

# **Evidence-Based Policy: What Constitutes Valid Evidence of Policy Effects?**

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SBCA

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# Evidence-based policy: Technical challenges

- What constitutes valid evidence?
- What are the right study designs and statistical analyses for producing and interpreting evidence about policy effects?
- What are common errors in interpreting evidence, and how can they be avoided?
- (Quick answer: Information-based causal analytics and valid quasi-experimental study designs)

# Example: Intervention study

## Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study

Luke Clancy, Pat Goodman, Hamish Sinclair, Douglas W Dockery

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### Summary

**Background** Particulate air pollution episodes have been associated with increased daily death. However, there is little direct evidence that diminished particulate air pollution concentrations would lead to reductions in death rates. We assessed the effect of air pollution controls—ie, the ban on coal sales—on particulate air pollution and death rates in Dublin.

**Methods** Concentrations of air pollution and directly-standardised non-trauma, respiratory, and cardiovascular death rates were compared for 72 months before and after the ban of coal sales in Dublin. The effect of the ban on age-standardised death rates was estimated with an interrupted time-series analysis, adjusting for weather, respiratory epidemics, and death rates in the rest of Ireland.

**Findings** Average black smoke concentrations in Dublin declined by 35.6  $\mu\text{g}/\text{m}^3$  (70%) after the ban on coal sales. Adjusted non-trauma death rates decreased by 5.7% (95% CI 4–7,  $p < 0.0001$ ), respiratory deaths by 15.5% (12–19,  $p < 0.0001$ ), and cardiovascular deaths by 10.3% (8–13,  $p < 0.0001$ ). Respiratory and cardiovascular standardised death rates fell coincident with the ban on coal sales. About 116 fewer respiratory deaths and 243 fewer cardiovascular deaths were seen per year in Dublin after the ban.

**Interpretation** Reductions in respiratory and cardiovascular death rates in Dublin suggest that control of particulate air pollution could substantially diminish daily death. The net benefit of the reduced death rate was greater than predicted from results of previous time-series studies.

*Lancet* 2002; **360**: 1210–14  
See Commentaries page 1184

### Introduction

Results of many epidemiological studies have suggested an association between particulate air pollution and daily deaths.<sup>1–3</sup> Despite these findings, it does not follow that a reduction in particulate air pollution would diminish daily deaths or increase life-expectancy.<sup>4</sup> Great improvements in air quality in Dublin after the introduction of domestic coal-burning regulations offered an opportunity to assess the effects of reduced particulate air pollution on death rates in the general population.

Dublin's air quality deteriorated in the 1980s after a switch from oil to cheaper and more readily available solid fuels, mainly bituminous coal for domestic space and water heating.<sup>5</sup> Periods of high air pollution were associated with increased in-hospital respiratory deaths.<sup>6</sup>

On Sept 1, 1990, the Irish Government banned the marketing, sale, and distribution of bituminous coals within the city of Dublin.<sup>7</sup> The effect of this intervention was an immediate and permanent reduction in average monthly particulate concentrations.<sup>8</sup> We assessed the effect of the ban of coal on death in Dublin.

### Methods

#### Procedures

We compared air pollution, weather, and deaths for 72 months before (Sept 1, 1984, to Aug 31, 1990) and after (Sept 1, 1990, to Aug 31, 1996) the ban, by seasons. We defined spring as March–May, summer as June–August, autumn as September–November, and winter as December–February. We calculated mean daily air pollution (black smoke and sulphur dioxide) concentrations with measurements from six residential monitoring stations in the city of Dublin (Dublin County Borough).<sup>8</sup> We obtained mean daily temperatures ( $^{\circ}\text{C}$ ) and mean daily relative humidity (%) from Dublin airport. We calculated the change in mean air pollution and weather variables

# Example: Intervention study

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## Effect of air-pollution control on death rates in Dublin, Ireland: an intervention study

