLUD stove would not be commercially viable in Uganda, with or without microfinance. The authors concluded that the community engagement model could help facilitate increased acquisition and use of a lower cost stove technology with similar performance and behavior change barriers.

**Population**
Households with the top-lit updraft (TLUD) stove; men and women in study communities; village health team members and community sales agents

**Health Outcomes**
- Not available

**Environmental Agents**

**List of Environmental Agents**
- Not available

**Source of Environmental Agents**
- Not available

**Economic Evaluation / Methods and Source**

**Type:**

**Costs Measured:**
- Wholesale cost from manufacturer of top-lit updraft stove; general, sales, and administrative costs with direct sales efforts; ongoing operation costs after sales; opportunity cost to prepare wood; cost to purchase processed wood

**Potential Cost Measures:**
- Additional cost to the household of pre-processed wood

**Benefits Measures:**
- Not available
Potential Benefits:
- Not available

Location:
- Wakiso district in central Uganda

Models Used:
- AirFOAM framework

Methods Used:
- The authors examined the effects of select behavior change interventions on the purchase and correct and consistent use of a locally fabricated top-lit updraft (TLUD) stove in Uganda and also analyzed the commercial viability of the stove in the study area. The authors — 1) conducted formative research to inform and design behavior change interventions; 2) implemented behavior change interventions (e.g., community cooking demonstrations); 3) collected qualitative and quantitative data to understand effects of interventions on adoption and correct use of the TLUD stove; 4) used a Stove Use Monitoring System with temperature-logging sensors to assess TLUD usage; and 5) conducted commercial viability analysis at the end of the project, which included: a profit-and-loss analysis, analysis of unit sales, analysis of costs incurred, and a breakeven analysis for a scenario including microfinance.

Sources Used:
- Ugandan Bureau of Statistics (2010); Qualitative data collected from men and women in the village and from village health teams; Data on number of stoves sold collected from direct sales agents; Data generated from Stove Use Monitoring System to assess TLUD usage

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Diminishing returns or compounding benefits of air pollution control? The case of NOx and ozone

<table>
<thead>
<tr>
<th>Details</th>
<th>Research article</th>
<th>Cost-benefit analysis (CBA)</th>
</tr>
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**Authors**  
Pappin AJ, Mesbah SM, Hakami A, and Schott S

**Journal**  
Environ Sci Technol

**Summary**  
This cost-benefit analysis estimated the marginal benefits (MB) for nitrous oxides (NOx) emitted from mobile and point sources, and characterized these benefits based on estimated ozone-related premature mortality in the United States population. Results showed that nation-wide emission control in the United States significantly increased NOx MBs for all sources. These findings provide economic incentive for higher levels of abatement, and demonstrate a strictly concave damage function and compounding benefits of progressively lower levels of NOx emission. These findings suggest that the traditional perception of a convex damage function and decreasing MB with abatement may not hold true for secondary pollutants such as ozone.

**Population**  
Not available

**Health Outcomes**
- Mortality

**Environmental Agents**

**List of Environmental Agents**
- Air pollutants (ozone (O3), nitrogen oxides (NOx))

**Source of Environmental Agents**
- Mobile and point sources

**Economic Evaluation / Methods and Source**

**Type:**  
Cost-benefit analysis (CBA)

**Costs Measured:**  
- Mortalities cost resulting from acute exposure to ozone

**Potential Cost Measures:**  
- Cost of environmental impacts; health impacts from other NOx related air pollutants (NO2 and inorganic PM)

**Benefits Measures:**  
- Marginal benefits (MB) of averted mortality resulting from reduced short-term (acute) exposure to ozone
Potential Benefits:
- Marginal benefits (MB) of averted mortality resulting from reduced long-term exposure to ozone; MB of averted morbidity resulting from reduced short-term (acute) exposure to ozone; MB of nonfatal health impacts of ozone; MB of environmental impacts of ozone; impacts of reduced emissions generated within US and resulting public health impacts for other nations

Location:
- United States

Models Used:
- US EPA Community Multiscale Air Quality (CMAQ) model; Sparse Matrix Operator Kernel Emissions (SMOKE) model; Weather Research and Forecasting (WRF) model

Methods Used:
- Authors performed an air quality cost-benefit assessment related to emissions control for nitrogen oxides (NOx) with respect to ozone formation. The authors — 1) estimated marginal benefits (MB) for mobile and point sources using adjoint sensitivity analysis in a regional air quality model (CMAQ); 2) constructed MB curves for 1 ton of emitted NOx using various US wide emissions abatement scenarios; and 3) reported MBs for 1 ton of NOx emitted over the 2007 ozone season according to the spatiotemporal distribution of emissions for any given source location.

Sources Used:
- Ozone and short-term mortality in 95 US urban communities, 1987-2000 (Bell et al., 2004); US EPA, Guidelines for preparing economic analyses (2010); Source attribution of health benefits from air pollution abatement in Canada and the United States: an adj

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- Pappin AJ, Mesbah SM, Hakami A, and Schott S 2015 Diminishing returns or compounding benefits of air pollution control? The case of NOx and ozone Environ Sci Technol 49 16

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