Resource Pack:
Risk, Economics, and Decisions


Overview

This resource pack, curated by the Center for Health Decision Science, includes articles from the Risk Analysis special issue “Risk Assessment, Economic Evaluation, and Decisions” honoring Professor John Evans. The special issue was guest edited by CHDS’ Deputy Director Lisa A. Robinson and builds upon a 2019 workshop organized by Ms. Robinson and CHDS faculty James K. Hammitt.

Articles include:

- James K. Hammitt, Lisa A. Robinson. Introduction to Special Issue on Risk Assessment, Economic Evaluation, and Decisions
- Katherine von Stackelberg, Pamela R.D. Williams. Evolving Science and Practice of Risk Assessment
- Christoph M. Rheinberger. A Unified Probabilistic Framework for Cancer Risk Management
- Weihsueh A. Chiu, Greg M. Paoli. Recent Advances in Probabilistic Dose-Response Assessment to Inform Risk-Based Decision Making
- Jonathan I. Levy. Accounting for Health Risk Inequality in Regulatory Impact Analysis: Barriers and Opportunities
- Patrick L. Kinney. Long-Term Effects of Fine Particles on Mortality: Insights from 1984
- Olivier Jolliet, Lei Huang, Ping Hou, Peter Fantke. High Throughput Risk and Impact Screening of Chemicals in Consumer Products

• John S. Evans, Leonora Rojas-Bracho, James K. Hammitt, Douglas W. Dockery. *Mortality Benefits and Control Costs of Improving Air Quality in Mexico City: The Case of Heavy Duty Diesel Vehicles*

• Adam M. Finkel, George M. Gray. *The Pebble Remains in the Master's Hand: Two Careers Spent Learning (Still) from John Evans*

Another article from the workshop was published previously in *Risk Analysis*:

• James K Hammitt, Peter Morfeld, Jouni T Tuomisto, Thomas C Erren. *Premature Deaths, Statistical Lives, and Years of Life Lost: Identification, Quantification, and Valuation of Mortality Risks*

Other papers from the 2019 workshop have been published elsewhere or are available as working papers; view the complete list of papers here.
Selected Resources – At a Glance

**Article. Risk, Economics, and Decisions: Introduction**
Not Open Access

**Article. Profile of John Evans**
Not Open Access

**Article. Evolving Science and Practice of Risk Assessment**
Not Open Access

**Article. Probabilistic Framework for Cancer Risk Management**
Not Open Access

**Article. Advances in Probabilistic Dose-Response Assessment**
Not Open Access

**Article. Accounting for Health Risk Inequality**
Not Open Access

**Article. Long-Term Mortality Effects of Fine Particles**
Not Open Access

**Article. Risk Screening for Consumer Products**

**Article. Health Benefits of Air Quality Warnings**
Not Open Access

**Article. Reducing Diesel Air Pollution in Mexico City**
Article. Learning from John Evans
Not Open Access

Article. Premature Deaths, Statistical Lives, and Years of Life
Annotated Bibliography

Article. Risk, Economics, and Decisions: Introduction
Not Open Access
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3695
This article introduces the Risk Analysis special issue “Risk Assessment, Economic Evaluation, and Decisions.” It highlights core challenges associated with integrating risk assessment, economic evaluation, and uncertainty to inform policy decisions. The issue builds on a workshop convened to address these issues and to honor John S. Evans, whose thoughtful and innovative work has greatly benefitted the field.

Article. Profile of John Evans
Not Open Access
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3696
This profile discusses the career of Professor John Evans. It highlights his pioneering work in the fields of risk analysis, decision making, and uncertainty, his contributions to resolving many important environmental problems, and his major influence as a teacher and mentor.

Article. Evolving Science and Practice of Risk Assessment
Not Open Access
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3697
This article addresses the need to incorporate recent conceptual and technological developments in risk assessment into regulatory decision making. The authors argue that the typical “one chemical at a time” approach is inadequate to deal with the hundreds of thousands of chemicals in use and the reality that humans are exposed to many stressors throughout their lives. New concepts like the adverse outcome pathway, aggregate exposure pathway, exposome (total lifetime exposure), and sustainability offer the promise of better understanding the multifaceted effects of the environment on human health. These concepts may also help incorporate rich and voluminous data from new technologies such as high-throughput screening and biomonitoring into risk-based decision making.

Article. Probabilistic Framework for Cancer Risk Management
Not Open Access
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3698
This article presents a framework to integrate uncertainty and variability when estimating the effects of changes in exposure, fatal and nonfatal cancer risk, years of life lost or lived with disability, and the monetary value of the risk reduction. The author illustrates the framework by evaluating the benefits of an occupational exposure limit for hexavalent chromium. Skewness in individuals’ exposure and susceptibility means that a small fraction of affected workers receive substantial benefits from limiting exposures. Of the
third of all workers whose exposure exceeds the threshold, a small fraction would gain several years of life expectancy while 80 percent would gain less than 0.2 years.