In conclusion, the ban on coal sales within Dublin County Borough led to a substantial decrease in concentration of black smoke particulate air pollution. After adjustment for age-distribution of the population, known predictors of death (including temperature, humidity, and respiratory epidemics), and death rates in the rest of Ireland as an index of unmeasured secular changes in deaths, we estimated that there were about 243 fewer cardiovascular deaths and 116 fewer respiratory deaths per year in Dublin after the ban on coal sales. These changes were seen immediately in the winter after introduction of the ban. Our findings suggest that control of particulate air pollution in Dublin led to an immediate reduction in cardiovascular and respiratory deaths. These data lend support to a relation between cause and the reported increase in acute mortality associated with daily particulate air pollution. Moreover, our data suggest time-series studies could be underestimating the benefits of particulate air pollution controls.

By what test?

# The evidence

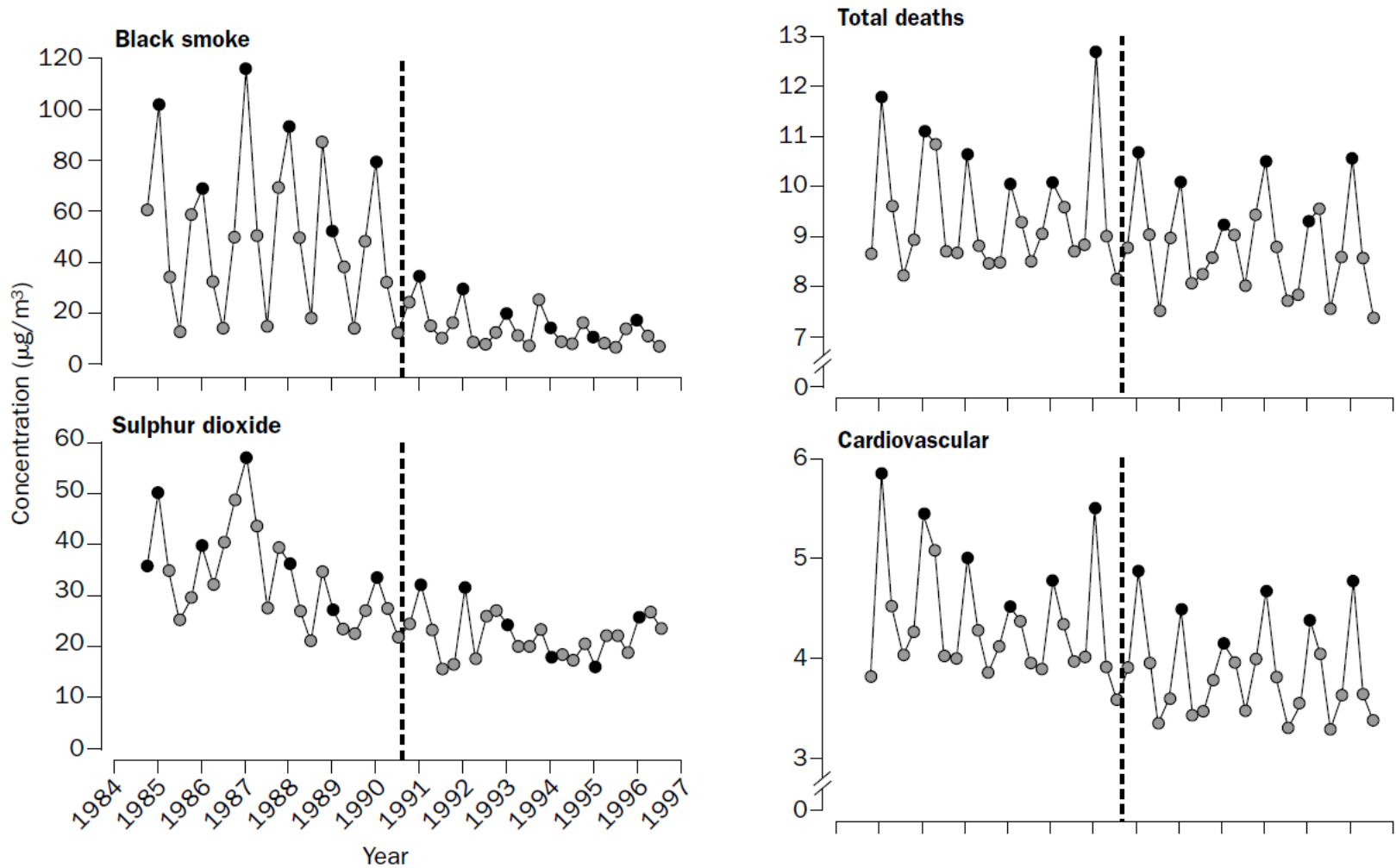


Figure 1: **Seasonal mean black smoke (upper) and sulphur dioxide (lower) concentrations, September 1984–96**

Vertical line shows date sale of coal was banned in Dublin County Borough. Black circles represent winter data.

# Interpretation 1 (Clancy et al., 2000)

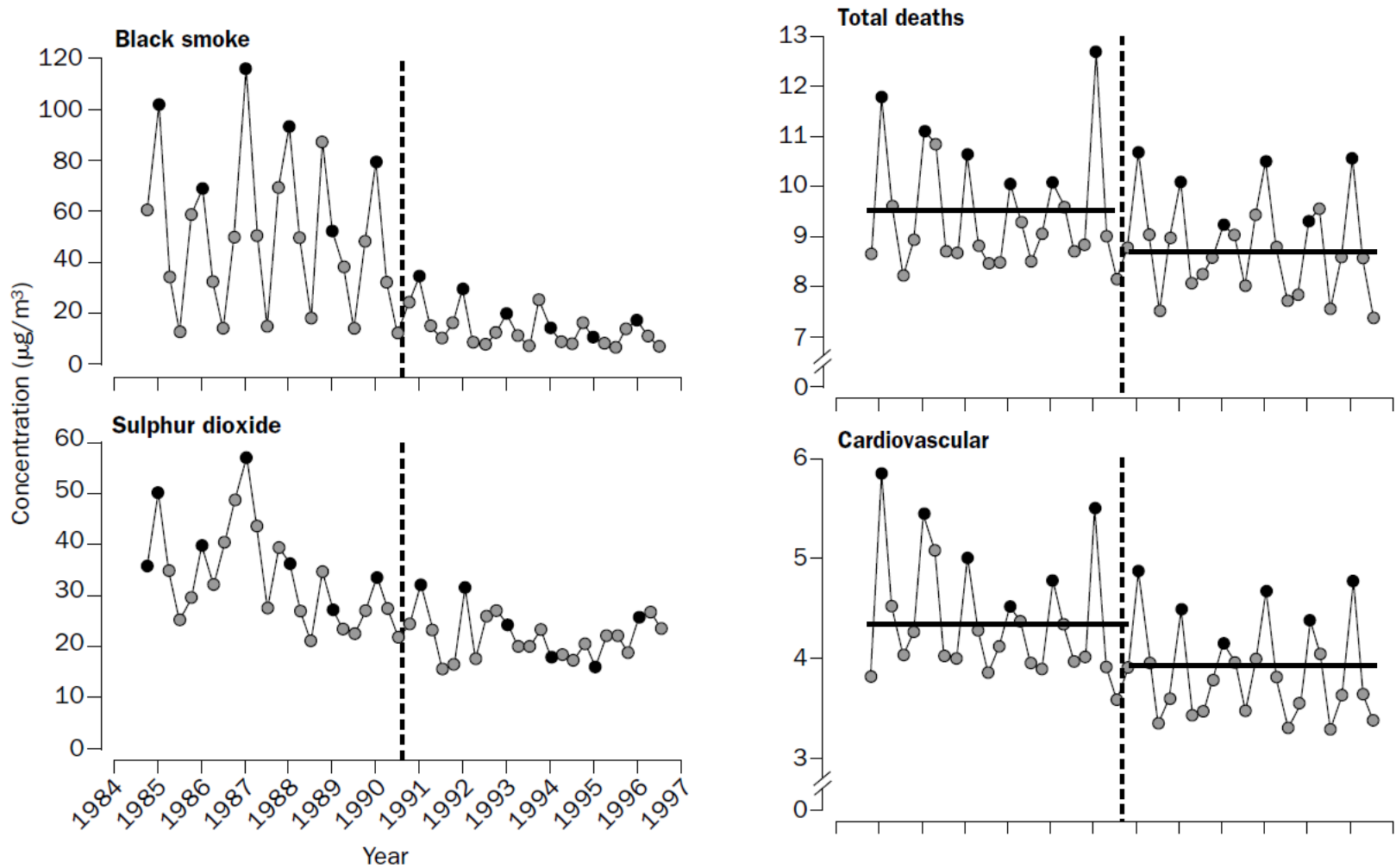


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“Adjusted non-trauma death rates