**Article. Advances in Probabilistic Dose-Response Assessment**  
Not Open Access  
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3699  
This article describes a framework for characterizing the effects of chemical exposures on human health developed by the World Health Organization International Programme on Chemical Safety. The framework provides a method for developing families of exposure-response functions (with confidence limits) indexed alternatively by the magnitude or probability of an adverse health effect. These functions are constructed using existing data on safety thresholds, supplemented by preliminary default distributions for interspecies dose conversion, uncertainty factors, and variability in human susceptibility. The authors describe how these methods permit a cleaner separation of risk assessment and risk management, allowing risk assessors to describe the probabilities and magnitudes of predicted effects at different exposures (and uncertainty about them) and risk managers to make the required judgments about appropriate tradeoffs between risk attributes, control cost, and other factors.

**Article. Accounting for Health Risk Inequality**  
Not Open Access  
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3700  
This article describes the use of quantitative measures to characterize the effects of environmental regulation on social inequality and its relationship to concerns about environmental justice. The author describes the available measures and finds that inequality of exposure is more easily assessed than inequality of health effects, as the latter requires information about between-group differences in vulnerability. Inequality measures have been used in several case studies. These have shown that when interventions can be targeted to benefit the groups facing the largest risks, there may be no conflict between efficiency (maximizing population health) and equity (decreasing inequality). To date, inequality measures have not been incorporated in U.S. regulatory assessment, perhaps due to analysts’ lack of familiarity with the measures, lack of demand from decisionmakers, or a concern that the indicators do not adequately capture all the dimensions of concern to environmental justice.

**Article. Long-Term Mortality Effects of Fine Particles**  
Not Open Access  
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3701  
This article reassesses a paper by Evans, Tosteson, and Kinney (1984) that evaluated how much credibility to place on earlier cross-sectional estimates of the mortality effects of particulate air pollution. Recognizing that cross-sectional estimates (based on aggregate mortality and air pollution in different cities) are ecological regressions and hence susceptible to unmeasured individual-level confounders, the author argues that Evans et al. demonstrated that cross-sectional estimates are within about a factor of two of the more-credible estimates from later cohort studies. The author concludes that cross-sectional studies can provide
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Article. Risk Screening for Consumer Products
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3702
This article presents and applies a framework for screening health risks from the 80,000 chemicals contained in consumer products. The authors combine data from product sales, mass-balance-based exposure modeling, and dose-response functions based on chemical-specific toxicity data. They find that average daily exposures from common household products vary over six orders of magnitude. For a set of 5,500 chemical product combinations, doses range over nine orders of magnitude. Estimated risks are substantial for some household products, including paints, paint strippers, pesticides, cleaners, and leave-on cosmetic products, with lifetime cancer risks exceeding one in 10,000 for almost a tenth of product-chemical combinations. The authors conclude that screening chemicals based only on toxicity is inadequate. Exposures and risks vary over 10 orders of magnitude and provide a useful basis for setting priorities for further investigation.

Article. Health Benefits of Air Quality Warnings
Not Open Access
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3703
This article explores the benefits of decreased mortality risk that could result from air quality warnings in three locations. It focuses on decreasing outdoor activities on days when air pollution exceeds a health-based standard for individuals aged 65 and over (who are more susceptible to associated mortality risks and may have more flexibility to adjust their daily activities). Adopting generally conservative assumptions, the authors find the value of the mortality risk reduction from shifting activities to avoid a peak hour of outdoor exposure is unlikely to be greater than $14 per resident. Over a year, the total value could be on the order of $1,000 per resident in Los Angeles (Riverside), where air quality frequently violates regulatory standards, but on the order of only $100 or less in Denver and Pittsburgh, where standards are less-often violated.

Article. Reducing Diesel Air Pollution in Mexico City
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3704
This article assesses the benefits and costs of a policy to retrofit diesel trucks and buses in Mexico City with diesel-particulate filters or oxidation catalysts. The authors differentiate among 45 vehicle classes (defined by vehicle type and model year/emission controls) and finds that retrofitting some type of emission-control equipment is with high probability cost-beneficial for almost all vehicle classes. Because of differences in the number and emissions of different vehicle types, most of the total net benefits could be achieved by retrofitting only long-haul tractor trailers and local-use concession buses that jointly account for three-quarters of diesel-vehicle emissions in the airshed.
Article. Learning from John Evans
Not Open Access
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3705
This article highlights four persistent challenges to risk-based decision making that the authors explored as John Evans’ students:

1. the possible existence of unidentified thresholds in dose-response functions,
2. the lengthy process for establishing reference values for health effects with the result that such values exist for only a small fraction of chemicals used in commerce,
3. difficulty in communicating and decision making because of uncertainty about which of several possible models of the relationship between exposure and risk is most accurate, and
4. the limited use of value-of-information analysis to help decide whether (and for how long) to postpone a decision about how to manage a risk.

Article. Premature Deaths, Statistical Lives, and Years of Life Lost
CHDS repository link: https://repository.chds.hsph.harvard.edu/repository/3485
This article clarifies some misconceptions about mortality risk and economic valuation. The mortality effects of exposure to environmental hazards such as air pollution are often described by the estimated number of “premature deaths” and the economic value of an exposure reduction as the number of “statistical lives saved” multiplied by the “value per statistical life.” These terms can be misleading because the number of deaths advanced by exposure cannot be determined from mortality data; it could be that everyone who is exposed dies a little earlier than they would otherwise or that most are unaffected and only a small fraction die much earlier. Economic evaluation is not affected by this difficulty, although additional information about individual’s risks could affect the value.