decreased by 5.7% (95% CI 4-7,  $p < 0.0001$ )”

# Interpretation 2 (Wittmaack, 2007)

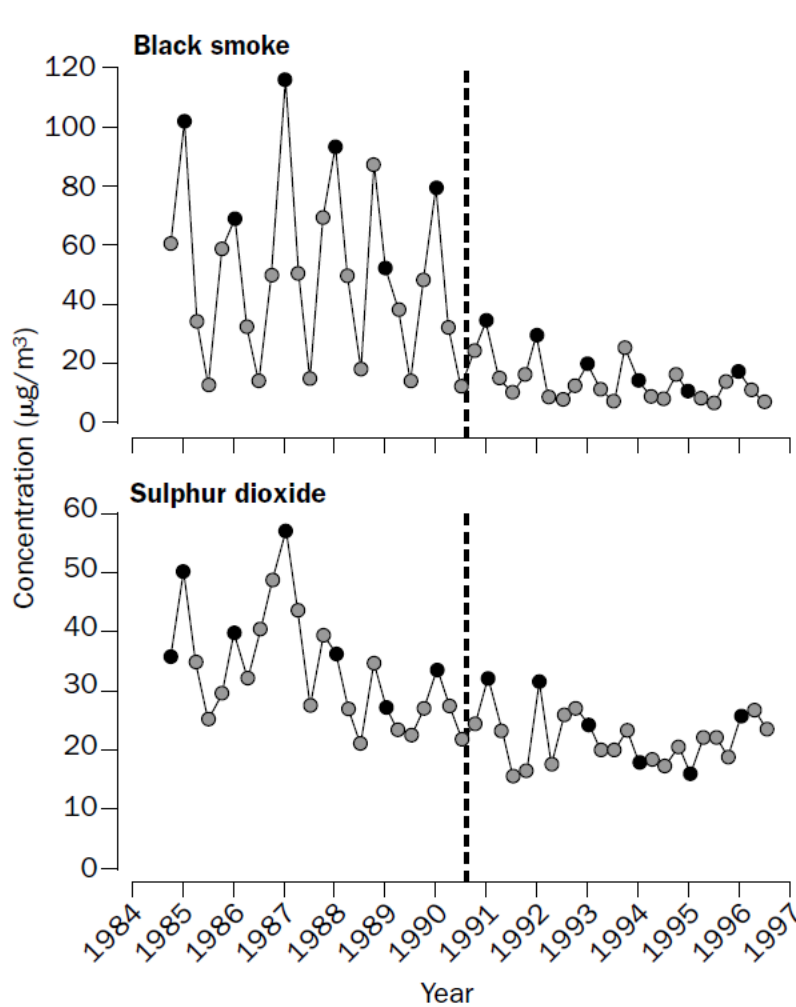
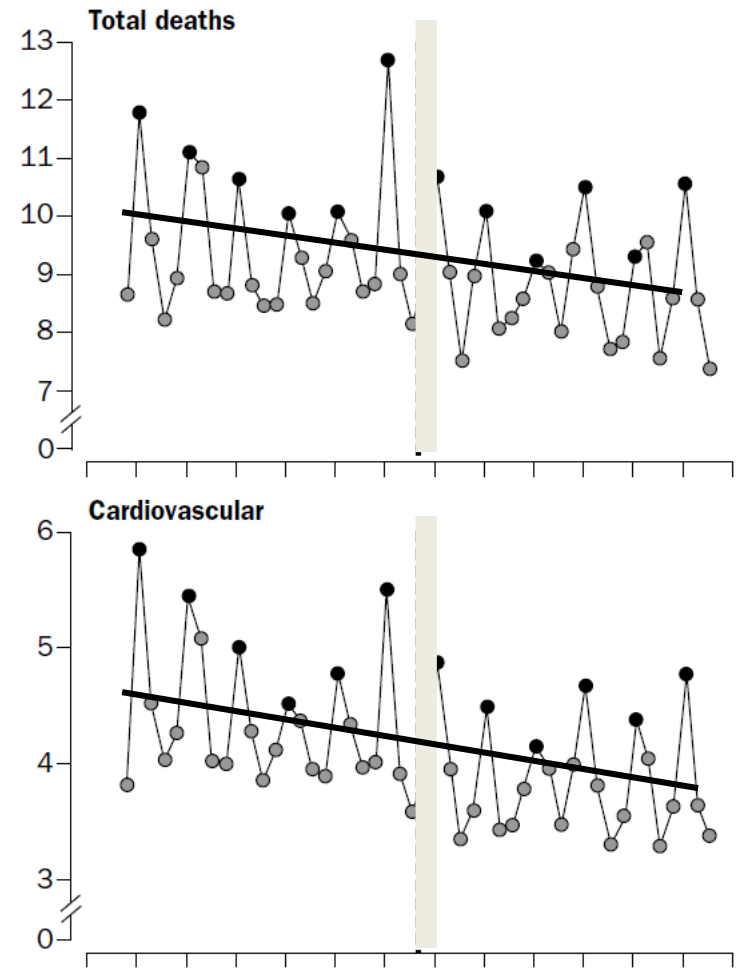


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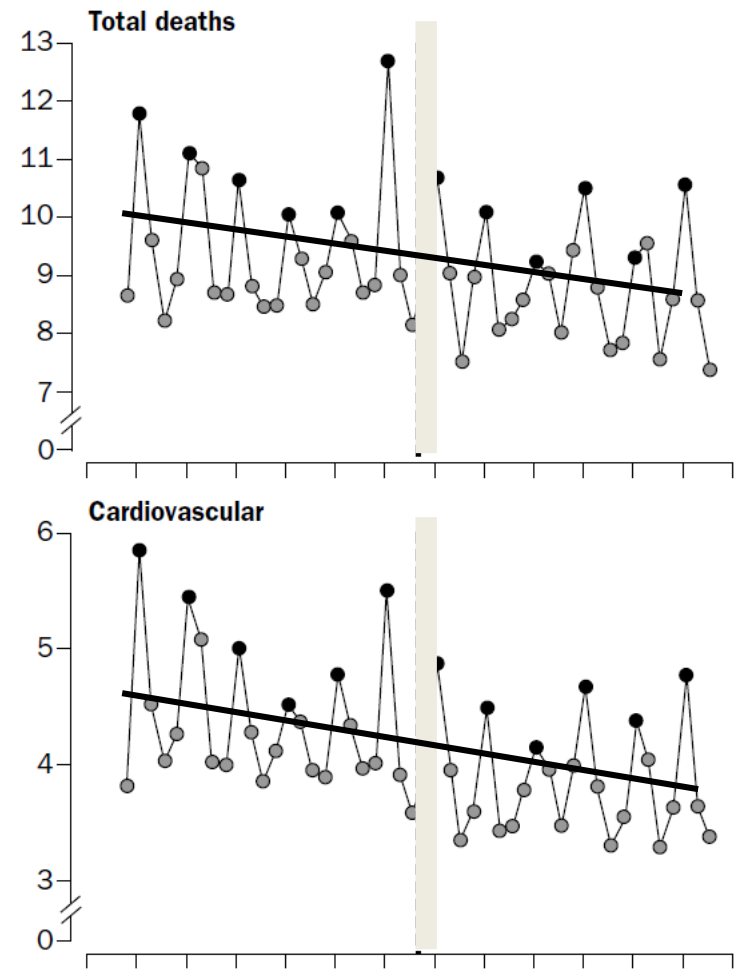


“No significant reduction was found in total death rates” (Dockery et al., 2013)



# How to interpret intervention studies?

- Informal causal conclusions have no known validity.
- Since 1960s, the “O X O” one-group pretest post-test quasi-experimental design has been cited as an example of a *design that is not valid* for causal inference
  - (Campbell & Stanley, 1963, p. 7)
  - No *control groups* outside the ban area
- Formal tests for predictive causality would have shown that *changes in exposure do not help to predict changes in mortality* (Wittmaack, 2007)



“No significant reduction was found in total death rates” (Dockery et al., 2013)



[Inhal Toxicol.](#) 2007 Apr;19(4):343-50.

**The big ban on bituminous coal sales revisited: serious epidemics and pronounced trends feign excess mortality previously attributed to heavy black-smoke exposure.**

[Wittmaack K.](#) SF-National Research Centre for Environment and Health, Institute of Radiation Protection, Neuherberg, Germany.

**Abstract**

The effect of banning bituminous coal sales on the black-smoke concentration and the mortality rates in Dublin, Ireland, has been analyzed recently. Based on the application of standard epidemiological procedures, the authors concluded that, as a result of the ban, the total nontrauma death rate was reduced strongly (-8.0% unadjusted, -5.7% adjusted). The purpose of this study was to reanalyze the original data with the aim of clarifying the three most important aspects of the study, (a) the effect of epidemics, (b) the **trends in mortality rates** due to advances in public health care, and (c) the correlation between mortality rates and black-smoke concentrations. Particular attention has been devoted to a detailed evaluation of the time dependence of mortality rates, stratified by season. Death rates were found to be strongly enhanced during three severe **pre-ban winter-spring epidemics**. The cardiovascular mortality rates exhibited a continuous decrease over the whole study period, in general accordance with trends in the rest of Ireland. These two effects can **fully account for the previously identified apparent correlation between reduced mortality and the very pronounced ban-related lowering of the black-smoke concentration**. The third important finding was that in nonepidemic pre-ban seasons **even large changes in the concentration of black smoke had no detectable effect on mortality rates**.

# Claimed health benefits vanish when control group information is used

[Res Rep Health Eff Inst.](#) 2013 Jul;(176):3-109.

**Effect of air pollution control on mortality and hospital admissions in Ireland.**

[Dockery DW<sup>1</sup>](#), [Rich DQ](#), [Goodman PG](#), [Clancy L](#), [Ohman-Strickland P](#), [George P](#), [Kotlov I](#); [HEI Health Review Committee](#).

## **Abstract**

During the 1980s the Republic of Ireland experienced repeated severe pollution episodes. Domestic coal burning was a major source of this pollution. In 1990 the Irish government introduced a ban on the marketing, sale, and distribution of coal in Dublin. The ban was extended to Cork in 1995 and to 10 other communities in 1998 and 2000. ... In comparisons with the pre-ban periods, **no significant reduction was found in total death rates** associated with the 1990 (1% reduction), 1995 (4% reduction), or 1998 (0% reduction) bans, nor for cardiovascular mortality (0%, 4%, and 1% reductions for the 1990, 1995, and 1998 bans, respectively). The successive coal bans resulted in immediate and sustained decreases in particulate concentrations ... but **no detectable improvement in cardiovascular mortality**.

# Different investigators interpret the same evidence very differently

Lessons from reducing air pollution, it can be done and it works!



Prof. Pat Goodman

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Europe day 13<sup>th</sup> June 2013

Helsinki

pat.goodman@dit.ie

# But interpretation of evidence is not necessarily driven by causality tests

- “Benefits of a smoky coal ban include **very significant reductions in respiratory problems and indeed mortalities** from the effects of burning smoky coal. The original ban in Dublin has been **cited widely as a successful policy intervention** and has become something of an icon of **best practice** within the international clean air community. ...
- **Research indicated that the ban in Dublin resulted in over 350 fewer annual deaths.** An estimate of these benefits in monetary terms put the value at over 20m euro.”
- “We intend to extend the health and environmental benefits of the ban on smoky coal, currently in place in our cities and large towns, **to the entire country.**”

[www.housing.gov.ie/environment/air-quality/coal/smoky-coal-ban](http://www.housing.gov.ie/environment/air-quality/coal/smoky-coal-ban), 2015

# Current perceptions in Ireland

## Fuel Regulations

The Air Pollution Act was introduced in 1987 and the Marketing, Sale and Distribution of Fuels Regulations came into force in September 1990. ...The introduction of natural gas combined with **the ban on the sale of smoky coal lead to a huge improvement in air quality and health in Dublin**. Subsequent regulations extended the ban to numerous cities including Cork, Limerick and Galway.

The Air Pollution Act (Marketing, Sale, Distribution and Burning of Specified Fuels) Regulations 2012 came into force nationally on 31 August 2012 following public consultation, making 7 new towns smokeless from May 2013, and making the burning of smoky coal an offence in smokeless areas

**If you witness the sale of smoky coal (Polish, Texan, Premium etc) in your area, please contact Dublin City Council** Customer Care with details of the vehicle, registration number, shop address etc. In addition, if your neighbour is causing a nuisance to you by burning smoky coal, please contact Dublin City Council to report the problem.

# How the coal ban dealt with Dublin's burning issue

The prohibition of 'smoky' coal in 1990 resulted in 350 fewer annual deaths in city

Sat, Sep 26, 2015, 01:00

[Olivia Kelly](#)

In September 1990, following a series of winters during which Dublin city was engulfed in thick black smog, a ban on the sale, marketing, and distribution of bituminous or "smoky" coal was introduced in Dublin.

The results were dramatic with the city's caustic winter air pollution disappearing almost immediately.

It has since been reckoned the prohibition **resulted in 350 fewer annual deaths in the capital.**



Mary Harney, who helped push through the ban on 'smoky coal' in Dublin in 1990. Photograph: Aidan Crawley

In monetary terms it has had an **estimated benefit of more than €20 million.**

Despite the clear causative link between household coal burning and smog,

there was strong resistance to the ban. Just one year previously [Fianna](#)

[Fáil](#) environment minister Pádraig Flynn had ruled out a ban, claiming it would hurt widows and old-age pensioners.

However later in 1989 he got a new junior minister in Progressive Democrat [Mary Harney](#), who was determined to see the ban through.

# Interpretation of “evidence” is not uniform

- Intervention studies such as the Dublin air ban study “have provided additional evidence of adverse human health effects of air pollution... How many other opportunities such as the Dublin coal ban (Clancy et al., 2002) are being missed?
  - Pope, 2009, “Evaluating the effectiveness of air quality regulations: A review of accountability studies and frameworks”
- Wittmaack, 2007: “The cardiovascular mortality rates exhibited a continuous decrease over the whole study period, in general accordance with trends in the rest of Ireland. ”



# Conclusions

- Sound interpretation of “evidence” of policy effects requires using sound causal analysis
- In current practice, interpretation is usually based on informal causal judgments
- Analyses showing that the data do not support a policy decision are widely ignored
  - Confirmation bias distorts perceived evidence
- To increase real benefits, evidence-based policy analysis must adopt study designs and analyses that support sound, formal causal analyses